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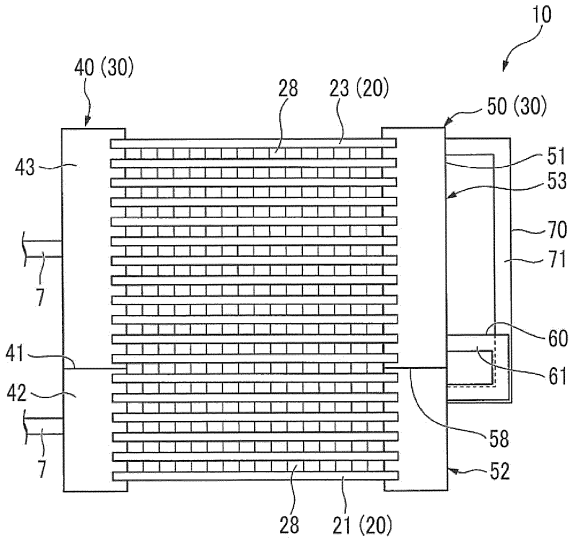
(54) **HEAT EXCHANGER AND AIR CONDITIONER**

(57) Provided is a heat exchanger which is equipped with first heat transfer tubes (21), a first header (52), second heat transfer tubes (23), a second header (53), and a plurality of communication paths (61, 71) that each have one end connected to the first header (52) and the other end connected to the second header (53) so as to allow communication between the first header (52) and the second header (53). The height positions where said ends of the communication paths (61, 71) are connected to the first header (52) are the same as each other. The height positions where the other ends of the communication paths (61, 71) are connected to the second header (53) are different from each other.

FIG. 2



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Description

Technical Field

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

[0002] This application claims priority from Japanese Patent Application No. 2016-038328 filed on February 29, 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 and is circulated in the other header via the heat transfer tubes, turns back at the other header to return to one header again via the heat transfer tubes, in order to secure a flow passage length for the refrigerant.

[0004] The inside of the header at a turnback side is 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] For example, a heat exchanger having the connection pipe connected to a lower portion of each region of a header, into which a refrigerant that has turned back is introduced, is disclosed in PTL 1.

Citation List

Patent Literature

[0006] [PTL 1] Japanese Patent No. 5071597

Summary of Invention

Technical Problem

[0007] However, in a case where the heat exchanger is used as an evaporator, not the entire refrigerant, which is introduced into one region of the header via heat transfer tubes, evaporates, and the refrigerant is in a state of a gas-liquid two phase refrigerant, in which a liquid phase refrigerant and a gas phase refrigerant are mixed. In a case where such a gas-liquid two phase refrigerant is introduced in a lower portion of the other region of the header via the connection pipe, a liquid phase refrigerant with a high density is unlikely to reach upper heat transfer tubes. For this reason, a refrigerant flowing in the upper heat transfer tubes is a liquid phase refrigerant having a lower flow rate. As a consequence, there is a problem that the heat exchanger does not show a desired performance.

[0008] An object of the invention 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

[0009] In order to solve the problems, the invention adopts the following means.

[0010] According to a first aspect of the invention, there is provided a heat exchanger including a plurality of first heat transfer tubes that extend in a horizontal direction to allow a refrigerant to circulate therein, and are arranged at intervals in a vertical direction, a first header part that has a cylindrical shape extending in the vertical direction and is connected to one end of each of the first heat transfer tubes in a communicating state, a plurality of second heat transfer tubes that extend in the horizontal direction to allow the refrigerant to circulate therein, and are arranged at intervals in the vertical direction, a second header part that has a cylindrical shape extending in the vertical direction and is connected to one end of each of the second heat transfer tubes in a communicating state, and a plurality of communication paths each of which has one end connected to the first header part and the other end connected to the second header part so as to allow the first header part to communicate with the second header part. A connection point of one end of each of one end of the communication paths to the first header part is at a height position which is the same for each of the communication paths, and a connection point of the other end of each of the communication paths to the second header part is at a height position different for each of the communication paths.

[0011] In such a heat exchanger, the refrigerant introduced in the first header part via the first heat transfer tubes is introduced into the communication paths connected to the same vertical position of the first header part. Herein, a liquid phase is likely to stay in a lower portion of the first header part and a gas phase is likely to stay in an upper portion of the first header part due to a density difference between a gas and a liquid in the refrigerant. For this reason, a difference in the gas-liquid ratios of refrigerants occurs in the vertical direction in the first header part.

[0012] In the heat exchanger of the invention, the plurality of communication paths connected to the second header part are connected to the same vertical position in the first header part. Therefore, refrigerants with almost the same gas-liquid ratio are introduced into each communication path. For this reason, the uniformization of flow rates of refrigerants for the plurality of respective communication paths can be achieved. Since the connection points of the plurality of communication paths to the second header part are at vertical positions different from each other, refrigerants with almost the same gas-liquid ratio are introduced from the plurality of height positions in the second header part into the second header part. Accordingly, since the refrigerants are mixed in the second header part in the vertical direction, a gas-liquid ratio of the refrigerant over the entire area in the second header part in the vertical direction can be homogenized. Accordingly, the uniformization of mass flow rates of refrigerants introduced into the respective second heat transfer tubes can be achieved.

[0013] The heat exchanger may further include a partitioning plate that partitions a space in the second header part into upper and lower regions vertically separated from each other between connection points of the communication paths to the second header part, which are vertically adjacent to each other, and has a communication-hole formed vertically therethrough.

[0014] In a case where there is no partitioning plate, a liquid phase with a high density is likely to go downwards and a gas phase with a low density is likely to go upwards in the second header part. Therefore, a difference in the mass flow rate in the vertical direction occurs in the second header part as a whole in some cases. On the contrary, a refrigerant is allowed to circulate through the respective regions and a refrigerant is likely to stay in each region at the same time by dividing the inside of the second header part into small regions with the partitioning plate having the communication-hole. Therefore, a density difference of a refrigerant in the second header part as a whole in the vertical direction can be reduced.

[0015] In the heat exchanger, the connection points having the height positions different from each other of the plurality of communication paths may be present in the respective regions partitioned with the partitioning plate.

[0016] Accordingly, a density difference of a refrigerant in each region can be further reduced since the refrigerant in each region is caused to be mixed.

[0017] The heat exchanger may further include a connection pipe that has a main pipe portion, of which one end is connected to the first header part and in which a plurality of split flow passages arranged in the horizontal direction are formed, and branch pipe portions, which branch off into a plurality of portions from the other end side of the main pipe portion, in which branch flow passages are formed so as to communicate with the split flow passages, and each of which is connected to the second header part. Each of the communication paths may be a flow passage formed by each of the split flow passages and each of the branch flow passages.

[0018] Consequently, construction is easy compared to a case where each communication path is configured of a separate individual connection pipe since there is one construction point to the first header part in the case of the branch connection pipe.

[0019] The heat exchanger may further include a header that has a header body which has a cylindrical shape extending in the vertical direction and a main partition plate which partitions an inside of the header body into upper and lower parts. The first header part may be a portion below the main partition plate in the header, and the second header part may be a portion above the main partition plate in the header.

[0020] The heat exchanger having the first header part and the second header part can be easily configured by forming the first header part and the second header part with the main partition plate in one header part.

[0021] According to a second aspect of the invention, there is provided an air conditioner including any one of the heat exchangers described above.

[0022] Accordingly, a decrease in a heat exchange performance caused by inhomogeneous distribution of the refrigerant is suppressed, and thus the air conditioner with a high efficiency can be provided.

Advantageous Effects of Invention

[0023] The heat exchanger and the air conditioner of the invention can achieve the suppression of an efficiency decrease.

Brief Description of Drawings

[0024]

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

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

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

Fig. 4 is a side view of a turnback side header and a branch connection pipe of a heat exchanger according to a second embodiment of the invention.

Fig. 5A is a view illustrating a sectional shape of a flow passage of a main pipe portion in the branch connection pipe of the heat exchanger according to the second embodiment of the invention.

Fig. 5B is a view illustrating the sectional shape of the flow passage of the main pipe portion in the branch connection pipe of the heat exchanger according to the second embodiment of the invention.

Fig. 6 is a side view of a turnback side header and a connection pipe of a heat exchanger according to a third embodiment of the invention.

Fig. 7 is a side view of a turnback side header and a connection pipe of a heat exchanger according to a fourth embodiment of the invention.

Fig. 8 is a side view of a turnback side header and a connection pipe of a heat exchanger according to a fifth embodiment of the invention.

Description of Embodiments

[0025] Hereinafter, an air conditioner including a heat exchanger according to a first embodiment of the invention will be described with reference to Figs. 1 to 3.

[0026] As illustrated in Fig. 1, an 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.

[0027] The compressor 2 compresses a refrigerant and supplies the compressed refrigerant to the refrigerant circuit.

[0028] 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.

[0029] The expansion valve 4 reduces a pressure by expanding the high-pressure refrigerant liquefied by the condenser exchanging heat.

[0030] The outdoor heat exchanger 5 performs heat exchange between the refrigerant and outdoor air. The outdoor heat exchanger 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.

[0031] The four-way valve 6 switches between directions where a refrigerant circulates 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.

[0032] 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 and 3.

[0033] The heat exchangers 10 each include a plurality of heat transfer tubes 20, a plurality of fins 28, a pair of headers 30, a first connection pipe 60, and a second connection pipe 70.

[0034] The heat transfer tubes 20 are tubular members linearly extending in a horizontal direction, and flow passages through which a refrigerant circulates 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.

[0035] In the embodiment, the heat transfer tubes 20 each have a flat tubular shape, and the plurality of flow passages 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 passages 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.

[0036] The fins 28 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 28 may be any shape insofar as the fins are provided so as to protrude from outer peripheral surfaces of the heat transfer tubes 20.

[0037] 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 of a refrigerant from the outside into the heat exchanger 10, and the other one is set as a turnback side header 50 for a refrigerant to turn back in the heat exchanger 10.

[0038] 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 41. The lower region partitioned with the partition plate 41 is set as a lower entry region 42 and the upper region 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.

[0039] 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, and the heat transfer tubes 20 connected to the upper entry region 43 in a communicating state are set as second heat transfer tubes 23.

[0040] The turnback side header 50 includes a header body 51 and a main partition plate 58.

[0041] 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 main partition plate 58 is provided in the header body 51, and partitions a space in the header body 51 into two upper and lower regions. A portion below the main partition plate 58 of the header body 51 is set as a first header part 52, and a portion above the main partition plate 58 of the header body 51 is set as a second header part 53. 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 main partition plate 58. In other words, the turnback side header 50 is configured with the first header part 52 and the second header part 53.

[0042] The plurality of first heat transfer tubes 21 each are connected to the first header part 52 so as to be in a communicating state with the inside of the first header part 52. That is, the heat transfer tubes 20 connected to the first header part 52 are set as the first heat transfer tubes 21.

[0043] The plurality of second heat transfer tubes 23 each are connected to the second header part 53 so as to be in a communicating state with the inside of the second header part 53. That is, the heat transfer tubes 20 connected to the second header part 53 are set as the second heat transfer tubes 23.

[0044] The first connection pipe 60 is a tubular member in which a flow passage is formed. One end of the first 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 first connection pipe 60 is connected to an upper portion of the first header part 52. In addition, the other end of the first connection pipe 60 is connected to a lower portion of the second header part 53. In the embodiment, the flow passage in the first connection pipe 60 is set as a first communication path 61 (communication path) that connects the first header part 52 and the second header part 53 together.

[0045] The second connection pipe 70 is a tubular member in which a flow passage is formed. One end of the second connection pipe is connected to the first header part 52 in a communicating state with the inside of the first header part 52 as in the first connection pipe 60. On the other hand, the other end of the second connection pipe 70 is connected to the second header part in a communicating state with the inside of the second header part 53. More specifically, one end of the second connection pipe 70 is connected to the upper portion of the first header part 52. In addition, the other end of the second connection pipe 70 is connected to an upper portion of the second header part 53. In the embodiment, the flow passage in the second connection pipe 70 is set as a second communication path 71 (communication path) that connects the first header part 52 and the second header part 53 together.

[0046] Herein, a connection point of the first connection pipe 60 to the first header part 52 and a connection point of the second connection pipe 70 to the first header part 52 are at the same vertical position, in the embodiment. That is, the connection point of the first connection pipe 60 to the first header part 52 is disposed so as to be adjacent to or to be spaced apart from the connection point of the second connection pipe 70 to the first header part 52 in the horizontal direction, and has the same vertical position as the connection point of the second connection pipe to the first header part.

[0047] "The same vertical position" is not limited to a case where the vertical position of a center of the connection point of the first connection pipe 60 to the first header part 52 and the vertical position of a center of the connection point of the second connection pipe 70 to the first header part 52 are the same, and it is sufficient that at least a part of the connection point of the first connection pipe 60 to the first header part 52 and a part of the connection point of the second connection pipe 70 to the first header part 52 overlap each other in the vertical direction.

[0048] In the embodiment, the connection point of the second connection pipe 70 to the second header part 53 is provided above the connection point of the first connection pipe 60 to the second header part 53, that is, the connection point of the first connection pipe 60 to the second header part 53 and the connection point of the second connection pipe 70 to the second header part 53 are at vertical positions different from each other.

[0049] Next, operation and effects in a case where the heat exchanger 10 is used as an evaporator will be described. 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 conditioner 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.

[0050] 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 circulating 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 the liquid phase to a gas phase.

[0051] Out of gas-liquid two phase refrigerants supplied into the first header part 52, a refrigerant with a high liquid phase content and a high density gathers at the lower portion of the first header part 52 due to gravity, and a refrigerant with a high gas phase content and a low density gathers at the upper portion of the first header part 52. That is, in the first header part 52, the gas-liquid ratio (density) of a refrigerant differs according to a vertical position. Herein, if the connection point of the first connection pipe 60 to the first header part 52 and the connection point of the second connection pipe 70 to the first header part 52 are different from each other in the vertical direction, the gas-liquid ratios of refrigerants introduced into the first connection pipe 60 and the second connection pipe 70 are different from each other. As a consequence, as a result of a refrigerant with a high density being introduced into one of the first connection pipe 60 and the second connection pipe 70, which is connected to a lower part of the first header part 52, the mass flow rate of the refrigerant becomes higher. In addition, as a result of a refrigerant with a low density being introduced into one of the first connection pipe 60 and the second connection pipe 70, which is connected to an upper part of the first header part 52, the mass flow rate of the refrigerant becomes lower.

[0052] On the contrary, in the embodiment, the connection point of the first connection pipe 60 to the first header part 52 and the connection point of the second connection pipe 70 to the first header part 52 are at the same vertical position. For this reason, refrigerants having almost the same gas-liquid ratio are introduced into the first connection pipe 60 and the second connection pipe 70 respectively. As a consequence, the gas-liquid ratios of the refrigerants introduced into the vertical positions of the second header part 53 different from each other via the first connection pipe 60 and the second connection pipe 70 respectively are almost the same. That is, the uniformization of the mass flow rates of refrigerants circulating in the first connection pipe 60 and the second connection pipe 70 is achieved.

[0053] In the embodiment, refrigerants having almost the same gas-liquid ratio are introduced into the second header part 53 from a plurality of height positions of the second header part 53. Accordingly, since the refrigerants are mixed in the second header part 53 in the vertical direction, a gas-liquid ratio of the refrigerant over the entire area in the second header part 53 in the vertical direction can be homogenized. Accordingly, the uniformization of mass flow rates of refrigerants introduced into the respective second heat transfer tubes 23 can be achieved.

[0054] After then, a refrigerant introduced in the second header part 53 via the first connection pipe 60 or the second connection pipe 70 is diverted to the plurality of second heat transfer tubes 23 connected thereto and circulates in the second heat transfer tubes 23. Then, the refrigerant again causes evaporation by exchanging heat with the external atmosphere of the second heat transfer tubes 23 in the process of circulating in the second heat transfer tubes 23. Consequently, in the second heat transfer tubes 23, the remaining liquid phase in the refrigerant changes to the gas phase and 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.

[0055] As described above, in the heat exchanger 10 of the invention, the first communication path 61 of the first connection pipe 60 and the second communication path 71 of the second connection pipe 70, each of which is connected to one of the second header part 53, are connected to the first header part 52 at the same vertical position. Therefore, refrigerants with almost the same gas phase-liquid phase ratio are introduced into respective communication paths 102. For this reason, the uniformization of flow rates of refrigerants for the plurality of respective communication paths 102 can be achieved. Refrigerants introduced in the second header part 53 via the first connection pipe 60 and the second connection pipe 70 are caused to be mixed in the second header part 53 in the vertical direction. Accordingly, the homogenization of a gas-liquid ratio in the second header part 53 can be further achieved. As a consequence, for example, in a case where the heat exchanger 10 is used as an air conditioner, a cooling performance and a heating performance are not impaired.

[0056] Next, a heat exchanger 80 according to a second embodiment of the invention will be described with reference to Fig. 4, Fig. 5A, and Fig. 5B. 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.

[0057] As illustrated in Fig. 4, the heat exchanger 80 of the second embodiment is different from the heat exchanger of the first embodiment in that one branch connection pipe 81 is included instead of the first connection pipe 60 and the second connection pipe 70 of the first embodiment.

[0058] The branch connection pipe 81 has a main pipe portion 82 and a plurality of (two, in the embodiment) branch pipe portions 85.

[0059] One end of the main pipe portion 82 is connected to the first header part 52. In the first header part 52, two split flow passages 83, which are formed by splitting the inside of the first header part 52 in the horizontal direction into two regions, are formed as illustrated in Fig. 5A and Fig. 5B. The split flow passages 83 are arranged in the horizontal direction so as to extend from one end to the other end of the main pipe portion 82. As illustrated in Fig. 5A, the main pipe portion 82 may have a structure in which the two split flow passages 83 are formed by providing a split wall portion 84 in the middle of a circular section of the flow passage in the horizontal direction. In addition, as illustrated in Fig. 5B, the main pipe portion may have a structure in which the split flow passages 83 obtained by linearly cutting out a part of the circular section of the flow passage are provided so as to be arranged side by side via the split wall portion 84 configuring the linear portion.

[0060] The two branch pipe portions 85 are provided so as to branch off into a plurality of portions from the other end side of the main pipe portion 82. One branch pipe portion of the two branch pipe portions 85 is connected to the lower portion of the second header part 53. The other branch pipe portion of the two branch pipe portions 85 is connected to the upper portion of the second header part 53. In addition, branch flow passages 86, which are flow passages inside the respective branch pipe portions 85, communicate with the split flow passages 83 in the main pipe portion 82 in a one-to-one relationship. Accordingly, out of the two split flow passages 83 of the main pipe portion 82, one split flow passage 83 is in a communicating state with the lower portion of the second header part 53 via one branch flow passage 86, that is, the first communication path 61 that allows the first header part 52 to communicate with the lower portion of the second header part 53 by means of one split flow passage 83 and one branch flow passage 86 is formed. In addition, the other split flow passage 83 is in a communicating state with the inside of the upper portion of the second header part 53 via the other branch flow passage 86, that is, the second communication path 71 that allows the first header part 52 to communicate with the upper portion of the second header part 53 by means of the other split flow passage 83 and the other branch flow passage 86 is formed.

[0061] In such a heat exchanger 80 of the second embodiment, the two split flow passages 83 in the main pipe portion 82 of the branch connection pipe 81 are arranged in the horizontal direction side by side. Therefore, refrigerants with almost the same density are introduced into the two split flow passages 83. Then, the refrigerants are introduced into the lower portion and the upper portion of the second header part 53 via the respective branch flow passages 86. Thus, the homogenization of mass flow rates of refrigerants introduced into the second header part 53 can be achieved as in the first embodiment.

[0062] In addition, since there is only one connection point to the first header part 52, construction can be performed more easily compared to a case where the first connection pipe 60 and the second connection pipe 70 are separately provided as in the first embodiment.

[0063] Although one of the two branch pipe portions 85 is connected to the lower portion of the second header part 53 and the other one is connected to the upper portion of the second header part 53 in the embodiment, it is sufficient that the connection points of the two branch pipe portions 85 to the second header part 53 are different from each other in the vertical direction.

[0064] Next, a heat exchanger 90 according to a third embodiment of the invention will be described with reference to Fig. 6. 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.

[0065] As illustrated in Fig. 6, the heat exchanger 90 of the third embodiment is different from the first embodiment in that a partitioning plate 91 is further included in the second header part 53.

[0066] The partitioning plate 91 is provided at a vertical position between the first connection pipe 60 and the second connection pipe 70 in the second header part 53, and partitions the inside of the second header part 53 into two upper and lower regions. A lower region, out of the two regions, is set as a second header lower region 93. The other end of the first connection pipe 60 is connected to the second header lower region 93 in a communicating state. In addition, an upper region, out of the two regions, is set as a second header upper region 94. The other end of the second connection pipe 70 is connected to the second header upper region 94 in a communicating state.

[0067] The partitioning plate 91 has a communication-hole 92 formed in the vertical direction. The communication-hole 92 allows the second header lower region 93 and the second header upper region 94, which are partitioned with the partitioning plate 91, to be in a communicating state. A position at which the communication-hole 92 is formed may be the middle of the partitioning plate 91 in the horizontal direction, or may be a position off the middle.

[0068] In a case where there is no partitioning plate 91, a liquid phase with a high density is likely to go downwards and a gas phase with a low density is likely to go upwards in the second header part 53. Therefore, a difference in the mass flow rate in the vertical direction occurs in the second header part 53 as a whole. On the contrary, in the embodiment, refrigerants are allowed to circulate through the respective regions and a refrigerant of each region is likely to stay in each region at the same time by dividing the inside of the second header part 53 into small regions with the partitioning plate 91 having the communication-hole 92. That is, the movement of the gas phase content of a refrigerant from the second header lower region 93 to the second header upper region 94 is inhibited by the partitioning plate 91. On the other hand, the movement of the liquid phase content of a refrigerant from the second header upper region 94 to the second header lower region 93 is inhibited by the partitioning plate 91. As a consequence, a tendency in which the liquid phase is likely to stay in the lower portion and the gas phase is likely to stay in the upper portion in the second header part 53 as a whole can be suppressed. Accordingly, a density difference of a refrigerant in the second header part 53 as a whole in the vertical direction can be reduced.

[0069] Next, a heat exchanger 100 according to a fourth embodiment of the invention will be described with reference to Fig. 7. In the fourth embodiment, the same configuration elements as the first and third embodiments will be assigned with the same reference signs as the embodiments, and the detailed description thereof will be omitted.

[0070] As illustrated in Fig. 7, the heat exchanger 100 of the embodiment has two partitioning plates 91 provided in the second header part 53. That is, the partitioning plates 91 are provided at intervals in the vertical direction, and accordingly a region in the second header part 53 is partitioned into three regions in the vertical direction. The same communication-holes 92 as in the third embodiment are formed in the partitioning plates 91.

[0071] Three connection pipes 101 that connect the first header part 52 and the three regions in the second header part 53 together respectively are provided in the embodiment. A flow passage in each of the connection pipes 101 is set as each of the communication paths 102 allowing the first header part 52 to communicate with the second header part 53.

[0072] The connection points of the three connection pipes 101 to the first header part 52 are at the same vertical position, as in the first embodiment. The other end of the first connection pipe 101, out of the three connection pipes 101, is connected to the lowermost region, out of the three regions in the second header part 53. The other end of the second connection pipe 101, out of the three connection pipes 101, is connected to the middle region, out of the three regions in the second header part 53. The other end of the third connection pipe 101, out of the three connection pipes 101, is connected to the uppermost region, out of the three regions in the second header part 53.

[0073] In the embodiment, since the inside of the second header part 53 is divided into the three regions by the partitioning plate 91, a deviation in the density of a refrigerant in the second header part 53 can be suppressed more than the third embodiment.

[0074] The inside of the second header part 53 may be partitioned into four or more regions and four or more connection pipes 101 may be provided according to the number of the partitioned regions. A density difference of a refrigerant in the second header part 53 as a whole can be further reduced by subdividing the inside of the second header part 53.

[0075] Next, a heat exchanger 110 according to a fifth embodiment of the invention will be described with reference to Fig. 8. In the fifth embodiment, the same configuration elements as the first and third embodiments will be assigned with the same reference signs as the first embodiment, and the detailed description thereof will be omitted.

[0076] As illustrated in Fig. 8, the heat exchanger 110 of the embodiment has one partitioning plate 91 provided in the second header part 53, as in the third embodiment. Accordingly, the inside of second header part 53 is partitioned into two regions in the vertical direction. The same communication-hole 92 as in the third embodiment is formed in the partitioning plate 91.

[0077] Six connection pipes 101 that connect the first header part 52 and the second header part 53 together are provided in the embodiment. The communication paths 102 are formed in the connection pipes 101, and the connection points of all the communication paths to the first header part 52 are at the same vertical position.

[0078] In addition, the other end of each of three connection pipes 101, out of the six connection pipes 101, is connected to the second header lower region 93. The connection points of the three connection pipes 101 to the second header lower region 93 are at vertical positions different from each other.

[0079] The other end of each of remaining three connection pipes 101, out of the six connection pipes 101, is connected to the second header upper region 94. The connection points of the three connection pipes 101 to the second header upper region 94 are at vertical positions different from each other.

[0080] In the heat exchanger 110 of the embodiment having the configuration described above, a refrigerant is introduced into the second header lower region 93 and the second header upper region 94 in the second header part 53 from the vertical positions different from each other. Accordingly, the mixing of a refrigerant in the second header lower region 93 and the second header upper region 94 can be further caused.

[0081] Although an example in which one partitioning plate 91 is provided is described in the embodiment, the inside of the second header part 53 may be partitioned into three or more regions with two or more partitioning plates 91.

[0082] In addition, the other end of each of four or more connection pipes 101, without being limited to only three, may be connected to each region in the second header part 53.

[0083] Although the embodiments of the invention are described, the invention is not limited thereto, and can be modified as appropriate without departing from the technical scope of the invention.

Reference Signs List

[0084]

1	air conditioner
2	compressor
3	indoor heat exchanger
4	expansion valve
5	outdoor heat exchanger
6	four-way valve
7	pipe
10	heat exchanger
20	heat transfer tube
21	first heat transfer tube
23	second heat transfer tube
28	fin
30	header
40	entrance side header
41	partition plate

42 lower entry region

43 upper entry region

50 turnback side header

51 header body

52 first header part

53 second header part

58 main partition plate

60 first connection pipe

61 first communication path

70 second connection pipe

71 second communication path

80 heat exchanger

81 branch connection pipe

82 main pipe portion

83 split flow passage

84 split wall portion

90 heat exchanger

91 partitioning plate

92 communication-hole

93 second header lower region

94 second header upper region

100 heat exchanger

101 connection pipe

102 communication path

110 heat exchanger

Claims

1. A heat exchanger comprising:

a plurality of first heat transfer tubes that extend in a horizontal direction to allow a refrigerant to circulate therein, and are arranged at intervals in a vertical direction;
a first header part that has a cylindrical shape extending in the vertical direction and is connected to one end of each of the first heat transfer tubes in a communicating state;
a plurality of second heat transfer tubes that extend in the horizontal direction to allow the refrigerant to circulate therein, and are arranged at intervals in the vertical direction;
a second header part that has a cylindrical shape extending in the vertical direction and is connected to one end of each of the second heat transfer tubes in a communicating state; and
a plurality of communication paths each of which has one end connected to the first header part and the other end connected to the second header part so as to allow the first header part to communicate with the second header part,
wherein a connection point of one end of each of the communication paths to the first header part is at a height position which is the same for each of the communication paths, and
a connection point of the other end of each of the communication paths to the second header part is at a height position different for each of the communication paths.

2. The heat exchanger according to Claim 1, further comprising:
a partitioning plate that partitions a space in the second header part into upper and lower regions vertically separated from each other between connection points of the communication paths to the second header part, which are vertically adjacent to each other, and has a communication-hole formed vertically therethrough.

3. The heat exchanger according to Claim 2,
wherein the connection points having the height positions different from each other of the plurality of communication paths are present in the respective regions partitioned with the partitioning plate.

4. The heat exchanger according to any one of Claims 1 to 3, further comprising:

a connection pipe that has a main pipe portion, of which one end is connected to the first header part and in which a plurality of split flow passages arranged in the horizontal direction are formed, and branch pipe portions, which branch off into a plurality of portions from the other end side of the main pipe portion, in which branch flow passages are formed so as to communicate with the split flow passages, and each of which is connected to the second header part,
wherein each of the communication paths is a flow passage formed by each of the split flow

passages and each of the branch flow passages.

5. The heat exchanger according to any one of Claims 1 to 4, further comprising:

a header that has a header body which has a cylindrical shape extending in the vertical direction and a main partition plate which partitions an inside of the header body into upper and lower parts,
wherein the first header part is a portion below the main partition plate in the header, and
the second header part is a portion above the main partition plate in the header.

6. An air conditioner comprising the heat exchanger according to any one of Claims 1 to 5.

FIG. 1

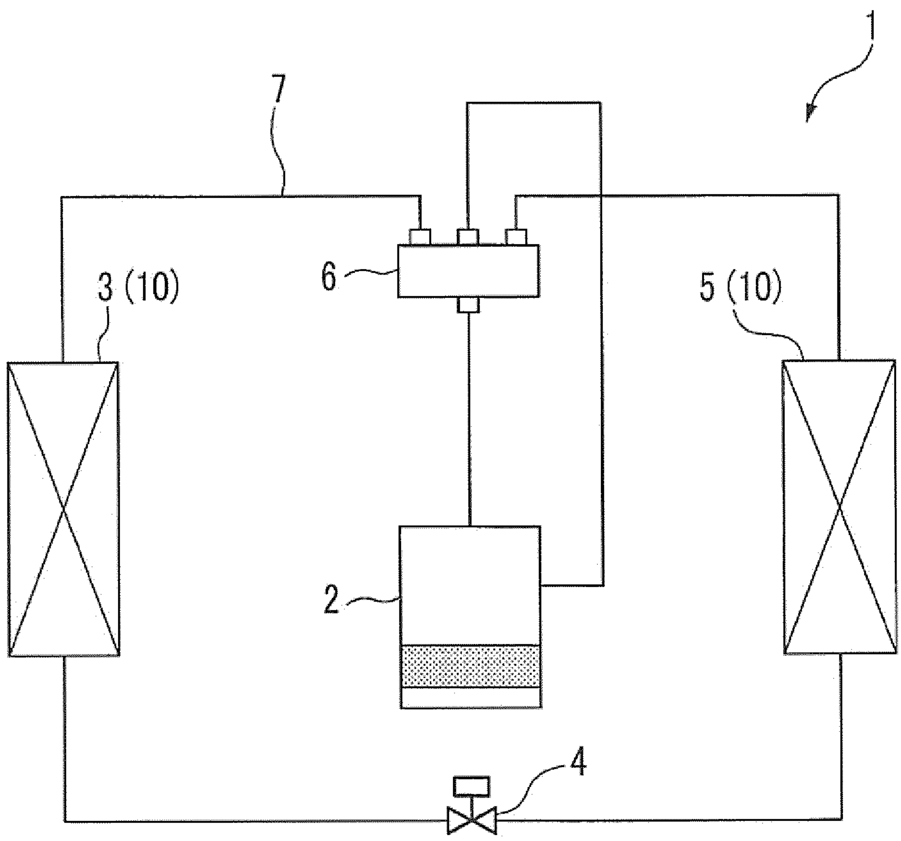


FIG. 2

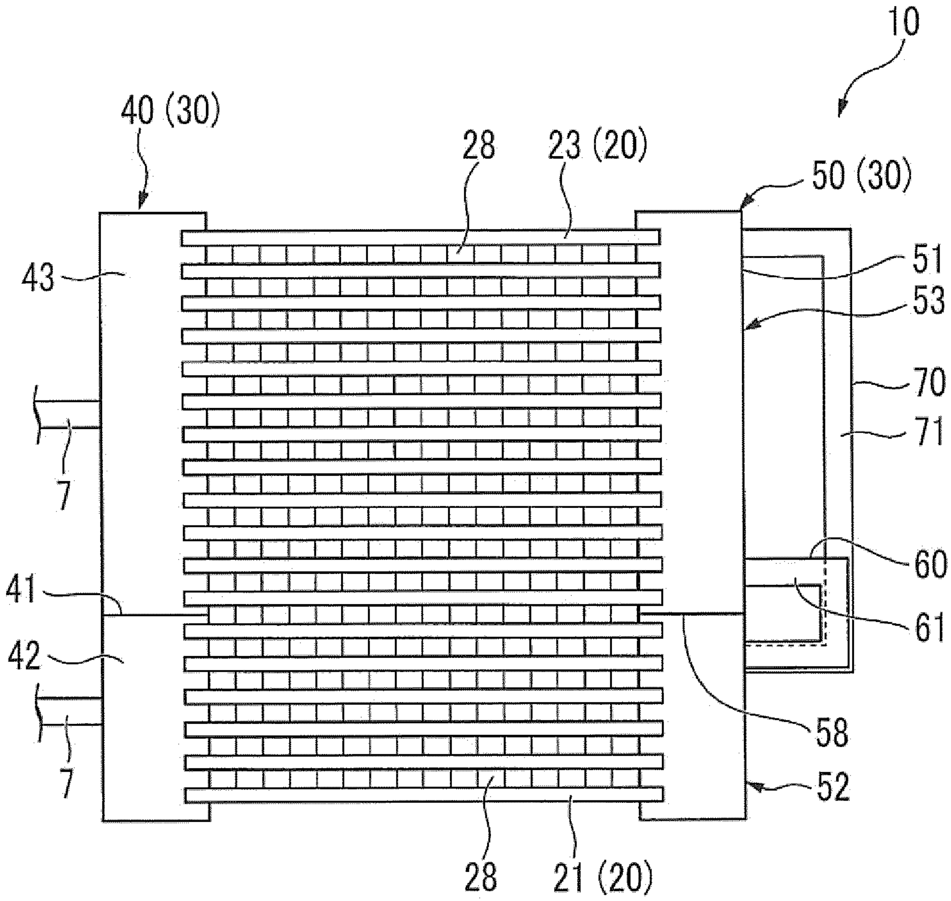


FIG. 3

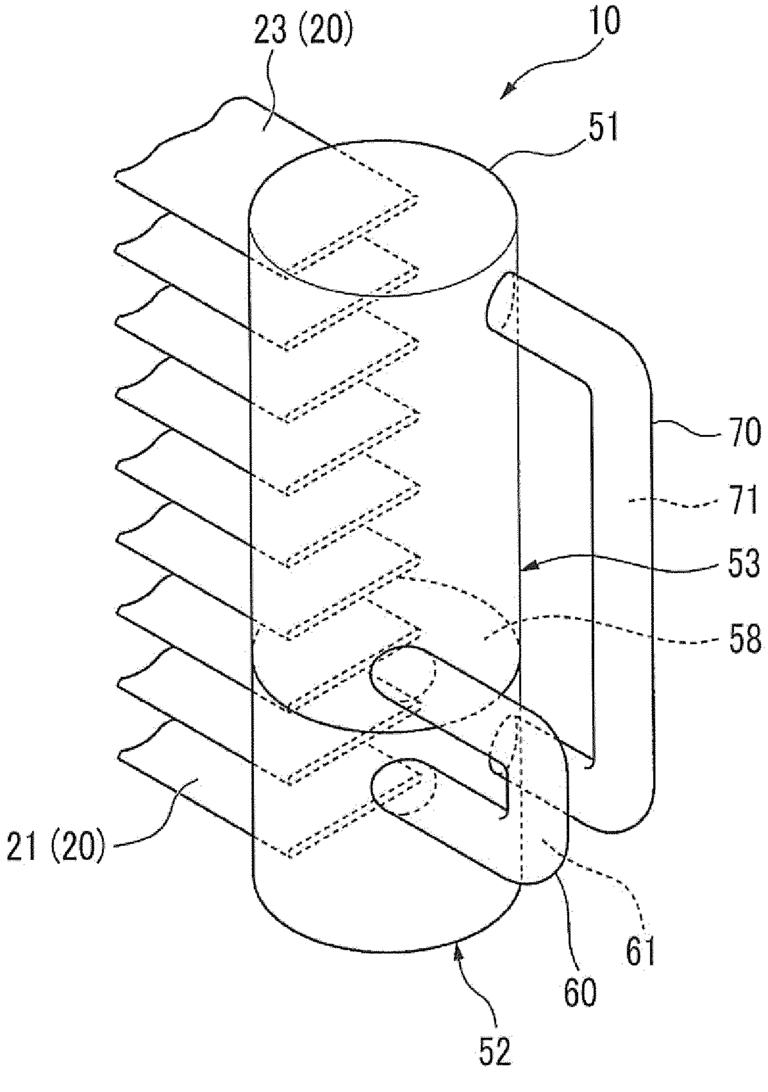


FIG. 4

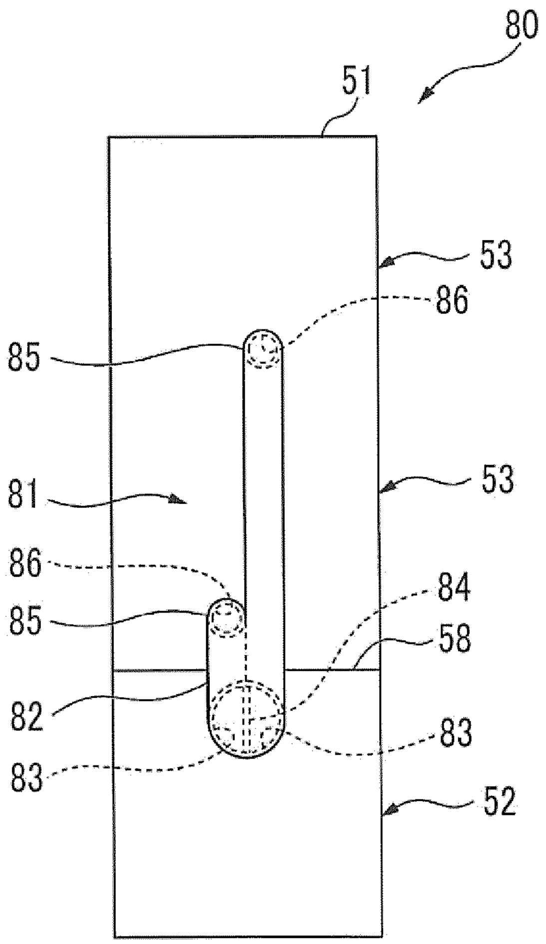


FIG. 5A

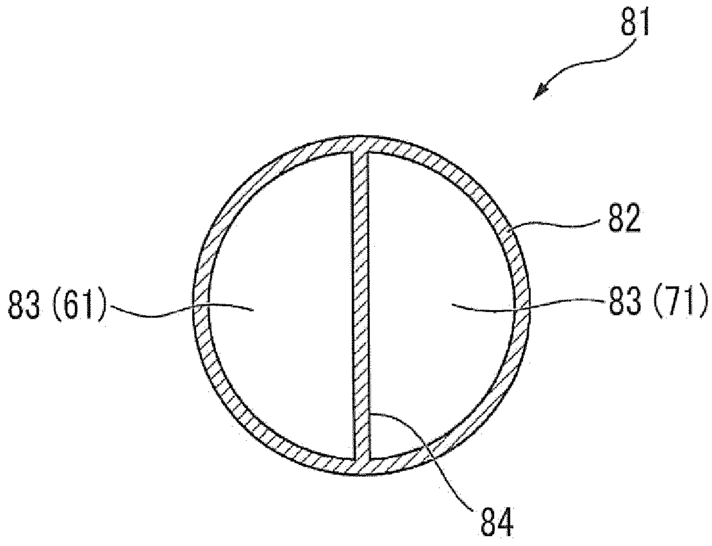


FIG. 5B

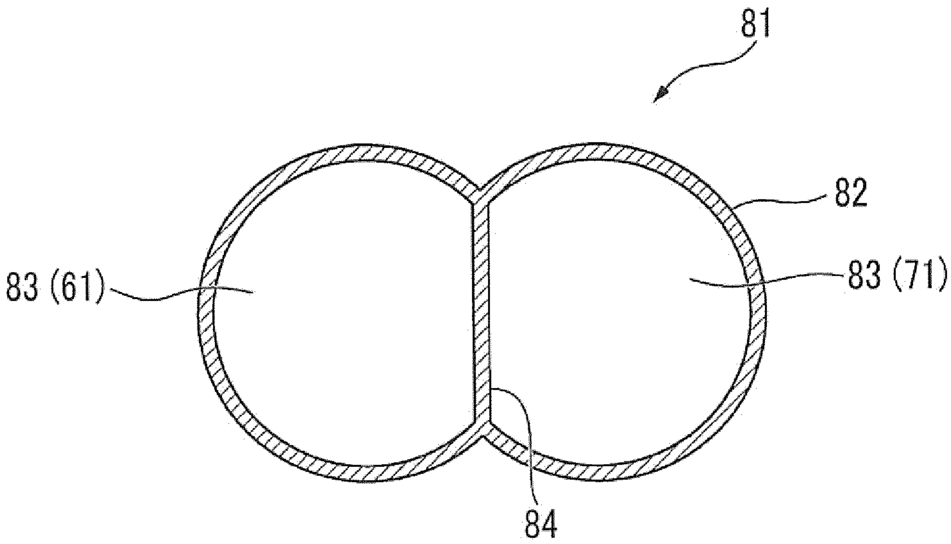


FIG. 6

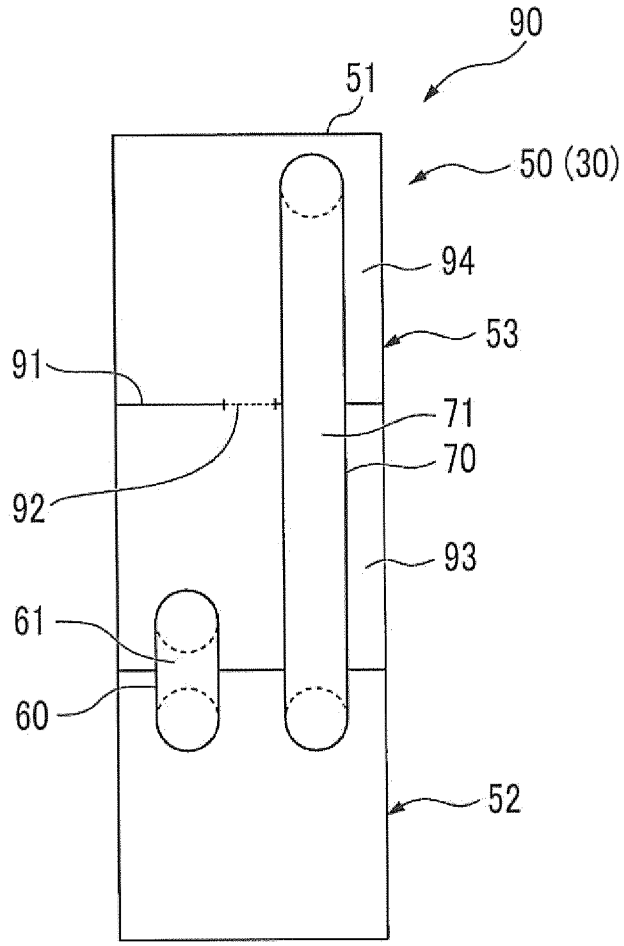


FIG. 7

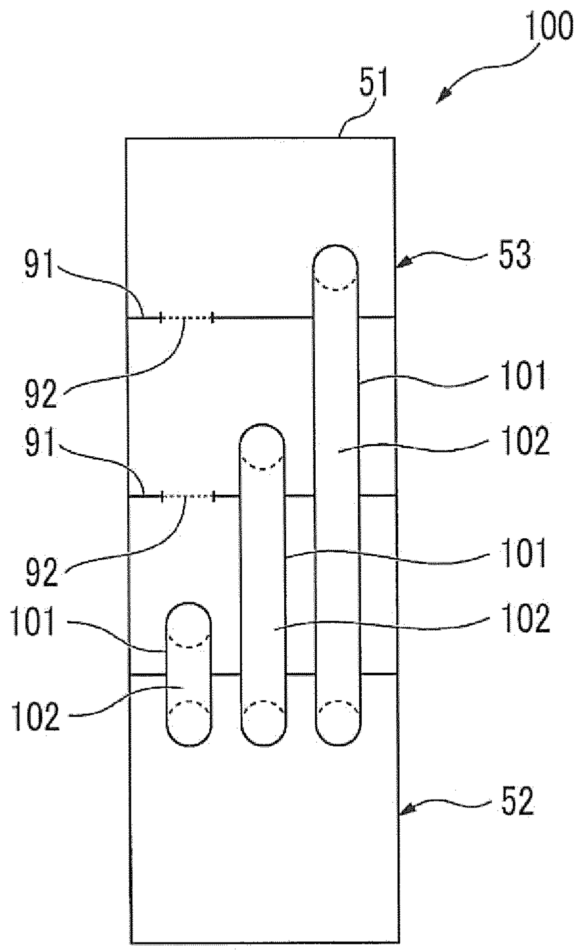
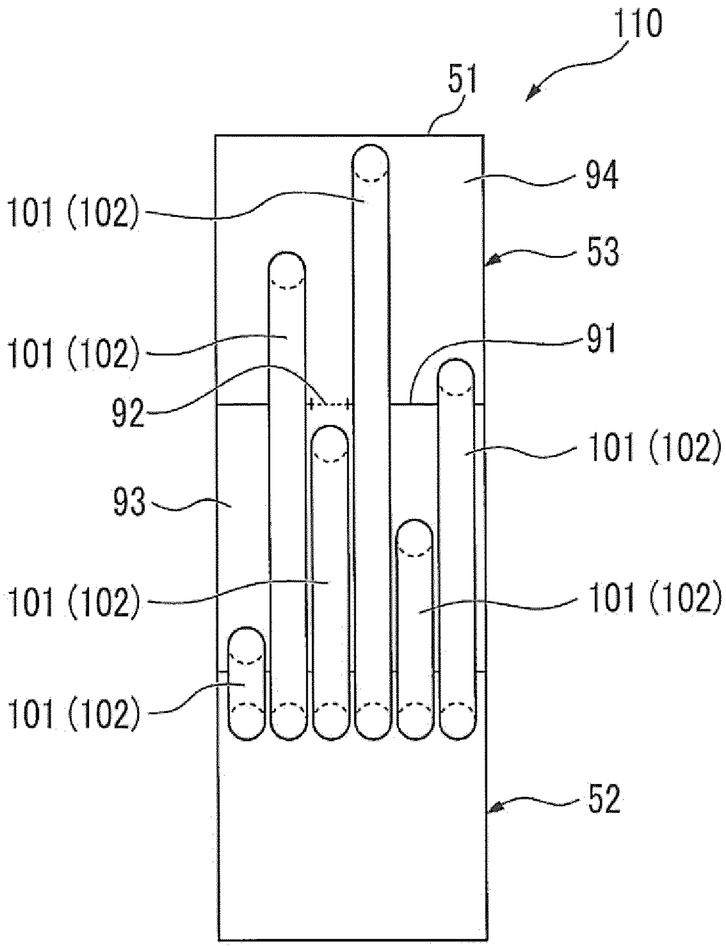


FIG. 8


110
51
94
101 (102)
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93
101 (102)
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52

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/005921

A. CLASSIFICATION OF SUBJECT MATTER
F28F9/02(2006.01)i, *F25B39/02*(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)
F28F9/02, F25B39/02

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 5071597 B2 (Daikin Industries, Ltd.), 14 November 2012 (14.11.2012), fig. 3 & US 2013/0306285 A1 fig. 3 & WO 2012/098917 A1 & EP 2660550 A1 & AU 2012208123 A & CN 103348212 A & KR 10-2013-0114249 A & ES 2544842 T	1-6
A	WO 2015/111220 A1 (Mitsubishi Electric Corp.), 30 July 2015 (30.07.2015), fig. 9 to 10 (Family: none)	1-6

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

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Date of the actual completion of the international search	Date of mailing of the international search report
19 April 2017 (19.04.17)	09 May 2017 (09.05.17)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/005921

C (Continuation). 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	JP 2012-47438 A (Showa Denko Kabushiki Kaisha), 08 March 2012 (08.03.2012), fig. 2 & US 2011/0303401 A1 fig. 2 & CN 102287970 A	1-6
A	JP 2015-200478 A (Keihin Thermal Technology Corp.), 12 November 2015 (12.11.2015), fig. 1, 3 & DE 102015105093 A & CN 204648765 U	1-6
A	JP 2004-177041 A (Matsushita Electric Industrial Co., Ltd.), 24 June 2004 (24.06.2004), fig. 5 to 6 & KR 10-2004-0047614 A & CN 1504707 A	1-6

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2016038328 A **[0002]**
- JP 5071597 B **[0006]**