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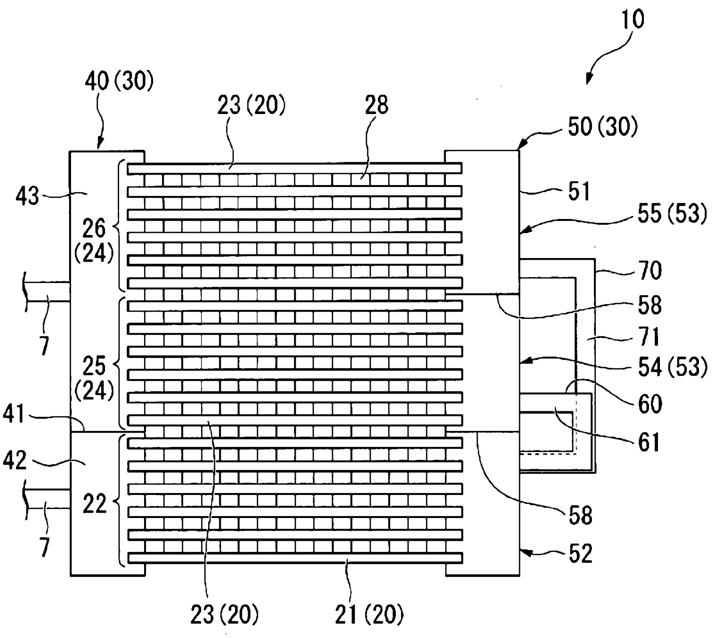
(54) Title: HEAT EXCHANGER AND AIR CONDITIONER

(54) 発明の名称 : 熱交換器及び空気調和機



(57) Abstract: A heat exchanger equipped with: a first tube group (22) which has an array of a plurality of first heat exchanger tubes (21); a first header (52) which has a cylindrical shape extending vertically, and is connected to one end of each of the first heat exchanger tubes (21) of the first tube group (22) so as to communicate therewith; a plurality of second tube groups (24) which each have an array of a plurality of second heat exchanger tubes (23); a plurality of second headers (53) which are provided so as to correspond to the plurality of second tube groups (24), and have a cylindrical shape extending vertically, and which are each connected to one end of each of the second heat exchanger tubes (23) of the corresponding second tube group (24) so as to communicate therewith; and a plurality of communication paths which are provided so as to correspond to the plurality of second headers (53), and each have one end connected to one position in the vertical direction of the first header (52) and the other end connected to the corresponding second header (53) so as to allow communication between the first header (52) and the second headers (53).

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— 補正された請求の範囲及び説明書（条約第 19 条(1))

複数が配列された第一伝熱管（２１）を有する第一管群（２２）と、上下方向に延びる筒状をなして第一管群（２２）の各第一伝熱管（２１）の一端が連通状態で接続される第一ヘッダ部（５２）と、複数が配列された第二伝熱管（２３）を有する複数の第二管群（２４）と、これら複数の第二管群（２４）に対応して複数が設けられ、上下方向に延びる筒状をなしてそれぞれに第二管群（２４）の各第二伝熱管（２３）の一端が連通状態で接続される第二ヘッダ部（５３）と、複数の第二ヘッダ部５３）に対応して複数が設けられて、第一ヘッダ部（５２）と各第二ヘッダ部（５３）とを連通させるように、一端が第一ヘッダ部（５２）の同一の上下方向位置に接続されるとともに他端が各第二ヘッダ部（５３）のいずれかに接続された連通路と、を備える熱交換器。

DESCRIPTION

Title of Invention

HEAT EXCHANGER AND AIR CONDITIONER

Technical Field

[0001]

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

This application claims priority from Japanese Patent Application No. 2016-038404 filed on February 29, 2016; the contents of which are incorporated herein by reference.

Background Art

[0002]

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 fan 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.

[0003]

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 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 introduced into the other region via a connection pipe.

For example, a heat exchanger including a connection pipe which has one main pipe portion and branch pipe portions that extend so as to branch off into a plurality of portions from the main pipe portion is disclosed in PTL 1. In the heat exchanger, the main pipe portion is connected to a region in one header, and the branch pipe portions each are connected to any one of the plurality of other regions in the header. In a case where the heat exchanger is used as an evaporator, a refrigerant introduced in one region of the header via the heat transfer tubes is introduced into the plurality of other regions via the main pipe portion and the branch pipe portions of the connection pipe.

Citation List

Patent Literature

[0004]

[PTL 1] Japanese Unexamined Patent Application Publication No. 2015-55404

Summary of Invention

Technical Problem

[0005]

However, in the heat exchanger in PTL 1, refrigerants having different degrees of dryness are introduced into the respective branch pipe portions in some cases when diverting refrigerants from the main pipe portion of the connection pipe to the branch pipe portions. That is, a large amount of liquid phase refrigerants flow into only some of a plurality of branch pipes in some cases according to the flow rate of a refrigerant and a branching direction, and thus there is a problem that a refrigerant is not uniformly diverted. In addition, a refrigerant in the connection pipe separates into a gas phase and a liquid phase in some cases according to a density difference between gas and liquid as well, and a refrigerant is diverted in some cases in a state where a deviation occurs in the flow rate or the degree of dryness.

[0006]

When a refrigerant is not uniformly diverted as described above, a change in a refrigerant distribution ratio at the time of diversion occurs since a flow aspect in each branch pipe differs according to a flow rate.

For this reason, when the refrigerant is again introduced into the heat transfer tubes via the headers, there is a heat transfer tube through which a liquid phase refrigerant hardly passes, and thus a heat transfer region of the heat exchanger cannot be sufficiently used. As a consequence, for example, in a case where the heat exchanger is used as an air conditioner, a cooling performance and a heating performance deteriorate, and thus indoor amenity is impaired.

[0006a]

Any reference herein to a patent document or other matter which is given as prior art is not to be taken as an admission that that document or matter was known or that the information it contains was part of the common general knowledge as at the priority date of any of the claims.

[0006b]

Throughout the description and claims of the specification, the word "comprise" and variations of the word, such as "comprising" and "comprises", is not intended to exclude other additives, components, integers or steps.

[0007]

At least some embodiments of the invention provide a heat exchanger which can suppress a performance decrease and an air conditioner in which the heat exchanger is used.

Summary of the Invention

[0008]

According to a first aspect, the present invention provides a heat exchanger comprising:

a first tube group that has a plurality of first heat transfer tubes which extend in a horizontal direction, allow a refrigerant to circulate therein, and are arranged at intervals in a vertical direction; a plurality of second tube groups that have a plurality of second heat transfer tubes which extend in the horizontal direction, allow the refrigerant to circulate therein, and are arranged at intervals in the vertical direction; a header that includes a header body which is a cylindrical member extending in the vertical direction, and two main partition plates which are provided in the header body and partition a space in the header body into upper and lower regions; and a first communication passage and a second communication passage that communicate with each other via the space partitioned by the main partition plates, wherein the header has: a first header part being a portion that includes the lowermost region among the three regions in the header body; and a lower second header part and an upper second header part being portions that each include one of the two upper regions, excluding the lowermost region among the three regions in the header body, wherein the first header part is connected to one end of each of the first heat transfer tubes of the first tube group in a communicating state, wherein the lower second header part is connected to one end of each of the second heat transfer tubes of the second tube group in a communicating state, wherein the upper second header part is connected to one end of each of the second heat transfer tubes of the second tube group in a communicating state, wherein the first communication passage connects the first header part and the lower second header part, wherein the second communication passage connects the first header part and the upper second header part, and wherein the number of the second heat transfer tubes of the second tube group of the upper second header part is larger than the number of the second heat transfer tubes of the second tube group of the lower second header part, wherein a flow passage sectional area of the second communication passage is larger than a flow passage sectional area of the first communication passage.

[0008a]

According to a second aspect, the present invention provides a heat exchanger comprising:

a casing capable of accommodating the heat exchanger; a first tube group that has a plurality of first heat transfer tubes which extend in a horizontal direction, allow a refrigerant to circulate therein, and are arranged at intervals in a vertical direction; a plurality of second tube groups that have a plurality of second heat transfer tubes which extend in the horizontal direction, allow the refrigerant to circulate therein, and are arranged at intervals in the vertical direction; a header that includes a header body which is a cylindrical member extending in the vertical direction, and two main partition plates which are provided in the header body and partition a space in the header body into upper and lower regions; and a first communication passage and a second communication passage that communicate with each other the space partitioned by the main partition plates, wherein the header has: a first header part being a portion that includes the lowermost region among the three regions in the header body; and a lower second header part and an upper second header part being portions that each include one of the two upper regions, excluding the lowermost region among the three regions in the header body, wherein the first header part is connected to one end of each of the first heat transfer tubes of the first tube group in a communicating state, wherein the lower second header part is connected to one end of each of the second heat transfer tubes of the second tube group in a communicating state, wherein the upper second header part is connected to one end of each of the second heat transfer tubes of the second tube group in a communicating state, wherein the first communication passage connects the first header part and the lower second header part, wherein the second communication passage connects the first header part and the upper second header part, wherein an air blowing unit formed of a fan that is rotatable about a vertical axis is provided on a top surface of the casing body, wherein since the air blowing unit is provided on the top surface of the casing, a speed of blowing air received by the second tube group of the upper second header part is higher than a speed of blowing air received by the second tube group of the lower second header part, wherein a flow passage sectional area of the second communication passage is set to be larger than a flow passage sectional area of the first communication passage.

[0009]

In such a heat exchanger, the refrigerant introduced in the first header part via each first heat transfer tube of the first tube group is introduced into the communication passage 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 due to a density difference between gas and liquid in the refrigerant and a gas phase is likely to stay in an upper portion of the first header part. For this reason, a difference in the gas-liquid ratios of refrigerants occurs in the vertical direction in the first header part. In the heat exchanger of the invention, the communication passages connected to the plurality of respective second header parts are connected to the same vertical position in the first header part. Therefore, refrigerants with almost the same gas phase-liquid phase ratio are introduced into each communication passage. For this reason, the uniformization of flow rates of refrigerants for the plurality of respective communication passages can be achieved. As a consequence, the flow rates of refrigerants introduced into the plurality of second heat transfer tubes can be uniformized.

[0010]

The heat exchanger may include a branch 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 each of the second header parts. Each of the communication passages may be a flow passage formed by each of the split flow passages and each of the branch flow passages.

[0011]

Consequently, construction is easy compared to a case where each communication passage 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.

[0012]

In the heat exchanger, the numbers of the second heat transfer tubes of the second tube groups may be different from each other, and the plurality of communication passages may be formed such that the communication passage connected to the second header part, to which the second tube group with a larger number of the second heat transfer tubes is connected, has a larger flow passage sectional area.

[0013]

Consequently, a larger amount of refrigerants are introduced into the second header part having a relatively larger number of the connected second heat transfer tubes. On the other hand, a smaller amount of refrigerants are introduced into the second header part having a relatively smaller number of the connected second heat transfer tubes. As a consequence, the uniformization of the amount of a refrigerant, which is diverted and introduced into each of the second heat transfer tubes, can be achieved.

[0014]

The heat exchanger may include an air blowing unit that blows air to each of the second tube groups, a speed of blowing air received by each of the second tube groups from the air blowing unit may be different for each of the second tube groups, and the plurality of communication passages may be formed such that the communication passage connected to the second header part, to which the second tube group receiving the blowing air of a higher speed is connected, has a larger flow passage sectional area.

[0015]

In such a heat exchanger, the higher the speed of blown air received by the second tube groups, the more heat exchange in the second tube groups is caused. Thus, the heat exchange efficiency of the heat exchanger as a whole can be improved by introducing a larger amount of refrigerants into the second header part connected to the second tube group that receives blowing air of which the speed is higher.

[0016]

The heat exchanger may further include another communication passage of which one end is connected to the first header part at the same height position as the communication passages connected to the first header part and the other end is connected to the second header part at a height position different from the communication passages connected to the second header parts such that the first header part communicates with any one of the plurality of second header parts.

[0017]

Consequently, refrigerants are introduced from a plurality of points different in the vertical direction into the second header parts. Thus, since the homogenization of gas-liquid ratio of a refrigerants in the vertical direction in the second header parts can be achieved, the flow rate of the refrigerant diverted into the respective second heat transfer tubes can be uniformized.

[0018]

In the heat exchanger, a header that has a header body which is in a cylindrical shape extending in the vertical direction and a plurality of main partition plates that partition an inside of the header body into a plurality of regions in the vertical direction may be included, the first header part may be a portion that includes the lowermost region out of the plurality of regions in the header, and each of the second header parts may be a portion that includes any one of the regions excluding the lowermost region, out of the plurality of regions in the header.

[0019]

The heat exchanger having the first header part and the plurality of second header parts can be easily configured by forming the first header part and the plurality of second header parts with the main partition plate in one header part.

[0020]

According to another aspect of the invention, there is provided an air conditioner including any one of the heat exchangers described above.

[0021]

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

[0022]

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

Brief Description of Drawings

[0023]

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 perspective view 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 the heat exchanger according to the third embodiment of the invention.

Fig. 8 is a perspective view of a heat exchanger according to a fourth embodiment of the invention.

Fig. 9 is a side view of a turnback side header and a connection pipe of the heat exchanger according to the fourth embodiment of the invention.

Fig. 10 is a perspective view illustrating an example of an air blowing unit according to the fourth embodiment of the invention.

Fig. 11 is a perspective view of a heat exchanger according to a fifth embodiment of the invention.

Fig. 12 is a side view of a turnback side header and a connection pipe of the heat exchanger according to the fifth embodiment of the invention.

Fig. 13 is a side view of a turnback side header and a connection pipe of a heat exchanger according to a sixth embodiment of the invention.

Description of Embodiments

[0024]

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 5.

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.

[0025]

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

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

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.

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.

[0026]

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 Fig. 2 and Fig. 3.

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

[0027]

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.

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.

[0028]

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

[0029]

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.

[0030]

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 header 40. The lower entry region 42 and the upper entry region 43 each are connected to the pipe 7 configuring the refrigerant circuit.

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.

[0031]

The turnback side header 50 includes a header body 51 and main partition plates 58.

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 plates 58 are provided in the header body 51, and partition a space in the header body 51 into upper and lower regions. In the embodiment, the two main partition plates 58 are disposed in the header body 51 at an interval in the vertical direction. Accordingly, the inside of the header body 51 is partitioned into three regions vertically arranged.

[0032]

Out of the three regions in the header body 51, a portion that includes the lowermost region is set as a first header part 52. In addition, out of the three regions, portions that each include one of the two upper regions, excluding the lowermost region, are set as second header parts 53. That is, in the embodiment, one first header part 52 and two second header parts 53 each of which has a space inside therein are formed in the turnback side header 50 by the inside of the header body 51 being partitioned with the two main partition plates 58.

In other words, the turnback side header 50 is configured with one first header part 52 and two second header parts 53.

[0033]

The 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. A first tube group 22 is configured with the plurality of first heat transfer tubes 21. In other words, the heat transfer tubes 20 connected to the first header part 52 are set as the first heat transfer tubes 21.

[0034]

The second heat transfer tubes 23 each are connected to one of the second header parts 53 so as to be in a communicating state with one of the insides of the second header parts 53. That is, the heat transfer tubes 20 connected to the second header parts 53 are set as the second heat transfer tubes 23.

Second tube groups 24 each are configured with the plurality of second heat transfer tubes 23 each of which is connected to one of the second header parts 53. That is, since there are two second header parts 53 in the embodiment, two second tube groups 24 are configured so as to be paired with the two second header parts 53.

[0035]

Hereinafter, out of the two upper and lower second header parts 53, the second header part 53 disposed on a lower side will be referred to as a lower second header part 54, and the second header part 53 disposed on an upper side will be referred to as an upper second header part 55, in the embodiment.

In addition, the second tube group 24 configured with the second heat transfer tubes 23 connected to the lower second header part 54 will be referred to as a lower second tube group 25, and the second tube group 24 configured with the second heat transfer tubes 23 connected to the upper second header part 55 will be referred to as an upper second tube group 26.

[0036]

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 lower second header part 54 in a communicating state with the inside of the lower second header part 54. 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 lower second header part 54. In the embodiment, the flow passage in the first connection pipe 60 is set as a first communication passage 61 (communication passage) that connects the first header part 52 and the lower second header part 54 together.

[0037]

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 upper second header part 55 in a communicating state with the inside of the upper second header part 55, unlike the first connection pipe 60. 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 first connection pipe 60 is connected to a lower portion of the upper second header part 55. In the embodiment, the flow passage in the second connection pipe 70 is set as a second communication passage 71 (communication passage) that connects the first header part 52 and the upper second header part 55 together.

[0038]

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.

"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, it is sufficient that at least a part of the vertical position of the connection point of the first connection pipe 60 to the first header part 52 and a part of the vertical position of the connection point of the second connection pipe 70 to the first header part 52 overlap each other in the vertical direction.

[0039]

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

[0040]

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.

[0041]

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 of a refrigerant, that is, the density of the refrigerant differs according to a vertical position. Herein, if the connection position of the first connection pipe 60 to the first header part 52 and the connection position 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. On the other hand, as a result of a refrigerant with a low density being introduced into a connection pipe connected to a higher part of the first header part, the mass flow rate of the refrigerant becomes lower.

[0042]

On the contrary, the connection position of the first connection pipe 60 to the first header part 52 and the connection position of the second connection pipe 70 to the first header part 52 are at the same vertical position, in the embodiment. 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 lower second header part 54 and the upper second header part 55 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.

[0043]

After then, a refrigerant introduced in the lower second header part 54 and the upper second header part 55 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.

[0044]

As described above, in the heat exchanger 10 of the invention, the first communication passage 61 of the first connection pipe 60 and the second communication passage 71 of the second connection pipe 70, each of which is connected to one of the plurality of second header parts 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 the respective communication passages. For this reason, the uniformization of flow rates of refrigerants for the plurality of respective communication passages can be 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.

[0045]

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.

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.

[0046]

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

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.

[0047]

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. The branch pipe portions 85 are connected to the lower second header part 54 and the upper second header part 55 respectively. 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 inside of the lower second header part 54 via one branch flow passage 86, that is, the first communication passage 61 that allows the first header part 52 to communicate with the lower second header part 54 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 second header part 55 via the other branch flow passage 86, that is, the second communication passage 71 that allows the inside of the first header part 52 to communicate with the upper second header part 55 by means of the other split flow passage 83 and the other branch flow passage 86 is formed.

[0048]

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 second header part 54 and the upper second header part 55 via the respective branch flow passages 86. Thus, the uniformization of mass flow rates of refrigerants introduced into the lower second header part 54 and the upper second header part 55 can be achieved as in the first embodiment.

[0049]

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.

[0050]

Next, a heat exchanger 90 according to a third embodiment of the invention will be described with reference to Fig. 6 and Fig. 7. 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.

As illustrated in Fig. 6 and Fig. 7, the heat exchanger 90 of the third embodiment is different from the first embodiment in that the number of the second heat transfer tubes 23 of the lower second tube group 25 and the number of the second heat transfer tubes 23 of the upper second tube group 26 are different from each other and the flow passage sectional areas of the first connection pipe 60 and the second connection pipe 70 are different from each other.

[0051]

The heat exchanger 90 of the embodiment is provided such that the number of the second heat transfer tubes 23 of the upper second tube group 26 is larger than the number of the second heat transfer tubes 23 of the lower second tube group 25. Since respective intervals between the second heat transfer tubes 23 in the vertical direction are the same, the upper second header part 55 has a larger dimension in the vertical direction than the lower second header part 54 has according to a difference between the number of the second heat transfer tubes 23 of the lower second tube group 25 and the number of the second heat transfer tubes 23 of the upper second tube group 26.

[0052]

The flow passage sectional area of the second connection pipe 70 is set so as to be larger than the flow passage sectional area of the first connection pipe 60 over the entire region in an extending direction of the first connection pipe 60 and an extending direction of the second connection pipe 70. The flow passage sectional areas are the areas of the sections, which are orthogonal to the extending direction of the first connection pipe 60 and the extending direction of the second connection pipe 70, of the flow passages.

[0053]

As described above, in the embodiment, the flow passage sectional area of the first connection pipe 60 connected to the lower second header part 54 corresponding to the lower second tube group 25 having a relatively smaller number of the second heat transfer tubes 23 is set so as to be relatively smaller. In addition, the flow passage sectional area of the second connection pipe 70 connected to the upper second header part 55 corresponding to the upper second tube group 26 having a relatively larger number of the second heat transfer tubes 23 is set so as to be relatively larger.

[0054]

In the heat exchanger 90 of the third embodiment, a larger amount of refrigerants are introduced into the upper second header part 55 having a relatively larger number of the connected second heat transfer tubes 23. On the other hand, a smaller amount of refrigerants are introduced into the lower second header part 54 having a relatively smaller number of the connected second heat transfer tubes 23. The larger the number of the connected second heat transfer tubes 23, the larger amount of refrigerants circulate in the second heat transfer tubes 23 and thus heat exchange can be caused. Therefore, the uniformization of mass flow rates of refrigerants circulating in the second heat transfer tubes 23 as a whole can be achieved.

[0055]

Next, a heat exchanger 100 according to a fourth embodiment of the invention will be described with reference to Fig. 8 to Fig. 10. 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.

As illustrated in Fig. 8 and Fig. 9, the heat exchanger 100 of the fourth embodiment is different from the first embodiment in that the speed of blowing air received by the second heat transfer tubes 23 of the lower second tube group 25 and the speed of blowing air received by the second heat transfer tubes 23 of the upper second tube group 26 are different from each other and the flow passage sectional areas of the first connection pipe 60 and the second connection pipe 70 are different from each other.

[0056]

In the embodiment, the speed of blowing air received by the upper second tube group 26 is higher than the speed of blowing air received by the lower second tube group 25. A difference in the speed of the received blowing air occurs, for example, due to an air blowing unit 103 illustrated in Fig. 10.

That is, the heat exchanger 100 of the embodiment has a casing 101 accommodating the heat exchanger 100 as illustrated in Fig. 10.

[0057]

The casing 101 has a casing body 102, a ventilating unit 104, and the air blowing unit 103. The casing body 102 is a substantially rectangular parallelepiped box extending in the vertical direction, and has the ventilating unit 104, through which air can circulate inside and outside the casing body 102, for example, on two side surfaces next to each other, out of four side surfaces. The air blowing unit 103 formed of a fan that is rotatable about a vertical axis is provided on a top surface of the casing body 102. When the fan of the ventilating unit 104 operates, air in the casing body 102 is sent toward the outside of the casing 101, that is, from the lower side toward the upper side. Conversely, air is sent from the outside of the casing body 102 into the casing body 102 via the ventilating unit 104. As described above, when the ventilating unit 104 operates such that air is blown from above the casing 101, the heat exchanger 100 disposed in the casing body 102 receives the blown air having a speed that differs according to the vertical direction. Accordingly, in the embodiment, the speed of blowing air received by the upper second tube group 26 is higher than the speed of blowing air received by the lower second tube group 25.

[0058]

In the embodiment, the flow passage sectional area of the second connection pipe 70 is set so as to be larger than the flow passage sectional area of the first connection pipe 60 over the entire region in the extending direction of the first connection pipe 60 and the extending direction of the second connection pipe 70, as in the third embodiment.

[0059]

As described above, in the embodiment, the flow passage sectional area of the first connection pipe 60 connected to the lower second header part 54 corresponding to the lower second tube group 25 that receives blowing air of a lower speed is set so as to be relatively smaller. In addition, the flow passage sectional area of the second connection pipe 70 connected to the upper second header part 55 corresponding to the upper second tube group 26, which receives blowing air of a higher speed and has a relatively larger number of the second heat transfer tubes 23, is set so as to be relatively larger.

[0060]

In such a heat exchanger 100, the higher the speed of blowing air received by the second tube groups 24, the more heat exchange in the second tube groups 24 is caused. Thus, the heat exchange efficiency of the heat exchanger 100 as a whole can be improved by introducing a larger amount of refrigerants into the second header parts 53 connected to the upper second tube group 26 that receives blowing air of a higher speed.

[0061]

Next, a heat exchanger 110 according to a fifth embodiment of the invention will be described with reference to Fig. 11 and Fig. 12. In the fifth 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.

As illustrated in Fig. 11 and Fig. 12, the heat exchanger 110 of the embodiment has three partition plates 58 provided in the turnback header 50. That is, the partition plates 58 are provided at intervals in the vertical direction, and accordingly, a region in the header 30 is partitioned into four regions in the vertical direction. Out of the four regions, a portion that includes the lowermost region is set as the first header part 52, as in the first embodiment. In addition, out of the four regions, portions that each include one of the three upper regions, excluding the lowermost region, are set as the second header parts 53. In the embodiment, one first header part 52 and three second header parts 53 are provided.

[0062]

In the embodiment, in total three connection pipes 120, including the connection pipe 120 that connects the first header part 52 and the lowermost second header part 53 together, out of the three second header parts 53, the connection pipe 120 that connects the first header part 52 and the middle second header part 53 together, out of the three second header parts 53, and the connection pipe 120 that connects the first header part 52 and the uppermost second header part 53 together, out of the three second header parts 53, are provided. A communication passage 121 that allows the first header part 52 to communicate with any one of the second header parts 53 is formed in each of the connection pipes 120.

In addition, connection points of the connection pipes 120 to the first header part 52 are at the same vertical position, as in the first embodiment.

[0063]

In such a heat exchanger 110, the uniformization of mass flow rates of refrigerants introduced from the first header part 52 into the respective second header parts 53 can be achieved as in the first embodiment.

Although an example in which the three second header parts 53 are provided is described in the embodiment, there may be four or more second header parts 53. In this case, also the number of the connection pipes 120 increases according to the number of the second header parts 53.

[0064]

Next, a heat exchanger 130 according to a sixth embodiment of the invention will be described with reference to Fig. 13. In the sixth 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.

The sixth embodiment is different from the first embodiment in that the plurality of first connection pipes 60 and the plurality of second connection pipes 70 are provided.

[0065]

That is, the plurality of (three, in the embodiment) first connection pipes 60 are provided in the sixth embodiment. While the connection points of the first connection pipes 60 to the first header part 52 are at the same vertical position, the connection points of the first connection pipes to the lower second header part 54 are at positions different from each other in the vertical direction. In the embodiment, out of the three first connection pipes 60, the first-tier first connection pipe

60 is connected to a lower portion of the lower second header part 54, the second-tier second connection pipe 70 is connected to a middle portion of the lower second header part 54, and the third-tier first connection pipe 60 is connected to an upper portion of the lower second header part 54.

[0066]

In addition, the plurality of (three, in the embodiment) second connection pipes 70 are also provided in the sixth embodiment. While the connection points of the second connection pipes 70 to the first header part 52 are at the same vertical position, the connection points of the second connection pipes to the upper second header part 55 are at positions different from each other in the vertical direction. In the embodiment, out of the three first connection pipes 60, the first-tier first connection pipe 60 is connected to a lower portion of the upper second header part 55, the second-tier second connection pipe 70 is connected to a middle portion of the upper second header part 55, and the third-tier first connection pipe 60 is connected to an upper portion of the upper second header part 55.

[0067]

In such a heat exchanger 130, the uniformization of mass flow rates of refrigerants introduced into the lower second header part 54 and the upper second header part 55 can be achieved as in the first embodiment.

In particular, in the embodiment, refrigerants are introduced from a plurality of points, of which height positions are different from each other, to the first header part 52 and the second header parts 53. For this reason, by a refrigerant being mixed in each of the first header part 52 and the second header parts 53 in the vertical direction, the homogenization of refrigerants in the first header part 52 and the second header parts 53 can be caused. Accordingly, the uniformization of mass flow rates of refrigerants introduced into the respective second heat transfer tubes 23 can be achieved.

[0068]

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.

[0069]

For example, the branch connection pipe 81 of the second embodiment may be applied to the third to fifth embodiments.

In addition, by combining the third embodiment with the fourth embodiment, the flow passage sectional areas of the first connection pipe 60 and the second connection pipe 70 may be adjusted according to the number of the second heat transfer tubes 23 configuring the second tube groups 24 and the amount of blowing air received by each of the second heat transfer tubes 23.

Reference Signs List

[0070]

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

22 first tube group

23 second heat transfer tube

24 second tube group

25 lower second tube group

26 upper second tube group

28 fan

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

54 lower second header part

55 upper second header part

58 main partition plate

60 first connection pipe

61 first communication passage

70 second connection pipe

71 second communication passage

80 heat exchanger

81 branch connection pipe

82 main pipe portion

83 split flow passage

84 split wall portion

85 branch pipe portion

86 branch flow passage

90 heat exchanger

100 heat exchanger

101 casing

102 casing body

103 air blowing unit

104 ventilating unit

110 heat exchanger

120 connection pipe

121 communication passage

130 heat exchanger

Claims

[Claim 1]

A heat exchanger comprising:

a first tube group that has a plurality of first heat transfer tubes which extend in a horizontal direction, allow a refrigerant to circulate therein, and are arranged at intervals in a vertical direction;

a plurality of second tube groups that have a plurality of second heat transfer tubes which extend in the horizontal direction, allow the refrigerant to circulate therein, and are arranged at intervals in the vertical direction;

a header that includes a header body which is a cylindrical member extending in the vertical direction, and two main partition plates which are provided in the header body and partition a space in the header body into upper and lower regions; and

a first communication passage and a second communication passage that communicate with each other via the space partitioned by the main partition plates,

wherein the header has:

a first header part being a portion that includes the lowermost region among the three regions in the header body; and

a lower second header part and an upper second header part being portions that each include one of the two upper regions, excluding the lowermost region among the three regions in the header body,

wherein the first header part is connected to one end of each of the first heat transfer tubes of the first tube group in a communicating state,

wherein the lower second header part is connected to one end of each of the second heat transfer tubes of the second tube group in a communicating state,

wherein the upper second header part is connected to one end of each of the second heat transfer tubes of the second tube group in a communicating state,

wherein the first communication passage connects the first header part and the lower second header part,

wherein the second communication passage connects the first header part and the upper second header part, and

wherein the number of the second heat transfer tubes of the second tube group of the upper second header part is larger than the number of the second heat transfer tubes of the second tube group of the lower second header part,

wherein a flow passage sectional area of the second communication passage is larger than a flow passage sectional area of the first communication passage.

[Claim 2]

A heat exchanger comprising:

a casing capable of accommodating the heat exchanger;

a first tube group that has a plurality of first heat transfer tubes which extend in a horizontal direction, allow a refrigerant to circulate therein, and are arranged at intervals in a vertical direction;

a plurality of second tube groups that have a plurality of second heat transfer tubes which extend in the horizontal direction, allow the refrigerant to circulate therein, and are arranged at intervals in the vertical direction;

a header that includes a header body which is a cylindrical member extending in the vertical direction, and two main partition plates which are provided in the header body and partition a space in the header body into upper and lower regions; and

a first communication passage and a second communication passage that communicate with each other the space partitioned by the main partition plates,

wherein the header has:

a first header part being a portion that includes the lowermost region among the three regions in the header body; and a lower second header part and an upper second header part being portions that each include one of the two upper regions, excluding the lowermost region among the three regions in the header body,

wherein the first header part is connected to one end of each of the first heat transfer tubes of the first tube group in a communicating state,

wherein the lower second header part is connected to one end of each of the second heat transfer tubes of the second tube group in a communicating state,

wherein the upper second header part is connected to one end of each of the second heat transfer tubes of the second tube group in a communicating state,

wherein the first communication passage connects the first header part and the lower second header part,

wherein the second communication passage connects the first header part and the upper second header part,

wherein an air blowing unit formed of a fan that is rotatable about a vertical axis is provided on a top surface of the casing body,

wherein since the air blowing unit is provided on the top surface of the casing, a speed of blowing air received by the second tube group of the upper second header part is higher than a speed of blowing air received by the second tube group of the lower second header part, wherein

a flow passage sectional area of the second communication passage is set to be larger than a flow passage sectional area of the first communication passage.

[Claim 3]

The heat exchanger according to Claim 2,

wherein the number of the second heat transfer tubes of the second tube group of the upper second header part is set to be larger than the number of the second heat transfer tubes of the second tube group of the lower second header part.

[Claim 4]

An air conditioner comprising the heat exchanger according to any one of Claims 1 to 3.

FIG. 1

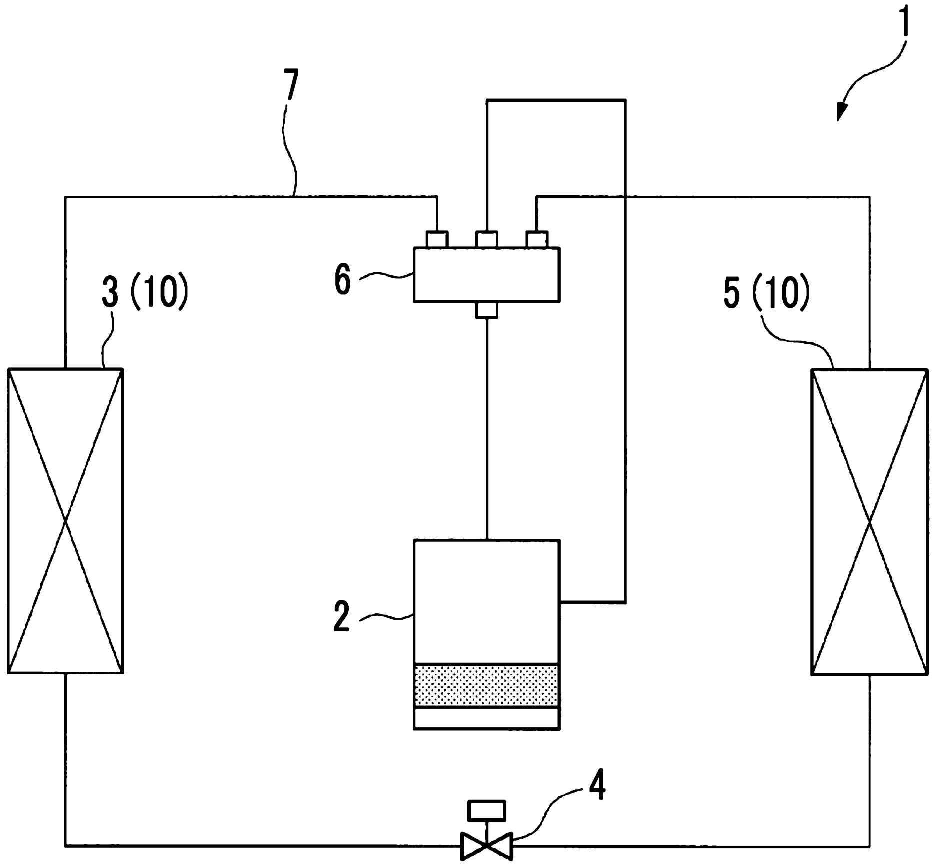

FIG. 2

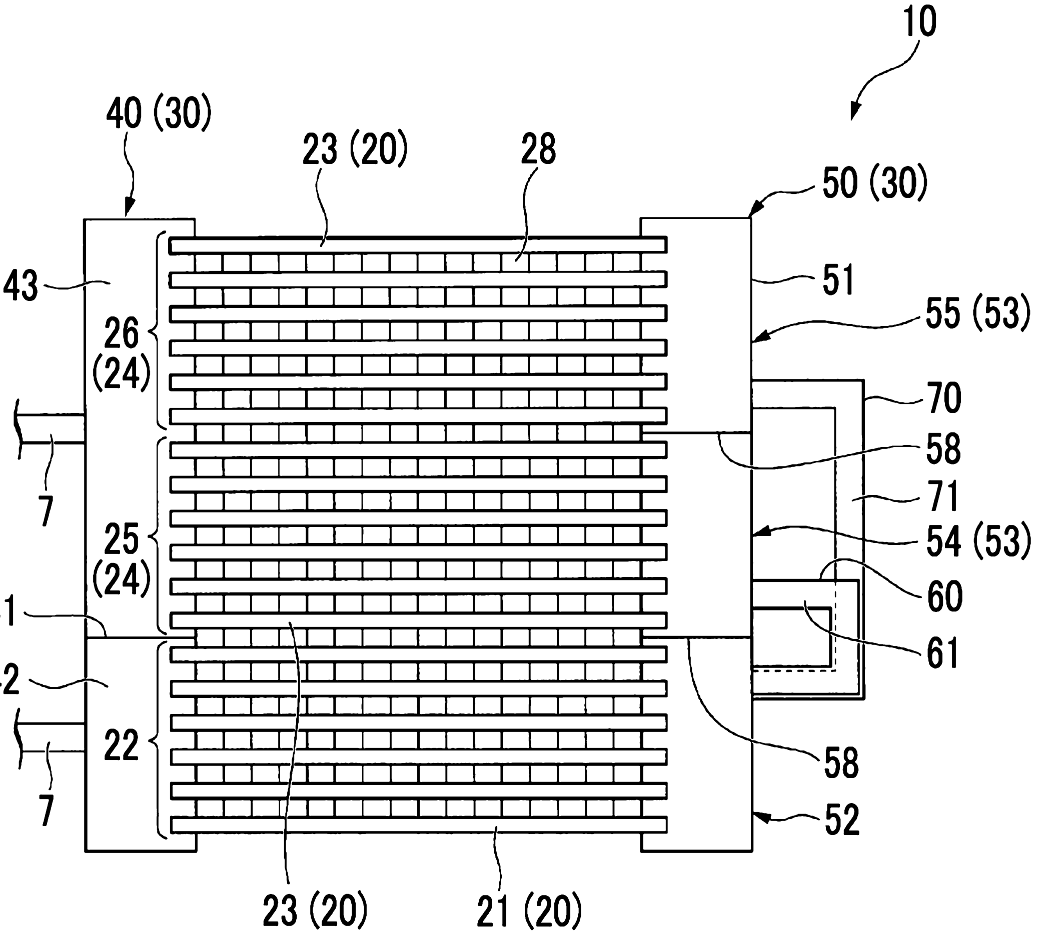
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FIG. 3

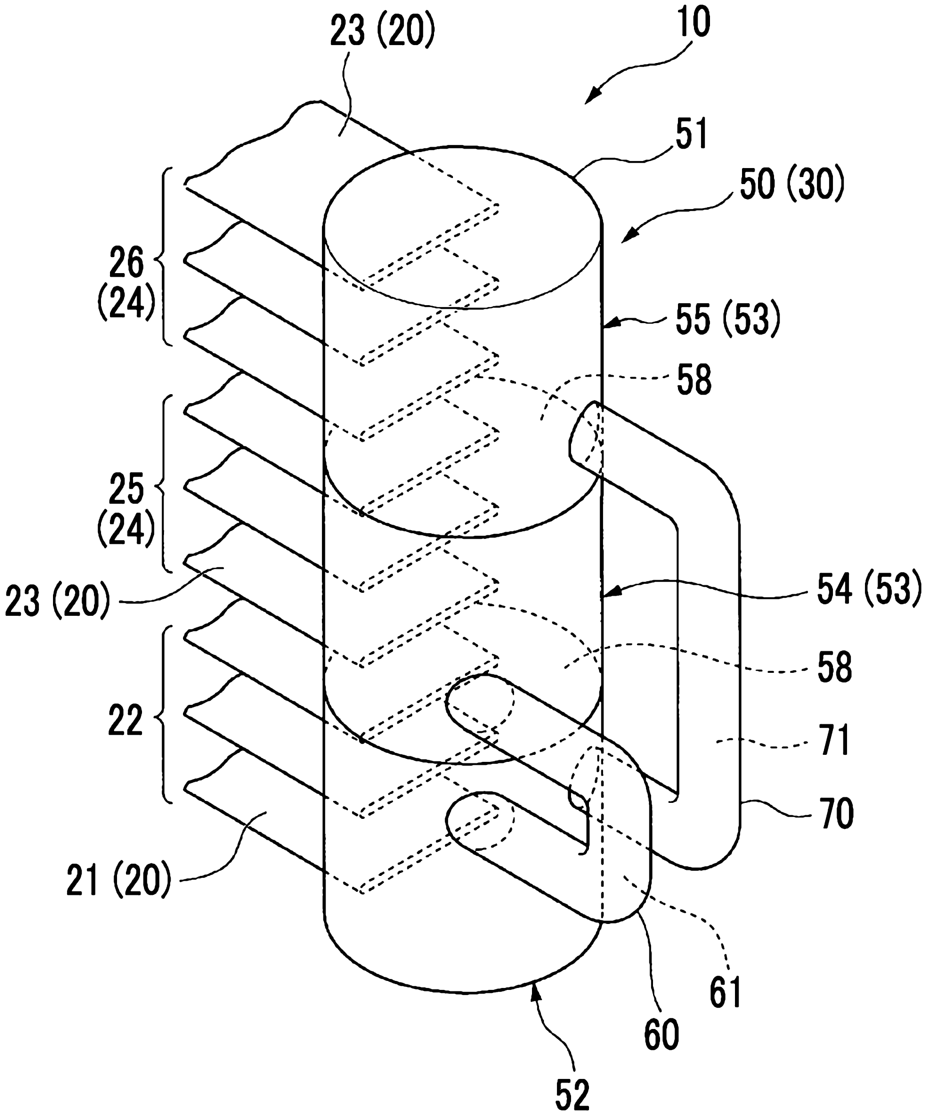

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FIG. 4

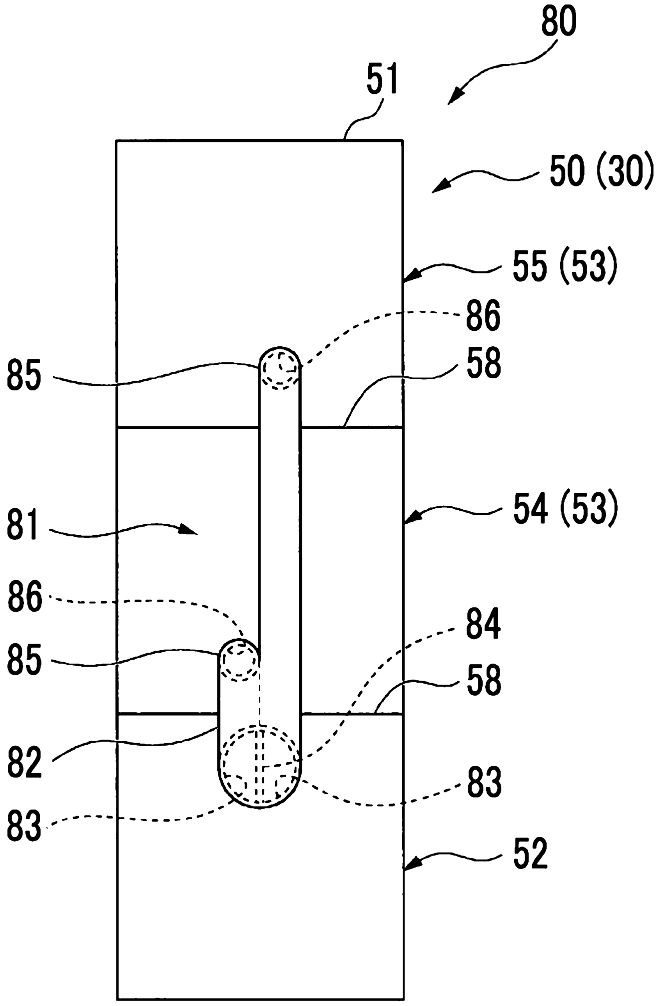

FIG. 5A

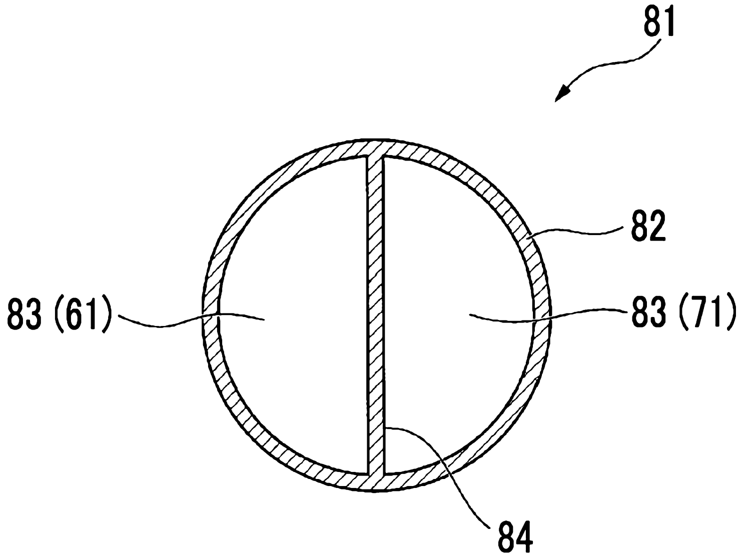

FIG. 5B

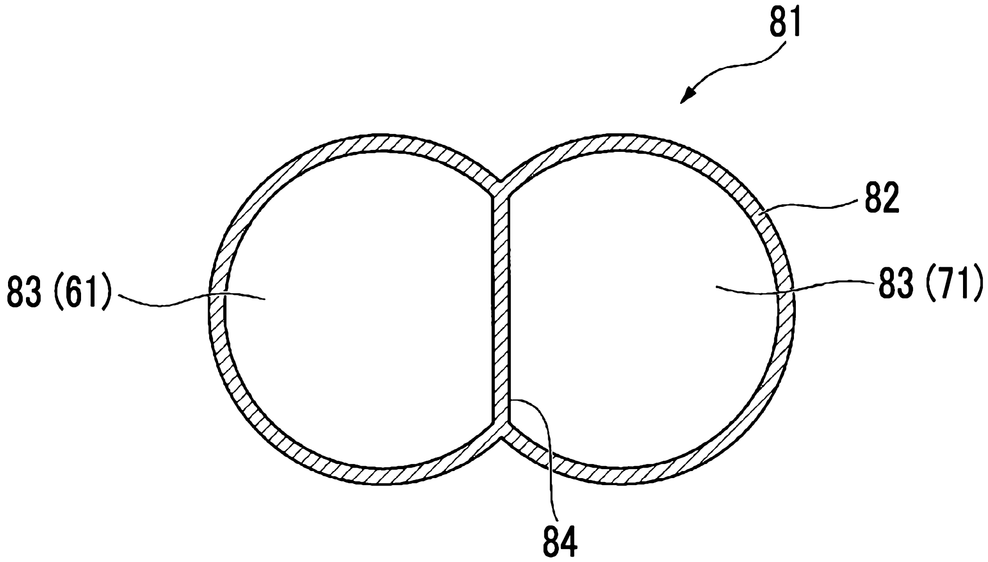

FIG. 6

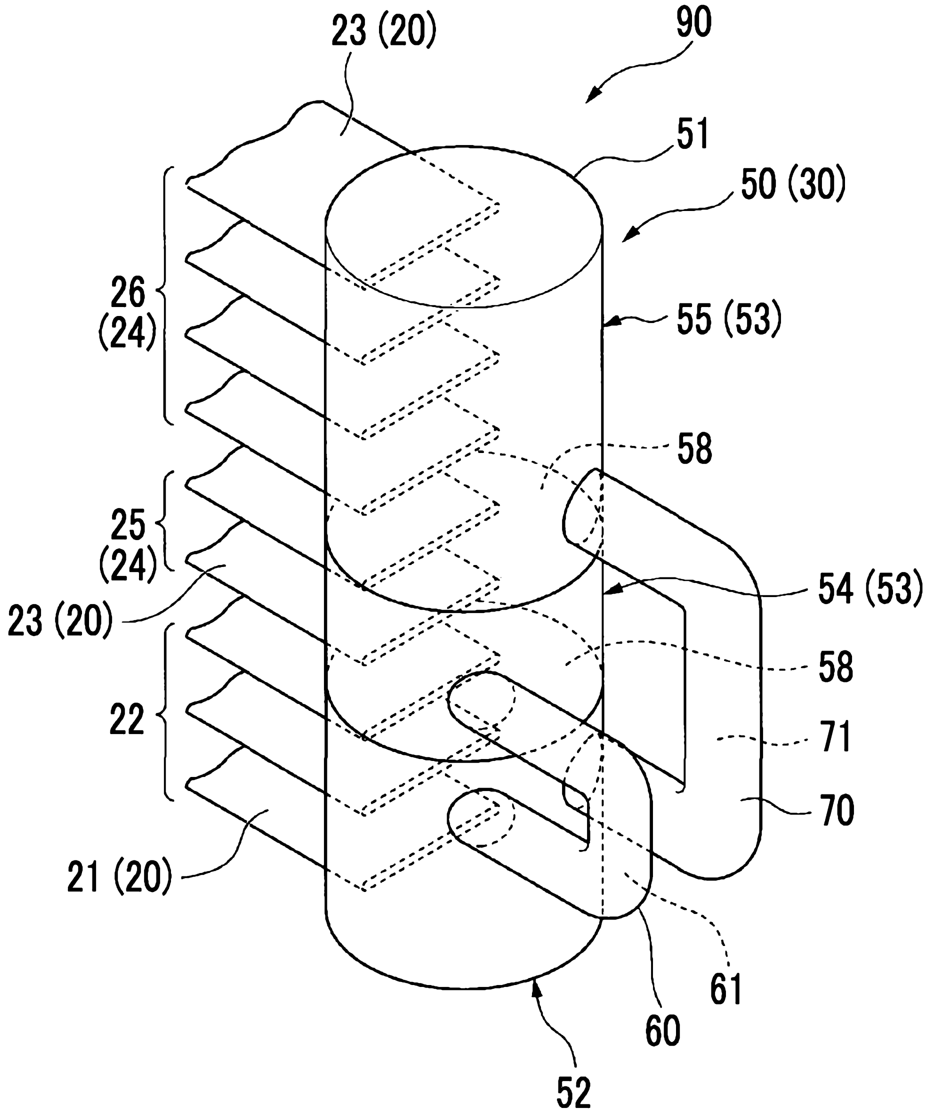
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FIG. 7

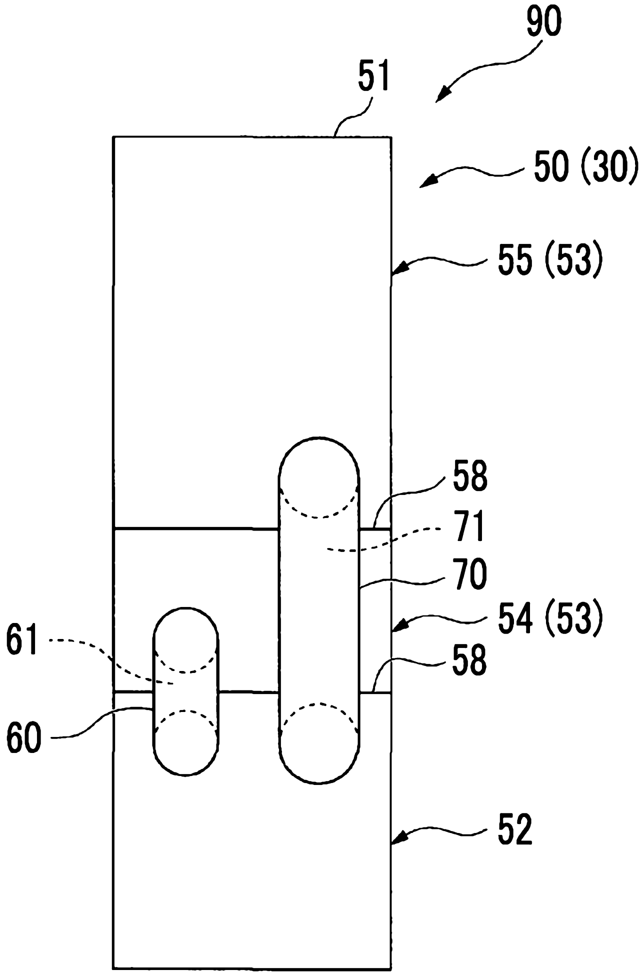

FIG. 8

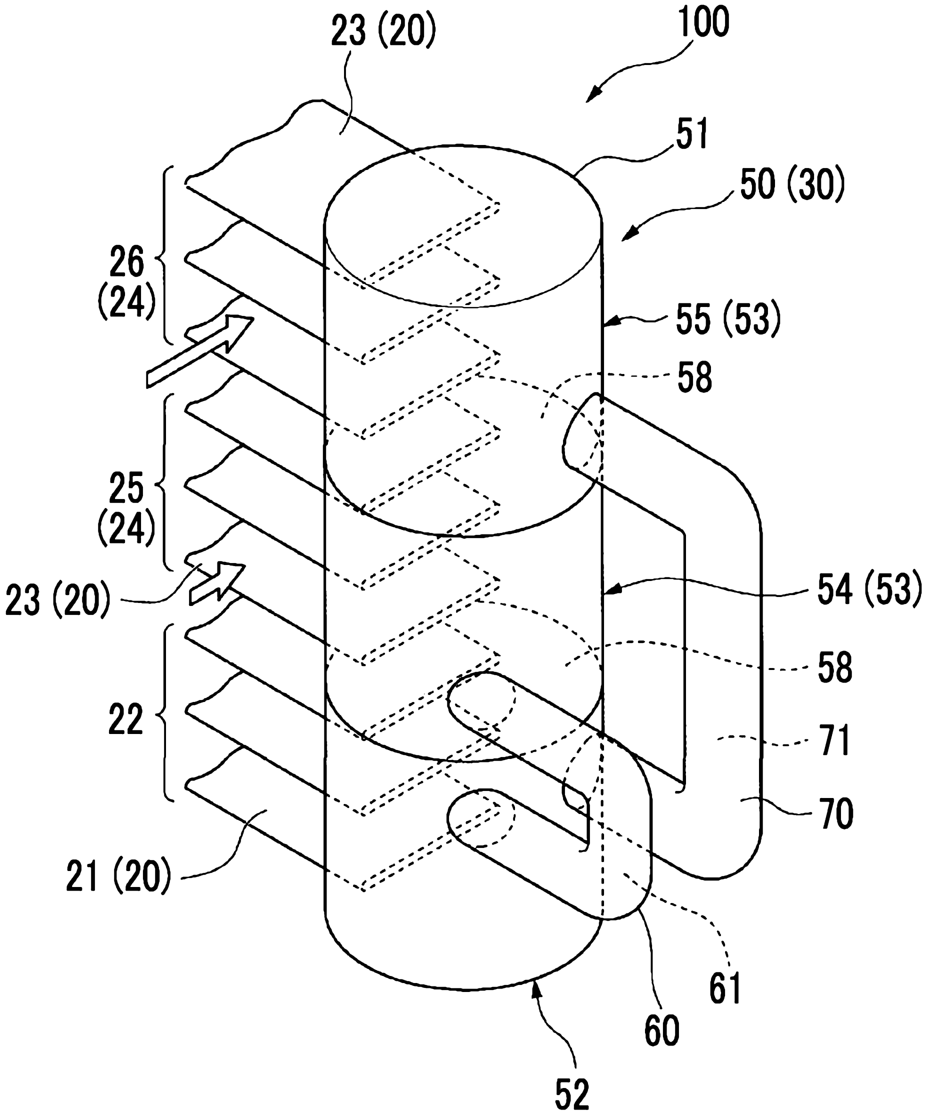

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FIG. 9

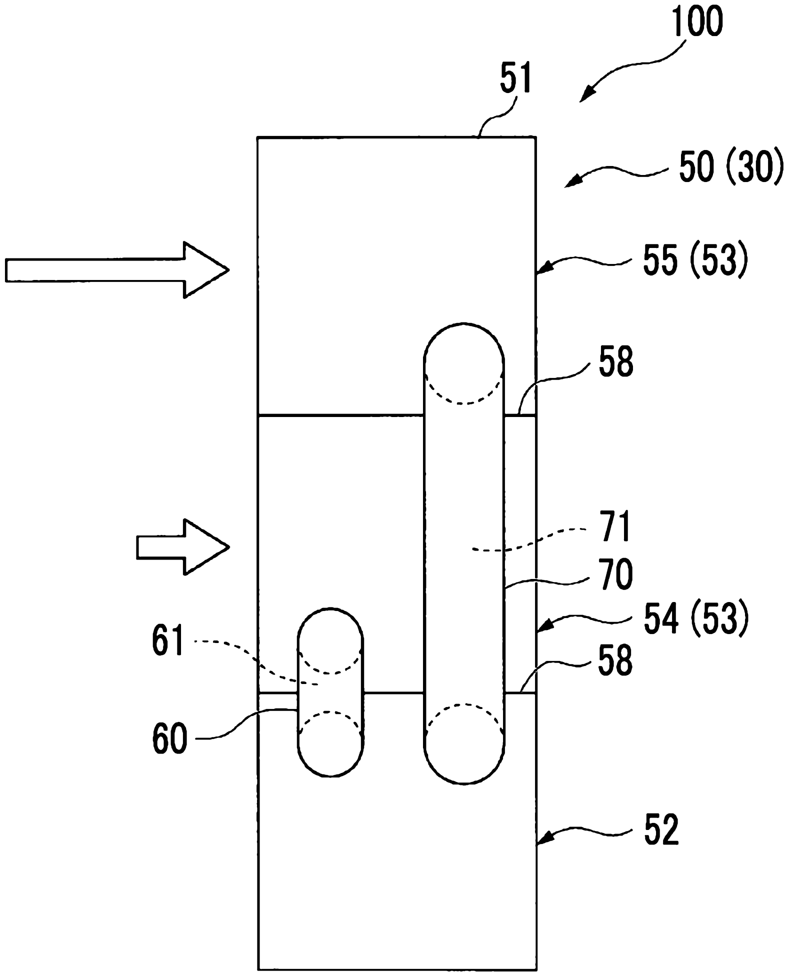


FIG. 10

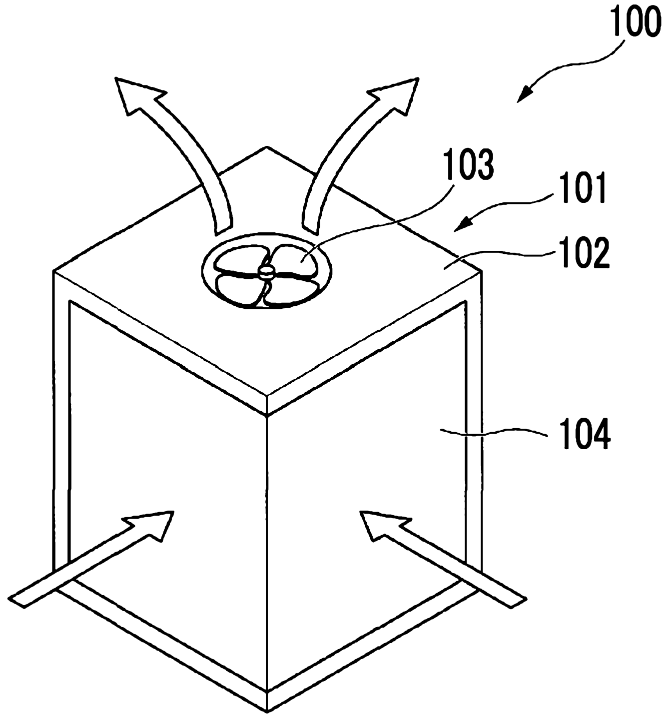
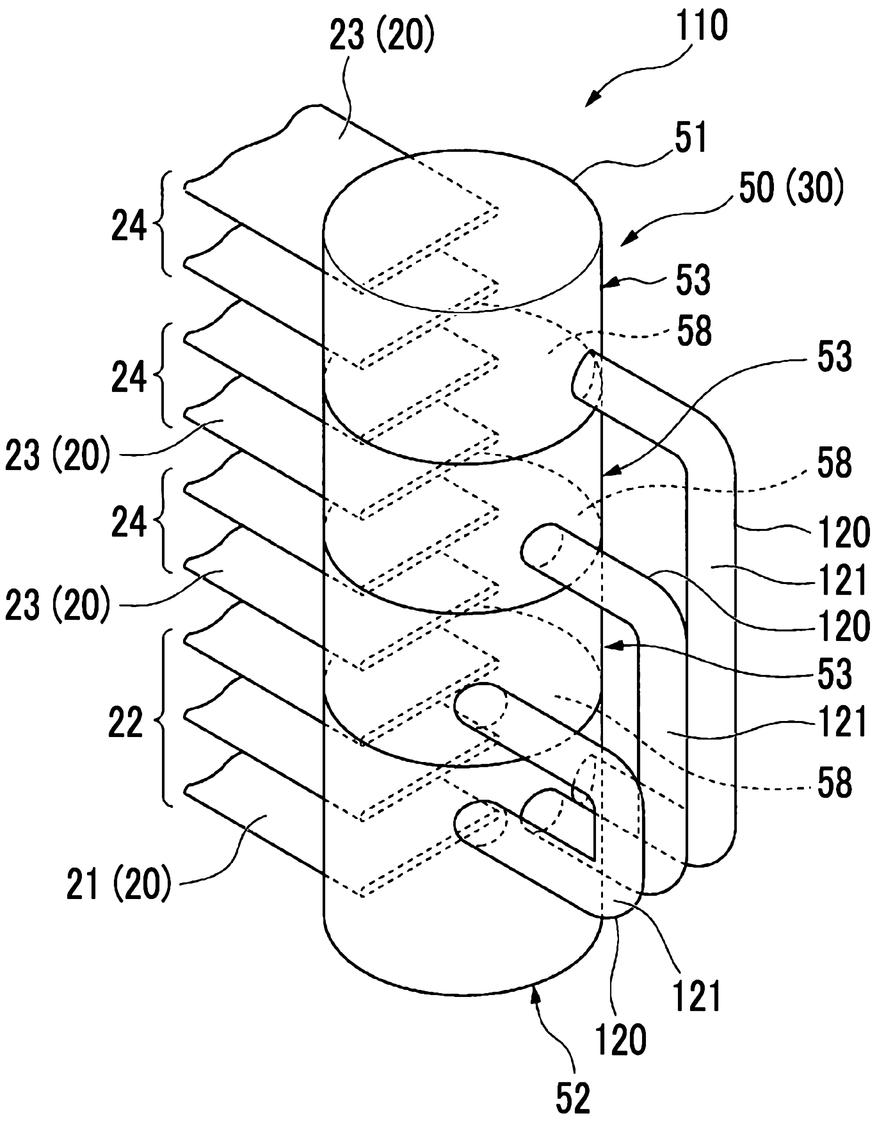


FIG. 11



110
23 (20)
51
50 (30)
24
53
58
53
24
23 (20)
58
24
120
121
23 (20)
120
53
22
121
58
21 (20)
121
120
52

FIG. 12

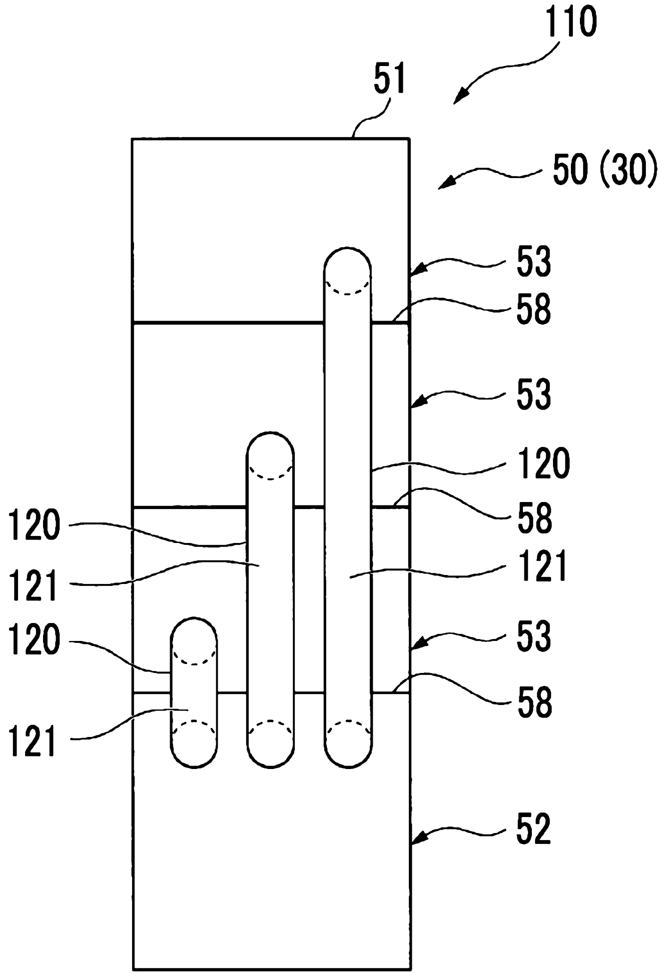


FIG. 13