



EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
24.04.2019 Bulletin 2019/17

(51) Int Cl.:
F28F 9/02 ^(2006.01) **F25B 39/00** ^(2006.01)
F28F 9/22 ^(2006.01)

(21) Application number: **17883828.0**

(86) International application number:
PCT/JP2017/044694

(22) Date of filing: **13.12.2017**

(87) International publication number:
WO 2018/116929 (28.06.2018 Gazette 2018/26)

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**
Designated Extension States:
BA ME
Designated Validation States:
MA MD TN

(72) Inventors:
• **TATENOI Hideaki**
Tokyo 108-8215 (JP)
• **AOKI Yasutaka**
Tokyo 108-8215 (JP)
• **KATSURAYAMA Yohei**
Tokyo 108-8215 (JP)
• **SAKAI Masayuki**
Tokyo 108-8215 (JP)

(30) Priority: **20.12.2016 JP 2016247153**

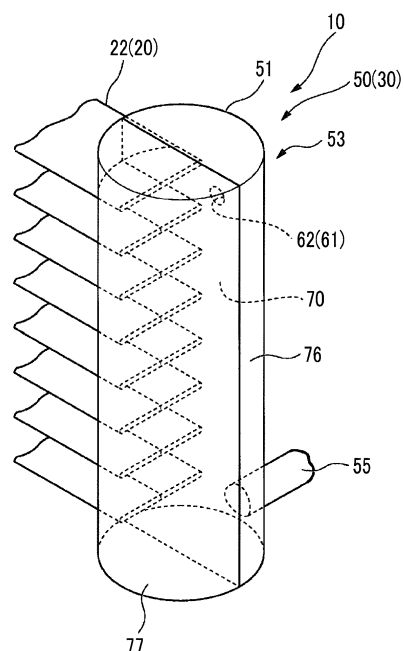
(74) Representative: **Henkel, Breuer & Partner**
Patentanwälte
Maximiliansplatz 21
80333 München (DE)

(71) Applicant: **Mitsubishi Heavy Industries Thermal
Systems, Ltd.**
Tokyo 108-8215 (JP)

(54) **HEAT EXCHANGER AND AIR CONDITIONER**

(57) This heat exchanger is provided with: a plurality of heat transfer pipes which extend horizontally, allow a refrigerant to flow therethrough, and are arranged at a distance from each other in the vertical direction; a header section which is pipe shaped, extends in the vertical direction, and has an internal space to which one end of each of the plurality of heat transfer pipes is connected in a communicating manner; a vertical partition plate which, in a horizontal cross-section, extends inside the header section between the inner peripheral surface of the header section and the heat transfer pipes, divides the inside of the header section into a first chamber and a second chamber, the first and second chambers being in communication with each of the heat transfer pipes, and has formed therein a first communication section for providing communication between the first chamber and the second chamber at a position higher than or equal to the height of the uppermost heat transfer pipe of the heat transfer pipes; and a flow path which is connected only to the first chamber of the first chamber and the second chamber and through which a refrigerant flows.

FIG. 3



Description

Technical Field

[0001] The present invention relates to a heat exchanger and an air conditioner.

[0002] This application claims priority based on Japanese Patent Application No. 2016-247153 filed on December 20, 2016, the contents of which are incorporated herein by reference.

Background Art

[0003] A heat exchanger, in which a plurality of heat transfer tubes extending in a horizontal direction are disposed at intervals in a vertical direction and a fin is provided on an outer surface of each heat transfer tube, is known as a heat exchanger of an air conditioner. Both ends of the plurality of heat transfer tubes are connected to a pair of headers extending in the vertical direction, respectively. Such a heat exchanger is configured such that a refrigerant, which is introduced into one header out of the pair of headers and has flowed in the other header via the heat transfer tubes, turns back at the other header to return to the one header again via the heat transfer tubes.

[0004] The inside of the header on a turnback side is formed by being partitioned into a plurality of regions with a partition plate partitioning the inside of the header in the vertical direction. Accordingly, a refrigerant introduced in one region of the header via the heat transfer tubes returns to one header on an entrance side via the plurality of heat transfer tubes connected to the other region after being introduced into the other region of the header via a connection pipe.

[0005] When the refrigerant turns back, a liquid phase refrigerant having a high specific gravity is likely to flow downwards, and a gas phase refrigerant having a low specific gravity is likely to flow upwards. For this reason, flow distortion occurs in the refrigerant flowing into each heat transfer tube.

[0006] For example, PTL 1 discloses that the inside of the header is divided by the partition plate into a heat transfer tube side space and a heat transfer tube opposite side space, the spaces are allowed to communicate with each other at an upper portion and a lower portion, and thus flow distortion of a refrigerant is suppressed.

Citation List

Patent Literature

[0007] [PTL 1] Japanese Unexamined Patent Application Publication No. 2015-68623

Summary of Invention

Technical Problem

[0008] Even when flow distortion of a refrigerant caused by liquid-gas separation between a liquid phase refrigerant and a gas phase refrigerant is suppressed, a difference in the flow rate of the refrigerant flowing into each heat transfer tube occurs at the time when the refrigerant flows from the lower portion in the header and rises in the header. In such a state, a heat transferring performance of the heat exchanger cannot be sufficiently used. In order to suppress a performance decrease of the heat exchanger, the flow rate of the refrigerant flowing into the heat transfer tubes is preferably uniformized in any heat transfer tube in the upper portion to the lower portion.

[0009] The present invention is devised in view of such problems, and an object thereof is to provide a heat exchanger which can suppress a performance decrease and an air conditioner in which the heat exchanger is used.

Solution to Problem

[0010] According to a first aspect of the present invention, there is provided a heat exchanger including a plurality of heat transfer tubes that extend in a horizontal direction to allow a refrigerant to flow therein and are arranged at intervals in a vertical direction, a header part that has a tubular shape extending in the vertical direction and has an internal space connected to one end of each of the plurality of heat transfer tubes in a communicating state, a vertical partition plate that extends from each of the heat transfer tubes to an inner peripheral surface of the header part, partitions an inside of the header part into a first chamber and a second chamber, each of which communicates with each of the heat transfer tubes, and has a first communication portion, which allows the first chamber and the second chamber to communicate with each other, at a position which is equal to or higher than a height of an uppermost heat transfer tube, out of the heat transfer tubes, in horizontal sectional view of the inside of the header part, and a flow passage that is connected to only the first chamber, out of the first chamber and the second chamber, and allows the refrigerant to flow therein.

[0011] In such a heat exchanger, a refrigerant is introduced into the first chamber in the header part via the flow passage in a case where the heat exchanger is used as an evaporator. Some of the refrigerant introduced in the first chamber is introduced into each of the heat transfer tubes. The refrigerant which is not introduced in the heat transfer tubes is introduced into the second chamber via the first communication portion formed in an upper portion of the vertical partition plate, and is introduced into each of the heat transfer tubes while moving downwards in the second chamber. Accordingly, even in a

case where the flow rate of a refrigerant is low, a decrease in the flow speed of the refrigerant moving in the first chamber can be suppressed, the amount of the refrigerant to be introduced into each of the heat transfer tubes connected to an upper portion or a middle portion in the header part is secured, and the occurrence of variations in the flow rate of a refrigerant flowing in each of the heat transfer tubes can be suppressed. In addition, in a case where the flow rate of a refrigerant is high, the refrigerant concentrates on an upper portion of the first chamber in some cases. However, the refrigerant is introduced into an upper portion of the second chamber via the first communication portion formed in the upper portion of the vertical partition plate, and is introduced into each of the heat transfer tubes while moving downwards in the second chamber. Therefore, the amount of the refrigerant to be introduced into each of the heat transfer tubes connected to a lower portion or the middle portion of the header part is secured, and the occurrence of variations in the flow rate of a refrigerant flowing in each of the heat transfer tubes can be suppressed as well without the refrigerant concentrating on the upper portion of the header part.

[0012] In the heat exchanger, the first communication portion may be a communication hole formed in the vertical partition plate.

[0013] In the heat exchanger, the first communication portion may be a gap between the vertical partition plate and an upper end of the header part.

[0014] In the heat exchanger, a second communication portion that allows the first chamber and the second chamber to communicate with each other may be formed in the vertical partition plate between the vertically nearby heat transfer tubes.

[0015] Accordingly, in a case where the heat exchanger is used as a condenser, a refrigerant is introduced from each of the heat transfer tubes into the first chamber and the second chamber in the header part, and the refrigerant introduced in the first chamber is introduced into the flow passage. After being introduced in the first chamber via the second communication portion formed in the vertical partition plate, the refrigerant introduced in the second chamber is introduced into the flow passage. Consequently, instead of the refrigerant introduced in the second chamber from each of the heat transfer tubes staying in the second chamber, the refrigerant can be introduced into the first chamber via the second communication portion, and can be introduced into the flow passage.

[0016] In the heat exchanger, a third communication portion that allows the first chamber and the second chamber to communicate with each other may be formed in the vertical partition plate at a position lower than a lowermost heat transfer tube, out of the heat transfer tubes.

[0017] Accordingly, in a case where the heat exchanger is used as a condenser, a refrigerant is introduced from each of the heat transfer tubes into the first chamber

and the second chamber in the header part, and the refrigerant introduced in the first chamber is introduced into the flow passage. After being introduced in the first chamber via the third communication portion formed in the vertical partition plate, the refrigerant introduced in the second chamber moves downwards in the second chamber and is introduced into the flow passage. Consequently, instead of the refrigerant introduced in the second chamber from each of the heat transfer tubes staying in the second chamber, the refrigerant can be introduced into the first chamber via the second communication portion, and can be introduced into the flow passage.

[0018] In the heat exchanger, a lower portion of the vertical partition plate may be bent from a second chamber side to a first chamber side, and the third communication portion may be a gap between the vertical partition plate and a lower end of the header part.

[0019] Accordingly, in a case where the heat exchanger is used as a condenser, a refrigerant is introduced from each of the heat transfer tubes into the first chamber and the second chamber in the header part, and the refrigerant introduced in the first chamber is introduced into the flow passage. After being introduced in the first chamber via the third communication portion formed in the vertical partition plate, the refrigerant introduced in the second chamber moves downwards in the second chamber and is introduced into the flow passage. Consequently, instead of the refrigerant introduced in the second chamber from each of the heat transfer tubes staying in the second chamber, the refrigerant can be introduced into the first chamber via the second communication portion, and can be introduced into the flow passage. In addition, since the lower portion of the vertical partition plate is bent to the second chamber side, the bent shape guides the flow of the refrigerant, and the refrigerant is likely to be introduced from the second chamber into the first chamber.

[0020] In the heat exchanger, a length L_p of each of the heat transfer tubes in the header part in an extending direction of the heat transfer tubes may be equal to or less than a half of an inner diameter D_i of the header part.

[0021] Accordingly, since the length of each of the heat transfer tubes in the header part is small in a case where the heat exchanger is used as an evaporator, a refrigerant in a gas-liquid two phase state which is introduced in the second chamber from the flow passage to the first chamber and then from the first chamber to the second chamber can suppress the turbulence of the flow of the refrigerant, which is caused by the refrigerant staying vertically between the respective heat transfer tubes in the first chamber and the second chamber, and a liquid phase refrigerant is likely to be introduced into each of the heat transfer tubes. Accordingly, the occurrence of variations in the flow rate of a refrigerant flowing in each of the heat transfer tubes can be further suppressed.

[0022] According to a second aspect of the present invention, there is provided an air conditioner including the heat exchanger according to any description made

above.

[0023] Accordingly, the occurrence of variations in the flow rate of a refrigerant flowing in each of the heat transfer tubes can be suppressed, and thus a decrease in a cooling and heating performance can be avoided.

Advantageous Effects of Invention

[0024] In the heat exchanger and the air conditioner described above, a performance decrease caused by the non-homogenization of flow rate of a refrigerant flowing in the plurality of heat transfer tubes can be suppressed.

Brief Description of Drawings

[0025]

Fig. 1 is an overall configuration view of an air conditioner according to a first embodiment of the present invention.

Fig. 2 is a longitudinal sectional view of a heat exchanger according to the first embodiment of the present invention.

Fig. 3 is a perspective view of the heat exchanger according to the first embodiment of the present invention.

Fig. 4 is a horizontal sectional view of a second header part of the heat exchanger according to the first embodiment of the present invention.

Fig. 5 is a view seen in a direction of an arrow A of Fig. 4.

Fig. 6 is a perspective view of a heat exchanger according to a modification example of the first embodiment of the present invention.

Fig. 7 is a horizontal sectional view of a second header part of the heat exchanger according to the modification example of the first embodiment of the present invention.

Fig. 8 is a view seen in a direction of an arrow B of Fig. 7.

Fig. 9 is a perspective view of a heat exchanger according to a second embodiment of the present invention.

Fig. 10 is a horizontal sectional view of a second header part of the heat exchanger according to the second embodiment of the present invention.

Fig. 11 is a view seen in a direction of an arrow C of Fig. 10.

Fig. 12 is a perspective view of a heat exchanger according to a modification example of the second embodiment of the present invention.

Fig. 13 is a horizontal sectional view of a second header part of the heat exchanger according to the modification example of the second embodiment of the present invention.

Fig. 14 is a view seen in a direction of an arrow D of Fig. 13.

Fig. 15 is a perspective view of a heat exchanger

according to a third embodiment of the present invention.

Fig. 16 is a horizontal sectional view of a second header part of the heat exchanger according to the third embodiment of the present invention.

Fig. 17 is a view seen in a direction of an arrow E of Fig. 16.

Fig. 18 is a perspective view of a heat exchanger according to a modification example of the third embodiment of the present invention.

Fig. 19 is a longitudinal sectional view of a second header part of the heat exchanger according to the modification example of the third embodiment of the present invention.

Fig. 20 is a view seen in a direction of an arrow F of Fig. 19.

Fig. 21 is a horizontal sectional view of a second header part of a heat exchanger according to a fourth embodiment of the present invention.

Description of Embodiments

[0026] Hereinafter, an air conditioner 1 including heat exchangers 10 according to a first embodiment of the present invention will be described with reference to Figs. 1 to 4.

[0027] As illustrated in Fig. 1, the air conditioner 1 includes a compressor 2, an indoor heat exchanger 3 (heat exchanger 10), an expansion valve 4, an outdoor heat exchanger 5 (heat exchanger 10), a four-way valve 6, and a pipe 7 that connects the configuration elements together, and a refrigerant circuit formed of the configuration elements is configured.

[0028] The compressor 2 compresses a refrigerant and supplies the compressed refrigerant to the refrigerant circuit.

[0029] The indoor heat exchanger 3 performs heat exchange between the refrigerant and indoor air. The indoor heat exchanger 3 is used as an evaporator to absorb heat from the inside during cooling operation, and is used as a condenser to radiate heat to the inside during heating operation. The outdoor heat exchanger 5 performs heat exchange between the refrigerant and outdoor air.

[0030] The expansion valve 4 reduces a pressure by expanding the high-pressure refrigerant liquefied by the condenser exchanging heat.

[0031] The outdoor heat exchanger 5 is used as a condenser to radiate heat to the outside during cooling operation and is used as an evaporator to absorb heat from the outside during heating operation.

[0032] The four-way valve 6 switches between directions where a refrigerant flows during heating operation and during cooling operation. Consequently, a refrigerant circulates in the compressor 2, the outdoor heat exchanger 5, the expansion valve 4, and the indoor heat exchanger 3 in this order during cooling operation. On the other hand, a refrigerant circulates in the compressor 2, the indoor heat exchanger 3, the expansion valve 4, and the

outdoor heat exchanger 5 in this order during heating operation.

[0033] Next, the heat exchangers 10 which are used as the indoor heat exchanger 3 and the outdoor heat exchanger 5 will be described with reference to Figs. 2 to 4.

[0034] As illustrated in Fig. 2, the heat exchangers 10 each include a plurality of heat transfer tubes 20, a plurality of fins 23, a pair of headers 30, and a connection pipe 55.

[0035] The heat transfer tubes 20 are tubular members linearly extending in a horizontal direction, and flow paths through which a refrigerant flows are formed therein. The plurality of heat transfer tubes 20 are arranged at intervals in a vertical direction, and are disposed so as to be parallel to each other.

[0036] In the embodiment, the heat transfer tubes 20 each have a flat tubular shape, and the plurality of flow paths arranged in the horizontal direction orthogonal to an extending direction of the heat transfer tubes 20 are formed inside the heat transfer tubes 20. The plurality of flow paths are arranged so as to be parallel to each other. Consequently, a sectional shape orthogonal to the extending direction of the heat transfer tubes 20 is a flat shape of which a longitudinal direction is the horizontal direction orthogonal to the extending direction of the heat transfer tubes 20.

[0037] The fins 23 each are disposed between the heat transfer tubes 20 arranged as described above, and extend in a so-called corrugated shape so as to be alternately in contact with the vertically nearby heat transfer tubes 20 as facing the extending direction of each of the heat transfer tubes 20 in the embodiment. Without being limited thereto, the shapes of the fins 23 may be any shape insofar as the fins are provided so as to protrude from outer peripheral surfaces of the heat transfer tubes 20.

[0038] At both ends of the plurality of heat transfer tubes 20, the pair of headers 30 is provided such that the heat transfer tubes 20 are sandwiched therebetween. One of the pair of headers 30 is set as an entrance side header 40, which is an entrance for a refrigerant from the outside to the heat exchanger 10. The other one of the pair of headers 30 is set as a turnback side header 50 for a refrigerant to turn back in the heat exchanger 10.

[0039] The entrance side header 40 is a cylindrical member extending in the vertical direction. An upper end and a lower end of the entrance side header are closed and the inside of the entrance side header is partitioned into two upper and lower regions with a partition plate. The lower region partitioned with an entry side partition plate 41 is set as a lower entry region 42. The upper region partitioned with the entry side partition plate 41 is set as an upper entry region 43. The lower entry region 42 and the upper entry region 43 are in a state of not communicating with each other in the entrance side header 40. The lower entry region 42 and the upper entry region 43 each are connected to the pipe 7 configuring

the refrigerant circuit.

[0040] Herein, out of the plurality of heat transfer tubes 20, the heat transfer tubes 20 connected to the lower entry region 42 in a communicating state are set as first heat transfer tubes 21. Out of the plurality of heat transfer tubes 20, the heat transfer tubes 20 connected to the upper entry region 43 in a communicating state are set as second heat transfer tubes 22 (heat transfer tubes 20).

[0041] The turnback side header 50 includes a header body 51, a turnback side partition plate 54, and a vertical partition plate 70.

[0042] The header body 51 is a cylindrical member extending in the vertical direction, and an upper end and a lower end of the header body are closed. The turnback side partition plate 54 is provided in the header body 51, and partitions a space in the header body 51 into two upper and lower regions. A lower portion of the turnback side partition plate 54 in the header body 51 is set as a first header part 52. An upper portion of the turnback side partition plate 54 in the header body 51 is set as a second header part 53 (header part). That is, in the embodiment, the first header part 52 and the second header part 53, each of which has a space therein, are formed in the turnback side header 50 by the inside of the header body 51 being partitioned with the turnback side partition plate 54. In other words, the turnback side header 50 is configured by the first header part 52 and the second header part 53.

[0043] The first heat transfer tubes 21 each are connected to one side of the first header part 52 in the horizontal direction so as to be in a communicating state with the inside of the first header part 52. The second heat transfer tubes 22 each are connected to one side of the second header part 53 in the horizontal direction so as to be in a communicating state with the inside of the second header part 53. In other words, the heat transfer tubes 20 connected to the first header part 52 are set as the first heat transfer tubes 21, and the heat transfer tubes 20 connected to the second header part 53 are set as the second heat transfer tubes 22.

[0044] As illustrated in Fig. 3, the vertical partition plate 70 is a plate-shaped member extending in the vertical direction, and is provided in the second header part 53. The vertical partition plate 70 partitions a space in the second header part 53 into two regions including a first chamber 76 and a second chamber 77 such that each of the first chamber and the second chamber communicates with each of the second heat transfer tubes 22, in horizontal sectional view. Specifically, the vertical partition plate 70 is mounted in a direction where the second heat transfer tubes 22 extend, in horizontal sectional view. The vertical partition plate 70 extends in the horizontal direction in the second header part 53. Accordingly, in the embodiment, one end on a second heat transfer tube side, out of both ends of the vertical partition plate 70 in the horizontal direction, is in contact with, out of the vertically nearby second heat transfer tubes 22, second heat transfer tubes at a portion where the first chamber

76 and the second chamber 77 are isolated from each other by the vertical partition plate 70 and each second heat transfer tube protrudes into the second header part 53. An opening of each of the second heat transfer tubes 22 is divided by one end of the vertical partition plate in the horizontal direction orthogonal to the extending direction of the second heat transfer tubes 22.

[0045] The connection pipe 55 is a tubular member in which a flow path is formed. One end of the connection pipe is connected to the first header part 52 in a communicating state with the inside of the first header part 52, and the other end is connected to the second header part 53 in a communicating state with the inside of the second header part 53. More specifically, one end of the connection pipe 55 is connected to a middle portion of the first header part 52 in the vertical direction. On the other hand, the other end of the connection pipe 55 is connected to a lower portion of the first chamber 76 of the second header part 53.

[0046] The flow path formed inside the connection pipe 55 is a flow passage 56 that allows a refrigerant to flow between the inside of the first header part 52 and the inside of the second header part 53.

[0047] Instead of using the connection pipe 55, the flow passage 56 may be formed in the turnback side partition plate 54 so as to directly communicate with the inside of the first header part 52 and the first chamber 76.

[0048] In the embodiment, the headers 30 each have a cylindrical shape extending in the vertical direction, and accordingly an internal space thereof also has a cylindrical shape. The vertical partition plate 70 is disposed in a diameter direction of the internal space of the second header part 53 having a cylindrical shape, in horizontal sectional view. Accordingly, each of the first chamber 76 and the second chamber 77 has a semicircular shape, in horizontal sectional view.

[0049] An upper communication hole 62 (first communication portion 61) that allows the first chamber 76 and the second chamber 77 to communicate with each other is formed in the vertical partition plate 70 by penetrating the vertical partition plate 70. Specifically, as illustrated in Fig. 5, the upper communication hole 62 is formed at the same position or a higher position as or than the height of a second header part uppermost heat transfer tube 24, which is a heat transfer tube positioned at an uppermost position out of the respective second heat transfer tubes 22. The upper communication hole 62 is formed at a position in front of a tip of each of the second heat transfer tubes 22, that is, on an opposite side to connecting portions between the second header part 53 and the second heat transfer tubes 22, in horizontal sectional view.

[0050] Next, operation and effects in a case where the heat exchanger 10 is used as an evaporator will be described.

[0051] In a case where the heat exchanger 10 is the indoor heat exchanger 3, the heat exchanger is used as an evaporator during cooling operation of the air condi-

tioner 1, and in a case where the heat exchanger is the outdoor heat exchanger 5, the heat exchanger is used as an evaporator during heating operation of the air conditioner 1.

[0052] When the heat exchanger 10 is used as an evaporator, a gas-liquid two phase refrigerant having a high liquid phase content is supplied from the pipe 7 to the lower entry region 42 of the entrance side header 40 illustrated in Fig. 2. The refrigerant is divided and supplied to the plurality of first heat transfer tubes 21 in the lower entry region 42, and exchanges heat with the external atmosphere of the first heat transfer tubes 21 in the process of flowing in the first heat transfer tubes 21, thereby causing evaporation. Consequently, the refrigerant supplied from the first heat transfer tubes 21 into the first header part 52 of the turnback side header 50 becomes a gas-liquid two phase refrigerant, in which the proportion of a liquid phase has dropped, by some of the refrigerant changing from a liquid phase to a gas phase.

[0053] As illustrated in Figs. 2 and 3, the refrigerant in a gas-liquid two phase state supplied into the first header part 52 is introduced into the connection pipe 55 connected to the first header part 52, and is introduced into the first chamber 76 in the second header part 53 via the connection pipe 55.

[0054] The refrigerant introduced in the first chamber 76 moves upwards in turn in the first chamber 76 as the refrigerant continues to be supplied, and is introduced into each of the second heat transfer tubes 22. The refrigerant which is not introduced in the second heat transfer tubes 22 is introduced into an upper portion of the second chamber 77 via the upper communication hole 62 formed in an upper portion of the vertical partition plate 70. The refrigerant introduced in the upper portion of the second chamber 77 is introduced into each of the second heat transfer tubes 22 while moving downwards in the second chamber 77.

[0055] Herein, since the second header part 53 is divided into the first chamber 76 and the second chamber 77 by the vertical partition plate 70, the sectional area of a refrigerant flow path of the first chamber 76 is smaller than the sectional area of the entire second header part 53. For this reason, even in a case where the flow rate of a refrigerant is low, a decrease in the flow speed of the refrigerant moving upwards in the first chamber 76 can be suppressed, the amount of the refrigerant to be introduced into each of the second heat transfer tubes 22 connected to an upper portion or a middle portion in the second header part 53 is secured, and the occurrence of variations in the flow rate of a refrigerant flowing in each of the second heat transfer tubes 22 can be suppressed. In addition, in a case where the flow rate of a refrigerant is remarkably high, the refrigerant concentrates on an upper portion of the first chamber 76 in some cases. However, the refrigerant is introduced into the upper portion of the second chamber 77 via the upper communication hole 62 formed in the upper portion of the vertical partition plate 70, and is introduced into each of

the second heat transfer tubes 22 while moving downwards in the second chamber 77. Therefore, the amount of the refrigerant to be introduced into each of the second heat transfer tubes 22 connected to a lower portion or the middle portion of the second header part 53 is secured, and the occurrence of variations in the flow rate of the refrigerant flowing in each of the second heat transfer tubes 22 can be suppressed as well without the refrigerant concentrating on the upper portion of the second header part 53.

[0056] Then, the refrigerant again causes evaporation by exchanging heat with the external atmosphere of the second heat transfer tubes 22 in the process of flowing in the second heat transfer tubes 22.

[0057] Consequently, in the second heat transfer tubes 22, the remaining liquid phase in the refrigerant changes to the gas phase and thus the refrigerant in a gas phase state is supplied to the upper entry region 43 of the entrance side header 40. Then, the refrigerant is introduced from the upper entry region 43 to the pipe 7, thereby circulating in the refrigerant circuit.

[0058] As described above, in the heat exchangers 10 of the embodiment, even in a case where the flow rate of a refrigerant supplied to the second header part 53 is low or high, the occurrence of variations in the amount of the refrigerant to be introduced into each of the second heat transfer tubes 22 can be suppressed, and a performance decrease of the heat exchangers caused by a deviation of the flow rate of the refrigerant flowing into the heat transfer tubes can be suppressed. As a consequence, a cooling performance and a heating performance are not impaired in the air conditioner in which the heat exchangers 10 of the embodiment are used.

[0059] Instead of forming the upper communication hole 62 in the vertical partition plate 70, as a modification example of the first embodiment, for example, the height of the vertical partition plate 70 may be set to the same height as that of the second header part uppermost heat transfer tube 24 or a height between the second header part uppermost heat transfer tube 24 and an upper end of the second header part 53 as illustrated in Figs. 6, 7, and 8. In this case, a gap is formed between the vertical partition plate 70 and the second header part 53, and the gap becomes an upper communication portion 63 (first communication portion 61) that allows the first chamber 76 and the second chamber 77 to communicate with each other.

[0060] Accordingly, a refrigerant introduced in the first chamber 76 moves upwards in turn in the first chamber 76 as the refrigerant continues to be supplied, and is introduced into each of the second heat transfer tubes 22. The refrigerant which is not introduced in each of the second heat transfer tubes 22 from the first chamber 76 is introduced into the upper portion of the second chamber 77 via the upper communication portion 63 formed in the upper portion of the vertical partition plate 70, and is introduced into each of the second heat transfer tubes 22 while moving downwards in the second chamber.

Therefore, the occurrence of variations in the amount of the refrigerant to be introduced into each of the second heat transfer tubes 22 can be suppressed as in the description above.

[0061] Next, a heat exchanger 80 according to a second embodiment of the present invention will be described with reference to Figs. 9, 10, and 11. In the second embodiment, the same configuration elements as the first embodiment will be assigned with the same reference signs as the first embodiment, and the detailed description thereof will be omitted.

[0062] As illustrated in Figs. 9, 10, and 11, as in the first embodiment, a vertical partition plate 71 of the heat exchanger 80 of the second embodiment is disposed in the diameter direction of the internal space of the second header part 53 having a cylindrical shape, in horizontal sectional view. The same upper communication hole 62 as in the first embodiment is formed in the vertical partition plate 71. In the embodiment, the length of the vertical partition plate 71 in the horizontal direction is from each of the positions of tips of the second heat transfer tubes 22 to an inner peripheral surface of the second header part 53. In upper and lower portions of each of the second heat transfer tubes 22 in the second header part 53, there is no vertical partition plate 71, and thus, a heat transfer tube side communication portion 65 (second communication portion 64) that allows the first chamber 76 and the second chamber 77 to communicate with each other is formed.

[0063] Next, operation and effects in a case where the heat exchanger 80 is used as a condenser will be described.

[0064] When the heat exchanger 80 operates as a condenser during cooling operation of the air conditioner 1, a refrigerant is introduced from each of the second heat transfer tubes 22 into the first chamber 76 and the second chamber 77 in the second header part 53, contrary to a case where the heat exchanger is used as an evaporator. The refrigerant introduced in the first chamber 76 moves downwards in the first chamber 76, and is introduced into the first header part 52 via the connection pipe 55. After being introduced in the first chamber 76 via the heat transfer tube side communication portion 65 formed in the vertical partition plate 71, the refrigerant introduced in the second chamber 77 is introduced into the first header part 52 via the connection pipe 55.

[0065] As described above, the same as the first embodiment applies in a case where the heat exchanger 80 of the embodiment operates as an evaporator. However, in a case of operating as a condenser, a refrigerant can be introduced into the first chamber 76 via the heat transfer tube side communication portion 65 formed in the vertical partition plate 71, and can be introduced into the first header part via the connection pipe 55 connected to the lower portion of the first chamber 76, instead of the refrigerant introduced in the second chamber 77 from each of the second heat transfer tubes 22 staying in the second chamber 77. As a consequence, a cooling per-

formance and a heating performance are not impaired in the air conditioner in which the heat exchanger 80 of the embodiment is used.

[0066] As a modification example of the second embodiment, for example, the first chamber 76 and the second chamber 77 may be allowed to communicate with each other by a heat transfer tube side communication hole 66 (second communication portion 64) being formed in the vertical partition plate 71 at a portion vertically corresponding to each of the second heat transfer tubes 22 as illustrated in Figs. 12, 13, and 14 although the length of the vertical partition plate 71 in the horizontal direction is the same as in the first embodiment. Accordingly, instead of a refrigerant introduced in the second chamber 77 from each of the second heat transfer tubes 22 staying in the second chamber 77, the refrigerant can be introduced into the first chamber 76 via the heat transfer tube side communication holes 66 formed in the vertical partition plate 71, and can be introduced into the first header part via the connection pipe 55 connected to the lower portion of the first chamber 76. As a consequence, a cooling performance and a heating performance are not impaired in the air conditioner in which the heat exchanger 80 of the embodiment is used.

[0067] Next, a heat exchanger 90 according to a third embodiment of the present invention will be described with reference to Figs. 15, 16, and 17. In the third embodiment, the same configuration elements as the first embodiment will be assigned with the same reference signs as the first embodiment, and the detailed description thereof will be omitted.

[0068] As illustrated in Figs. 15, 16, and 17, as in the first embodiment, a vertical partition plate 72 of the heat exchanger 90 of the third embodiment is disposed along the diameter direction of the internal space of the second header part 53 having a cylindrical shape, in horizontal sectional view, and the upper communication hole 62 that is the same as in the first embodiment is formed therein. In the embodiment, a lower communication hole 68 (third communication portion 67) that allows the first chamber 76 and the second chamber 77 to communicate with each other is formed in the vertical partition plate 72 at a position lower than a second header part lowermost heat transfer tube 25, which is a heat transfer tube positioned at a lowermost position out of the respective second heat transfer tubes 22. In addition, the lower communication hole 68 is formed at a position in front of the tip of each of the second heat transfer tubes 22, that is, on the opposite side to the connecting portions between the second header part 53 and the second heat transfer tubes 22, in horizontal sectional view.

[0069] Next, operation and effects in a case where the heat exchanger 90 is used as a condenser will be described.

[0070] When the heat exchanger 90 operates as a condenser during cooling operation of the air conditioner 1, a refrigerant is introduced from each of the second heat transfer tubes 22 into the first chamber 76 and the second

chamber 77 in the second header part 53, contrary to a case where the heat exchanger is used as an evaporator. The refrigerant introduced in the first chamber 76 moves downwards in the first chamber 76, and is introduced into the first header part 52 via the connection pipe 55. The refrigerant introduced in the second chamber 77 moves downwards in the second chamber 77. Then, the refrigerant is introduced into the first header part 52 via the connection pipe 55 after being introduced in the first chamber 76 via the lower communication hole 68 formed in the vertical partition plate 72.

[0071] As described above, the same as the first embodiment applies in a case where the heat exchanger 90 of the embodiment operates as an evaporator. However, in a case of operating as a condenser, a refrigerant can be introduced into the first chamber 76 via the lower communication hole 68 formed in the vertical partition plate 72, and can be introduced into the first header part via the connection pipe 55 connected to the lower portion of the first chamber 76, instead of the refrigerant introduced in the second chamber 77 from each of the second heat transfer tubes 22 staying in the second chamber 77. As a consequence, a cooling performance and a heating performance are not impaired in the air conditioner in which the heat exchanger 90 of the embodiment is used.

[0072] As a modification example of the third embodiment, for example, a lower communication portion 69 (third communication portion 67) that bends a lower portion of the vertical partition plate 72 to a first chamber 76 side and allows the first chamber 76 and the second chamber 77 to communicate with each other under the second header part lowermost heat transfer tube 25 may be formed as illustrated in Figs. 18, 19, and 20. In this case, the lower communication portion 69 is formed as a gap between a lower end of the vertical partition plate 72 and a lower end of the second header part 53. Accordingly, instead of a refrigerant introduced in the second chamber 77 from each of the second heat transfer tubes 22 staying in the second chamber 77, the refrigerant can be introduced into the first chamber 76 via the lower communication portion 69 formed in the vertical partition plate 72, and can be introduced into the first header part via the connection pipe 55 connected to the lower portion of the first chamber 76. In addition, since the lower portion of the vertical partition plate 72 is bent to a second chamber 77 side, the bent shape guides the flow of the refrigerant, and the refrigerant is likely to be introduced from the second chamber 77 into the first chamber 76. As a consequence, a cooling performance and a heating performance are not impaired in the air conditioner in which the heat exchanger 90 of the embodiment is used.

[0073] In the third embodiment, the second communication portion 64 described in the second embodiment may be provided.

[0074] Next, a heat exchanger 100 according to a fourth embodiment of the present invention will be described with reference to Fig. 21. In the fourth embodi-

ment, a vertical partition plate has a configuration which is the same as that of any one of the first embodiment to the third embodiment. In the embodiment, a configuration which is the same as the vertical partition plate 70 of the first embodiment will be described. The same configuration elements as the first embodiment will be assigned with the same reference signs as the first embodiment, and the detailed description thereof will be omitted.

[0075] As illustrated in Fig. 21, in the heat exchanger 100 of the fourth embodiment, a length L_p of each of the second heat transfer tubes 22 in the second header part 53 in the extending direction of the second heat transfer tubes 22 is equal to or less than the half of an inner diameter D_i of the second header part 53. That is, the position of the tip of each of the second heat transfer tubes 22 is the same as the center position of the second header part 53 or is on a side closer to the connecting portions between the second header part 53 and the second heat transfer tubes 22 than the center of the second header part 53.

[0076] Since the length of each of the second heat transfer tubes 22 in the second header part 53 is small in a case where such a heat exchanger 100 operates as an evaporator, a refrigerant in a gas-liquid two phase state which is introduced in the second chamber 77 from the connection pipe 55 to the first chamber 76 and then from the first chamber 76 to the upper communication hole 62 can suppress the turbulence of the flow of the refrigerant, which is caused by the refrigerant staying in vertically between the respective second heat transfer tubes 22 in the first chamber 76 and the second chamber 77, and a liquid phase refrigerant is likely to be introduced into each second heat transfer tube. Accordingly, the occurrence of variations in the flow rate of a refrigerant flowing in each of the second heat transfer tubes 22 can be further suppressed.

[0077] Consequently, in each of the second heat transfer tubes 22, the remaining liquid phase refrigerant changes to a gas phase refrigerant and thus the refrigerant in a gas phase state is supplied to the upper entry region 43 of the entrance side header 40. Then, the refrigerant is introduced from the upper entry region 43 to the pipe 7, thereby circulating in the refrigerant circuit.

[0078] Although the embodiments of the present invention are described, the present invention is not limited thereto, and can be modified as appropriate without departing from the technical scope of the invention.

Industrial Applicability

[0079] In the heat exchanger and the air conditioner described above, a performance decrease caused by the non-homogenization of flow rate of a refrigerant flowing in the plurality of heat transfer tubes can be suppressed.

Reference Signs List

[0080]

- 1: air conditioner
- 2: compressor
- 3: indoor heat exchanger
- 4: expansion valve
- 5 5: outdoor heat exchanger
- 6: four-way valve
- 7: pipe
- 10: heat exchanger
- 20: heat transfer tube
- 10 21: first heat transfer tube
- 22: second heat transfer tube
- 23: fin
- 24: second header part uppermost heat transfer tube
- 25: second header part lowermost heat transfer tube
- 15 30: header
- 40: entrance side header
- 41: entry side partition plate
- 42: lower entry region
- 43: upper entry region
- 20 50: turnback side header
- 51: header body
- 52: first header part
- 53: second header part
- 54: turnback side partition plate
- 25 55: connection pipe
- 56: flow passage
- 61: first communication portion
- 62: upper communication hole
- 63: upper communication portion
- 30 64: second communication portion
- 65: heat transfer tube side communication portion
- 66: heat transfer tube side communication hole

35 Claims

1. A heat exchanger comprising:

- a plurality of heat transfer tubes that extend in a horizontal direction to allow a refrigerant to flow therein and are arranged at intervals in a vertical direction;
- a header part that has a tubular shape extending in the vertical direction and has an internal space connected to one end of each of the plurality of heat transfer tubes in a communicating state;
- a vertical partition plate that extends from each of the heat transfer tubes to an inner peripheral surface of the header part, partitions an inside of the header part into a first chamber and a second chamber, each of which communicates with each of the heat transfer tubes, and has a first communication portion, which allows the first chamber and the second chamber to communicate with each other, at a position which is equal to or higher than a height of an uppermost heat transfer tube, out of the heat transfer tubes, in horizontal sectional view of the inside of the

header part; and
 a flow passage that is connected to only the first
 chamber, out of the first chamber and the sec-
 ond chamber, and allows the refrigerant to flow
 therein.

5

2. The heat exchanger according to Claim 1,
 wherein the first communication portion is a commu-
 nication hole formed in the vertical partition plate. 10
3. The heat exchanger according to Claim 1,
 wherein the first communication portion is a gap be-
 tween the vertical partition plate and an upper end
 of the header part. 15
4. The heat exchanger according to any one of Claims
 1 to 3,
 wherein a second communication portion that allows
 the first chamber and the second chamber to com-
 municate with each other is formed in the vertical 20
 partition plate between the vertically nearby heat
 transfer tubes.
5. The heat exchanger according to any one of Claims
 1 to 4, 25
 wherein a third communication portion that allows
 the first chamber and the second chamber to com-
 municate with each other is formed in the vertical
 partition plate at a position lower than a lowermost
 heat transfer tube, out of the heat transfer tubes. 30
6. The heat exchanger according to Claim 5,
 wherein a lower portion of the vertical partition plate
 is bent from a second chamber side to a first chamber
 side, and 35
 the third communication portion is a gap between
 the vertical partition plate and a lower end of the
 header part.
7. The heat exchanger according to any one of Claims 40
 1 to 6,
 wherein a length L_p of each of the heat transfer tubes
 in the header part in an extending direction of the
 heat transfer tubes is equal to or less than a half of
 an inner diameter D_i of the header part. 45
8. An air conditioner comprising the heat exchanger
 according to any one of Claims 1 to 7.

50

55

FIG. 1

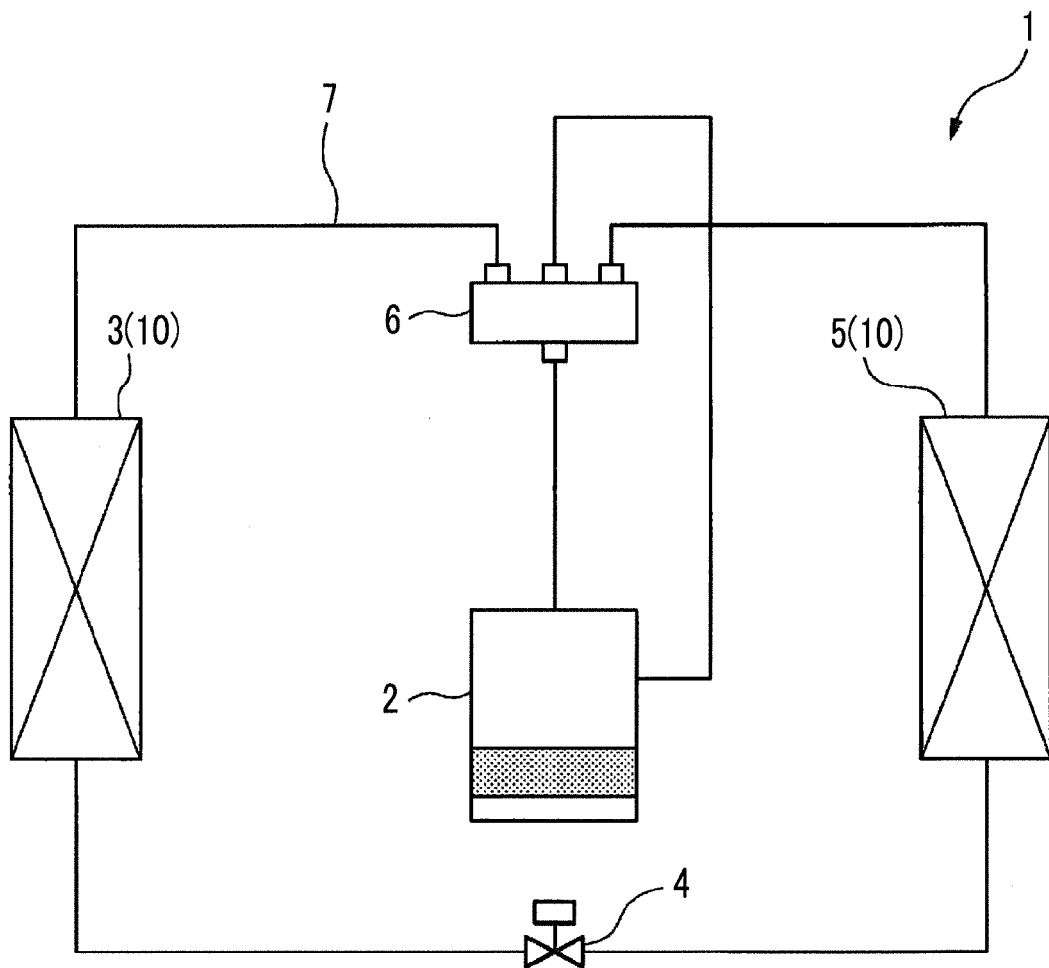


FIG. 2

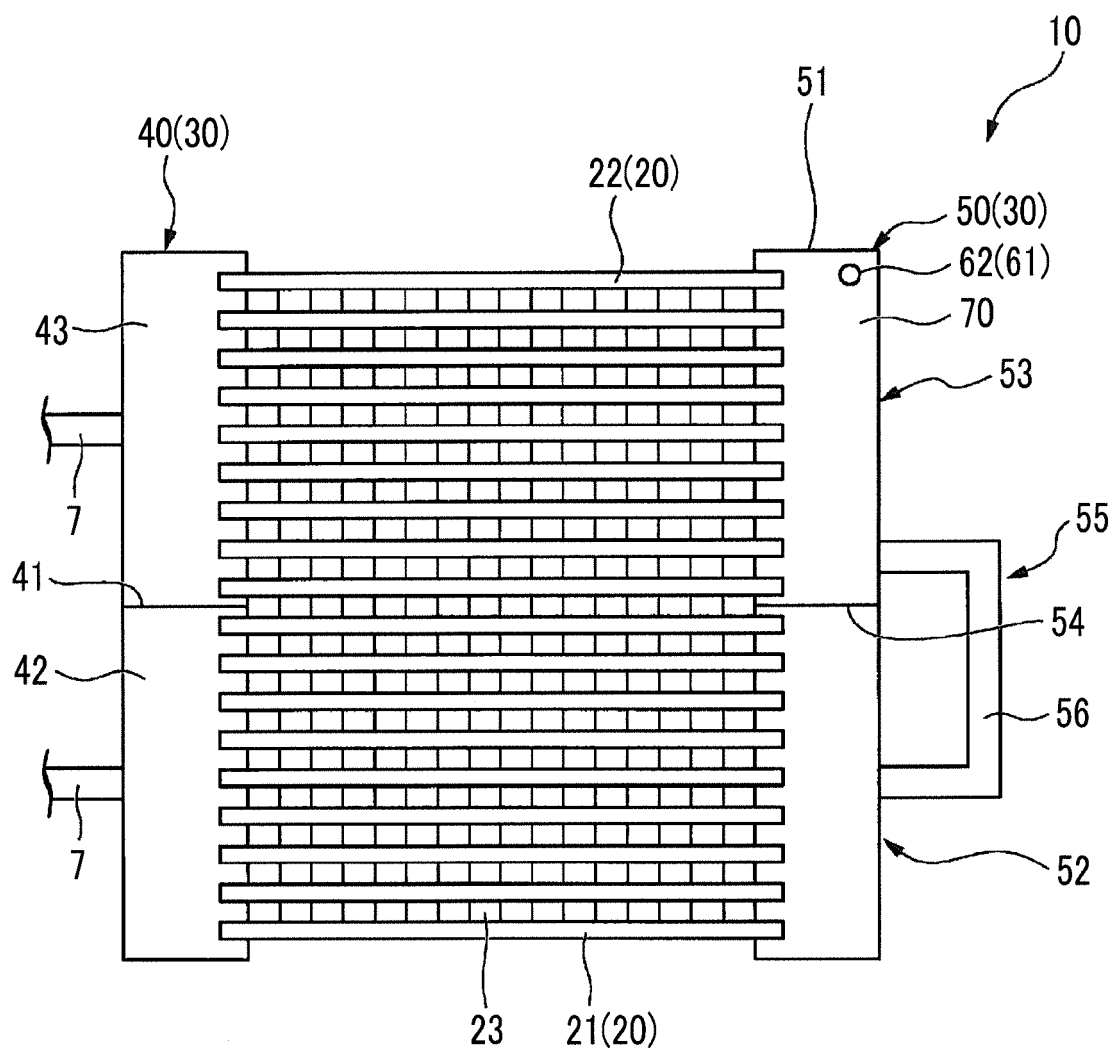


FIG. 3

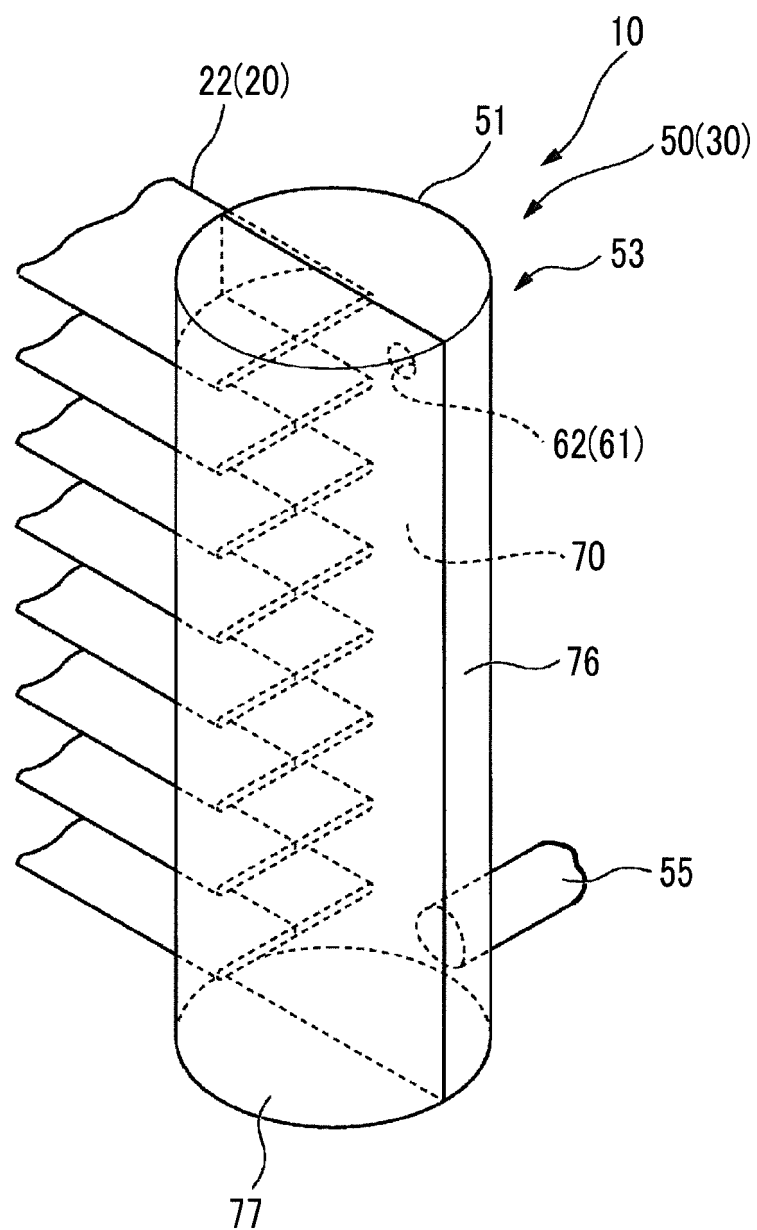


FIG. 4

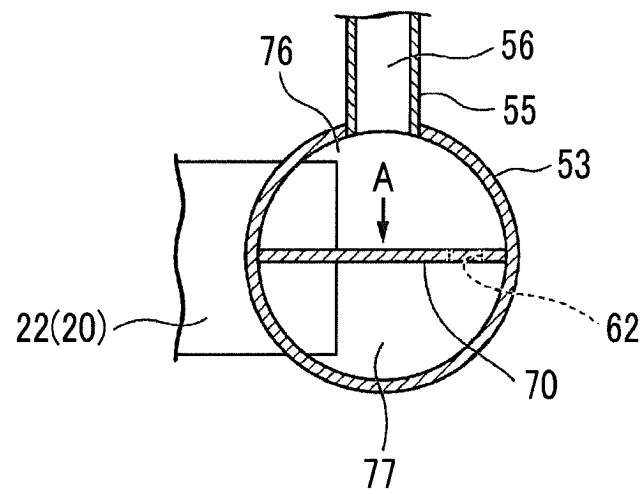


FIG. 5

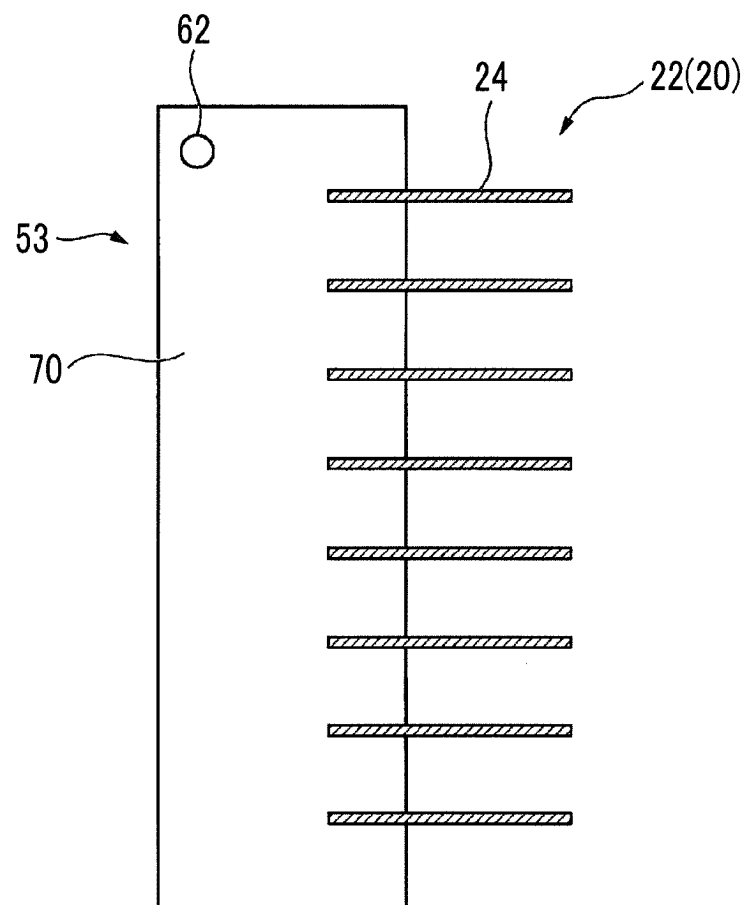


FIG. 6

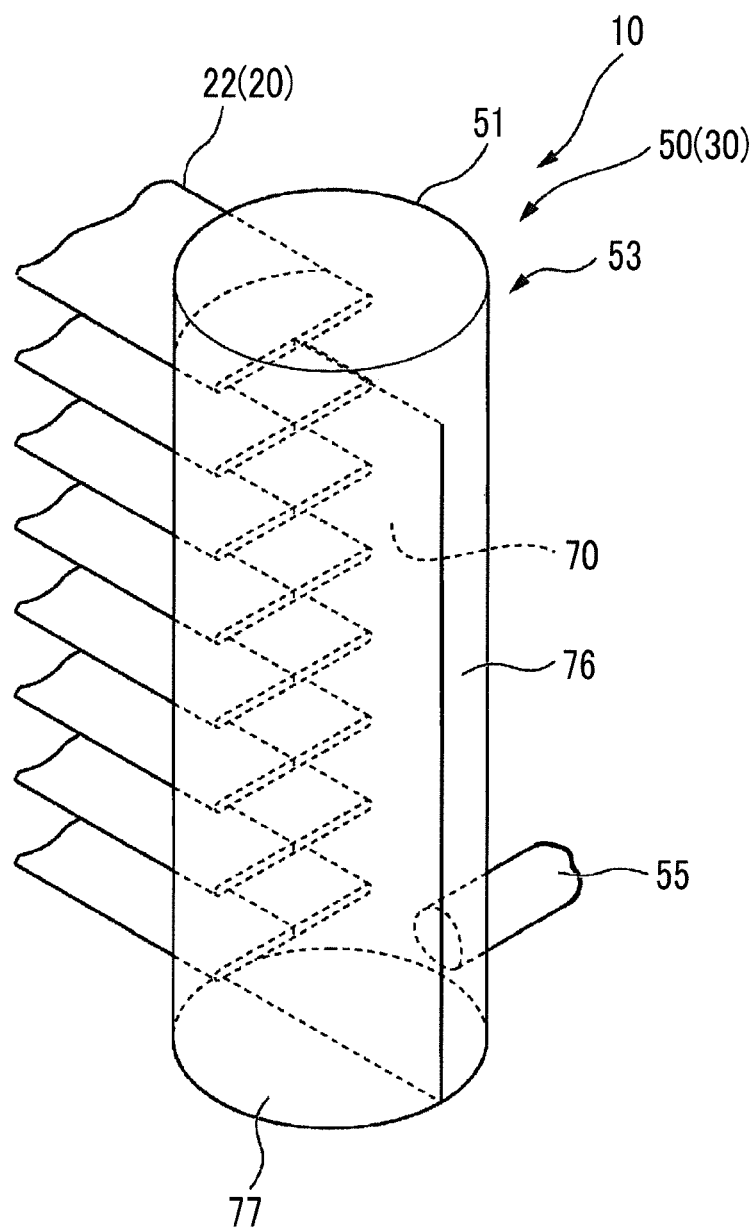


FIG. 7

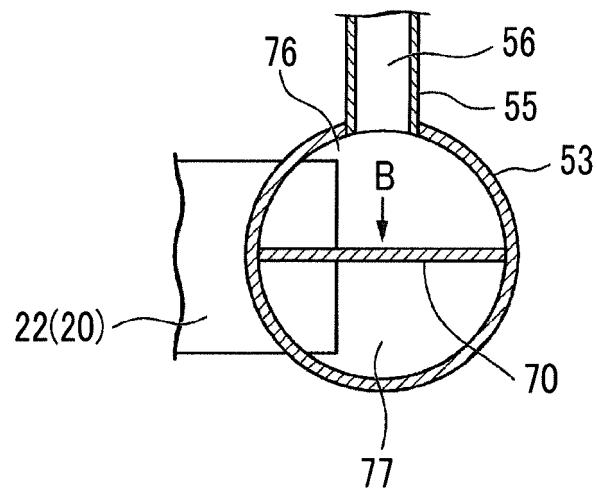


FIG. 8

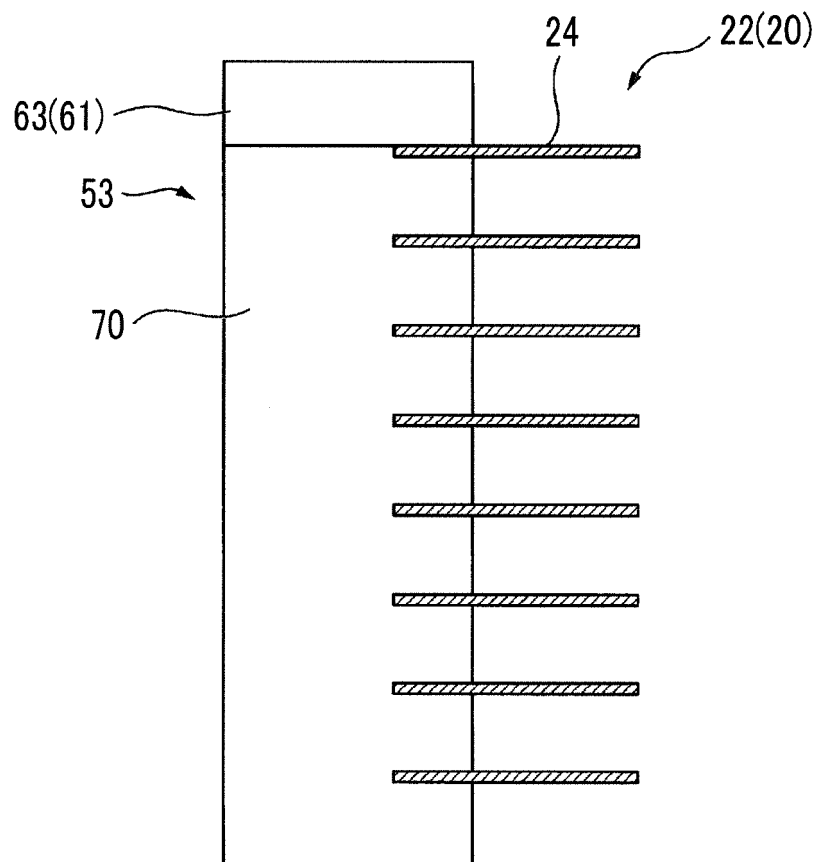


FIG. 9

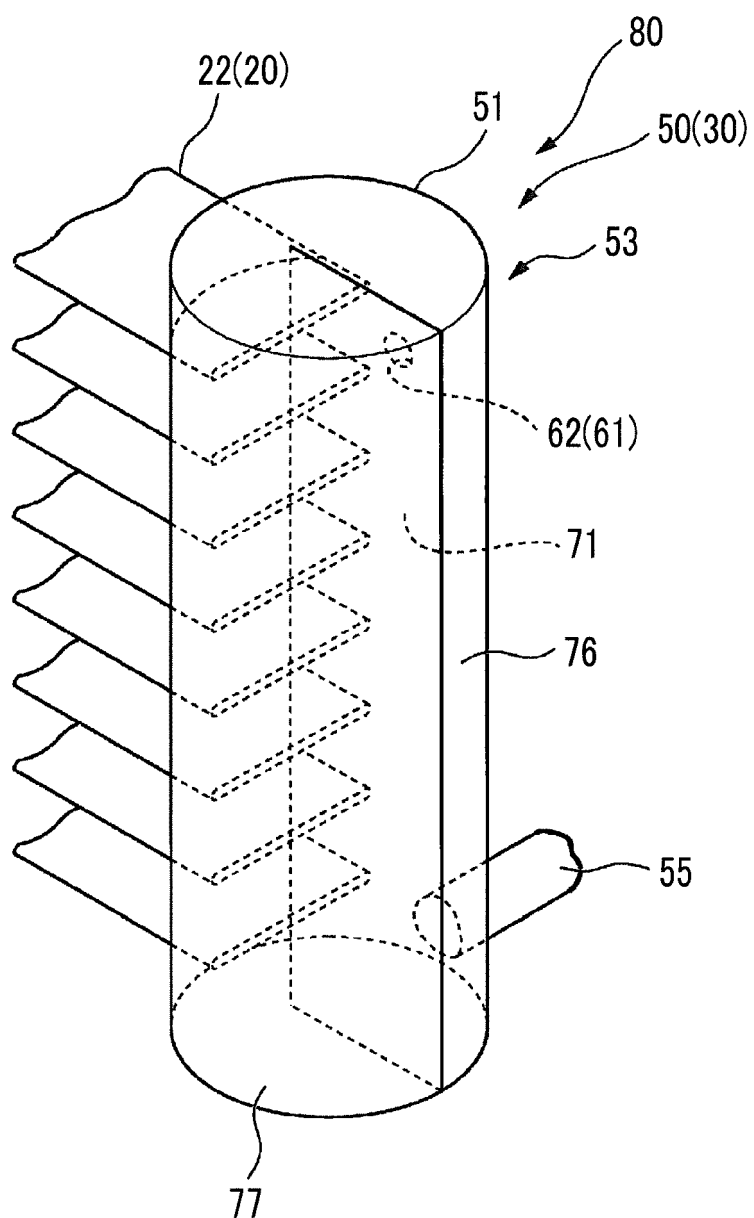


FIG. 10

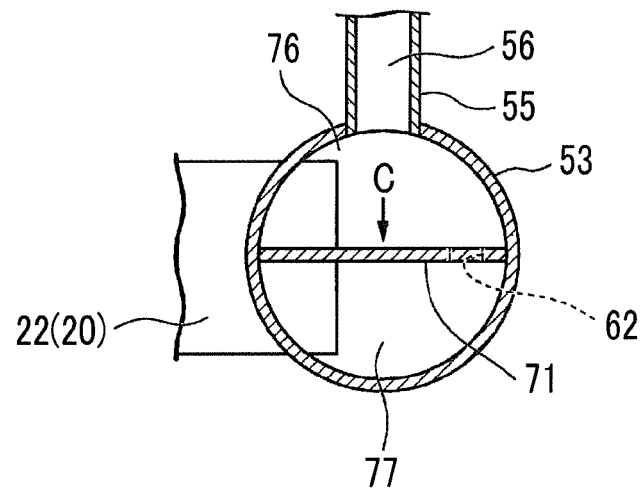


FIG. 11

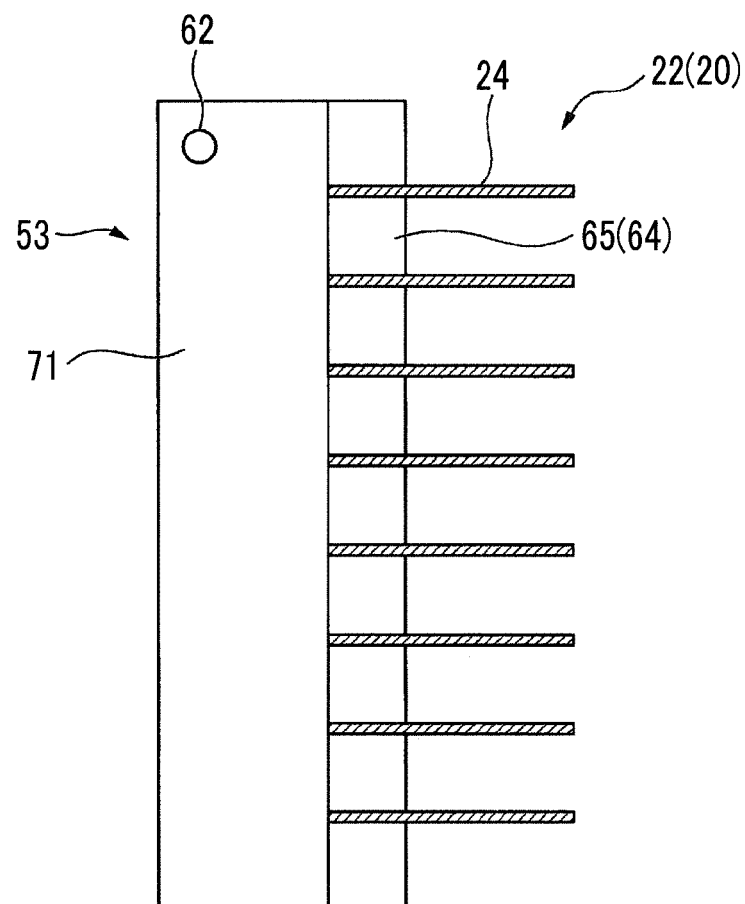


FIG. 12

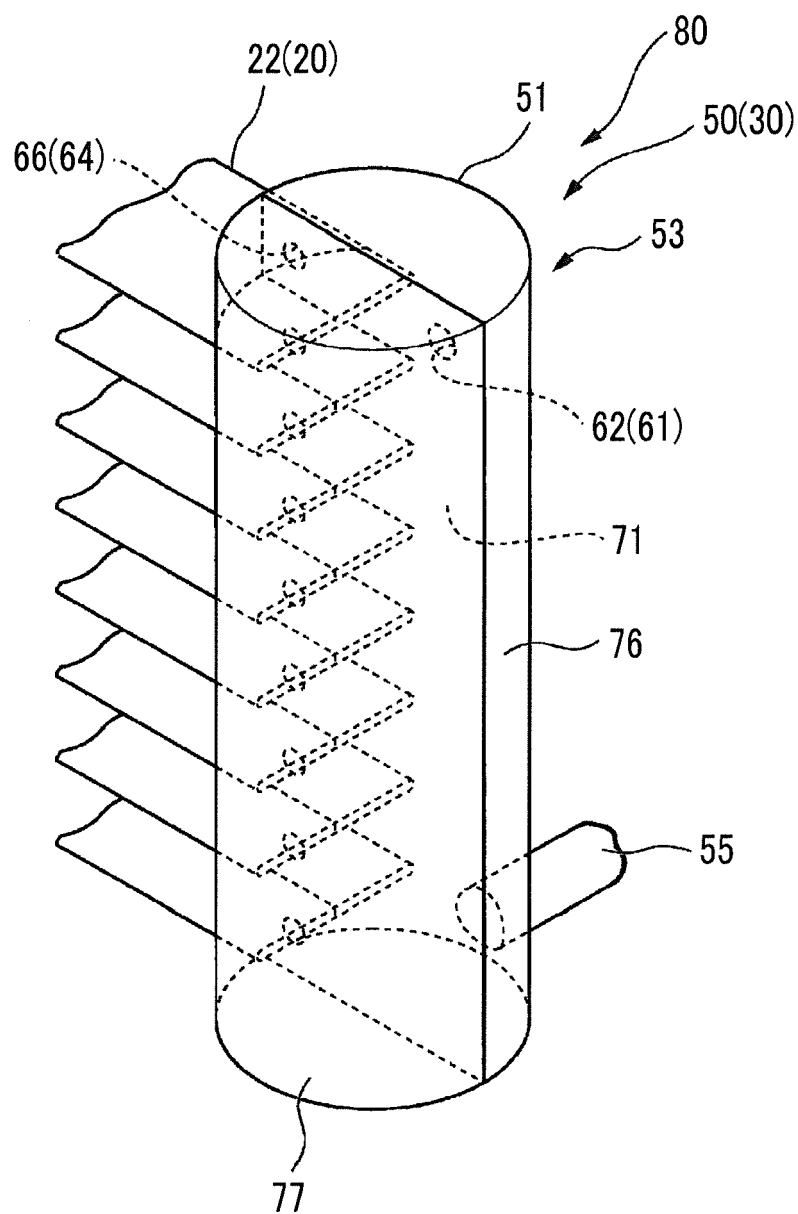


FIG. 13

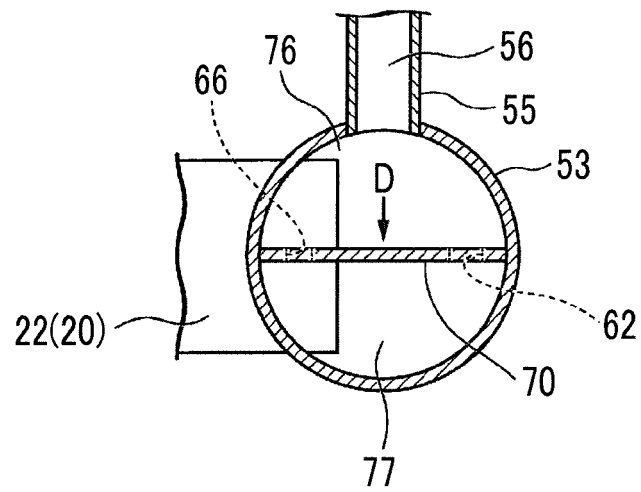


FIG. 14

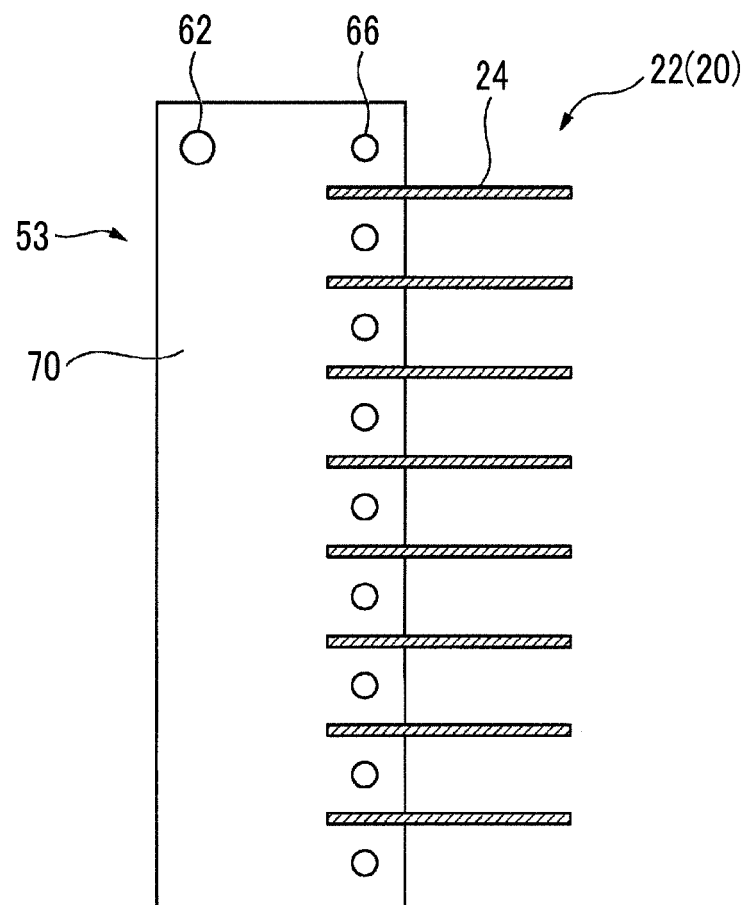


FIG. 15

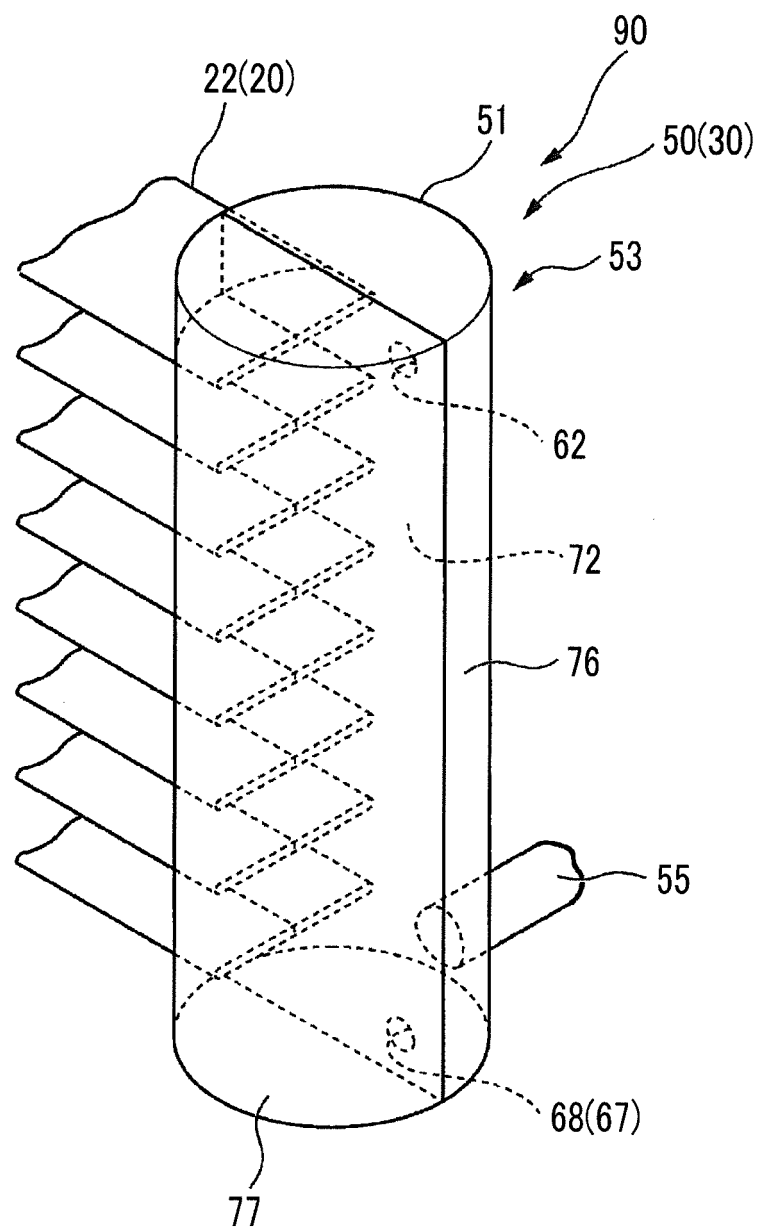


FIG. 16

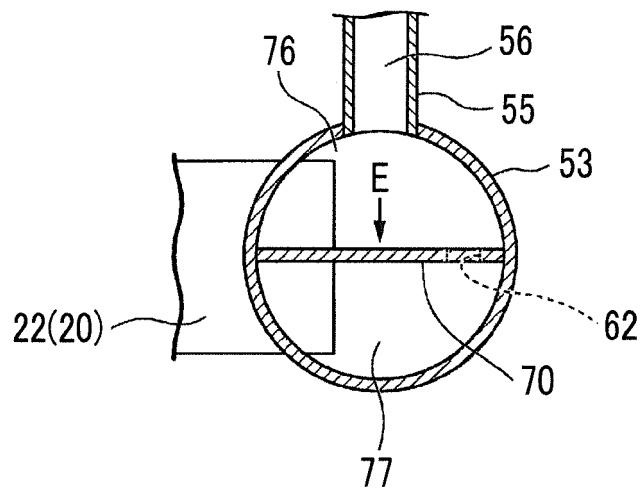


FIG. 17

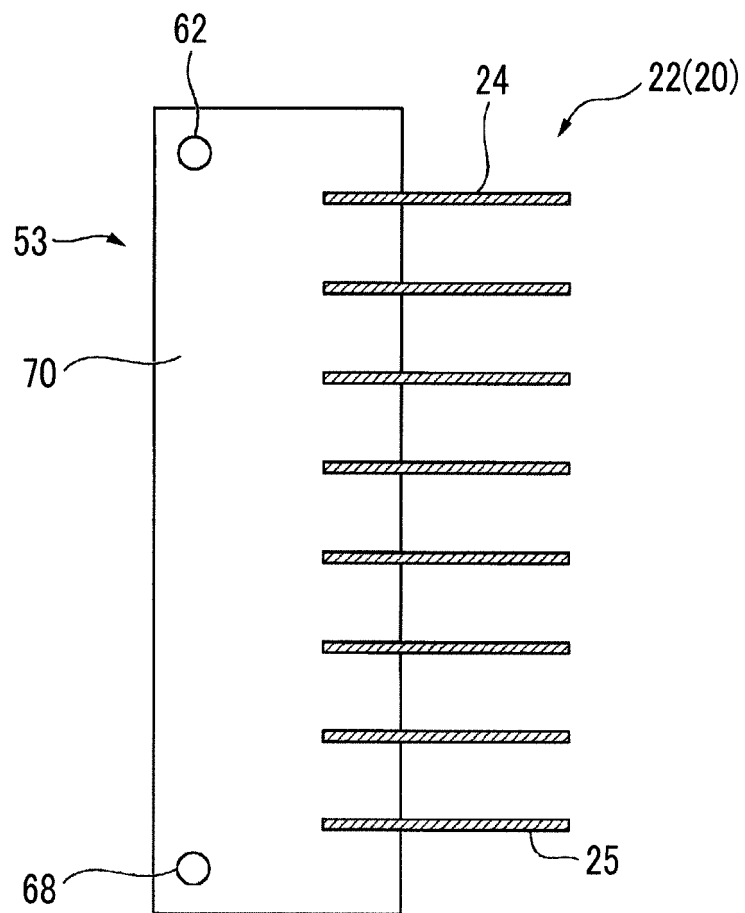


FIG. 18

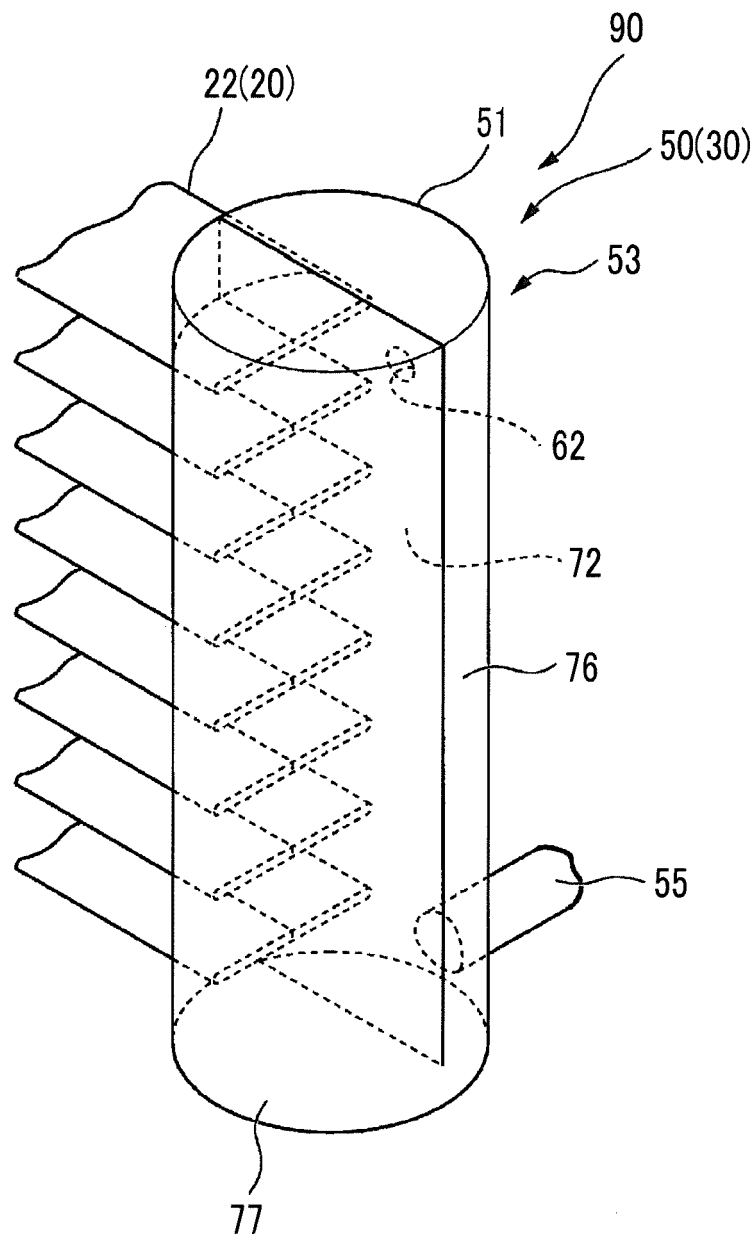


FIG. 19

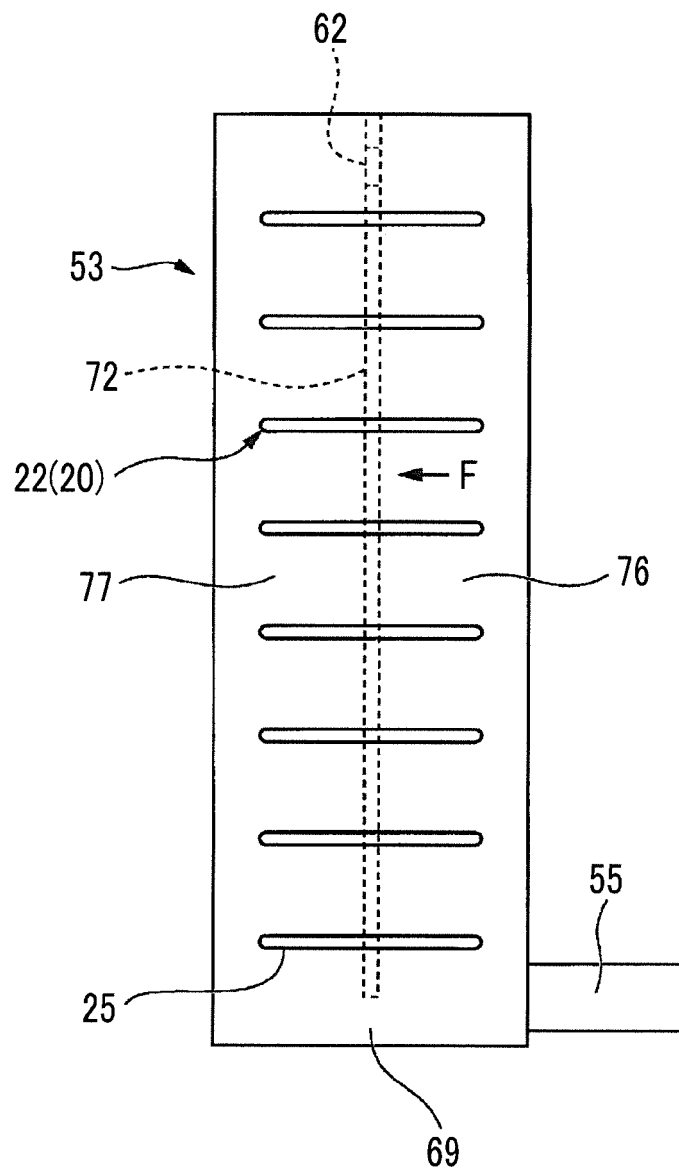


FIG. 20

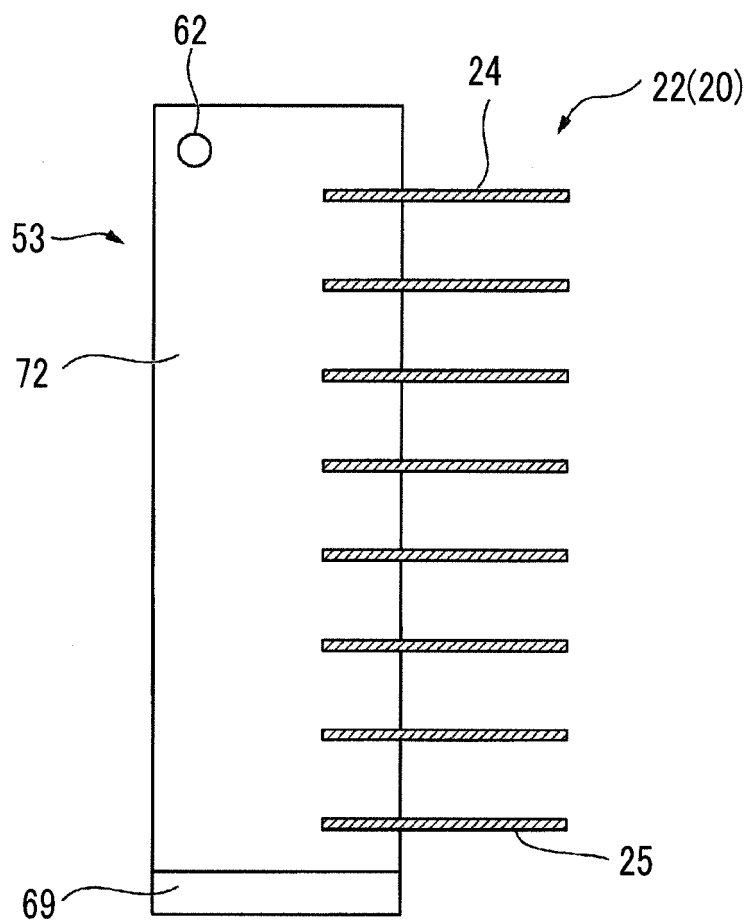
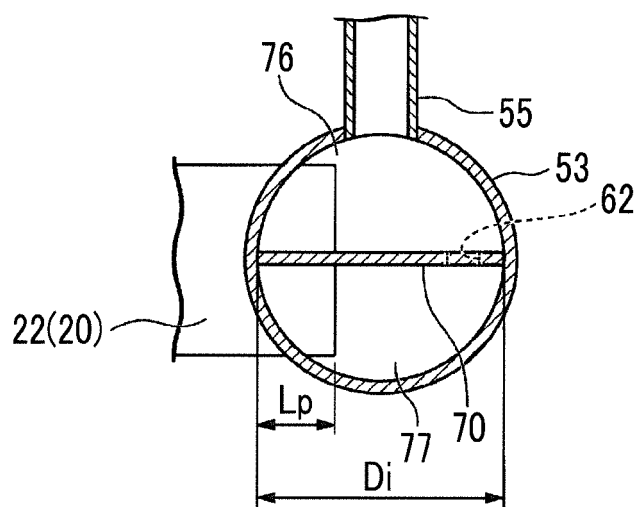


FIG. 21



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/044694

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. F28F9/02 (2006.01) i, F25B39/00 (2006.01) i, F28F9/22 (2006.01) i

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. F28F9/02, F25B39/00, F28F9/22

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 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

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.
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 172494/1986 (Laid-open No. 080492/1988) (SHOWA ALUMINUM CORPORATION) 27 May 1988, description, page 5, line 2 to page 7, line end, fig. 1-2 (Family: none)	1, 3-5, 7-8 2, 6
Y A	JP 04-363593 A (SANDEN CORPORATION) 16 December 1992, paragraphs [0017]-[0030], fig. 1 & US 5174373 A, column 6, lines 1-24, fig. 10	1, 3-5, 7-8 2, 6



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I" 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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/044694

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2003-166797 A (TOYO RADIATOR CO., LTD.) 13 June 2003, paragraph [0011], fig. 1-5 (Family: none)	1-8
A	JP 06-300477 A (MATSUSHITA REFRIGERATION COMPANY) 28 October 1994, entire text, all drawings (Family: none)	1-8
A	JP 2002-139293 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 17 May 2002, entire text, all drawings (Family: none)	1-8
A	JP 2005-337669 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 08 December 2005, entire text, all drawings (Family: none)	1-8
A	JP 2009-041876 A (GAC KK) 26 February 2009, entire text, all drawings & WO 2009/022575 A1	1-8
A	WO 2015/045564 A1 (DAIKIN INDUSTRIES, LTD.) 02 April 2015, entire text, all drawings & JP 2015-68623 A & US 2016/0238322 A1 & EP 3054255 A1 & AU 2014325773 A & CN 105593628 A	1-8

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2016247153 A [0002]
- JP 2015068623 A [0007]