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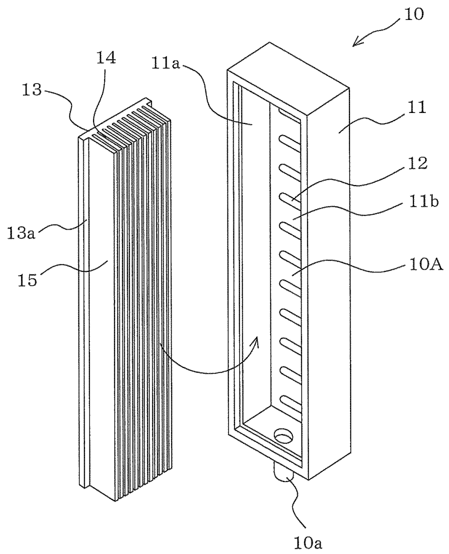
(54) **HEAT-EXCHANGER HEADER AND HEAT EXCHANGER PROVIDED THEREWITH**

(57) A heat exchanger header for a heat exchanger in which refrigerant is flowed in parallel through a plurality of flat tubes 30 disposed in parallel includes a header main body 11 in which a plurality of through-holes 12 to which ends of the plurality of flat tubes 30 are connected are arranged side by side in a longitudinal direction, and a lid body 13 that faces the plurality of through-holes 12 of the header main body 11 and is joined to the header main body 11. At least one chamber communicating with the plurality of through-holes 12 and serving as a refrigerant flow passage is formed between the header main body 11 and the lid body 13. Each of the plurality of through-holes 12 is an inlet side through-hole or an outlet side through-hole to which a refrigerant inlet side end or a refrigerant outlet side end of the plurality of flat tubes 30 is connected. In a part of the lid body 13 that faces the inlet side through-holes, a plurality of grooves extending in the longitudinal direction of the lid body 13 are formed in a lateral direction perpendicular to the longitudinal direction.

FIG. 3



EP 2 865 983 A1

Description

Technical Field

[0001] The present invention relates to a heat exchanger header for a heat exchanger used in a refrigeration cycle apparatus such as an air-conditioning apparatus, and a heat exchanger having the heat exchanger header.

Background Art

[0002] Hitherto, there has been a heat exchanger configured such that a pair of headers extending in the vertical direction are spaced in the lateral direction, a plurality of flat tubes are disposed in parallel between the pair of headers, and both ends of the plurality of heat exchanging tubes communicate with the plurality of headers. In this type of heat exchanger, when it is used as an evaporator, two-phase gas-liquid refrigerant flows into it, and therefore liquid is accumulated in the gravity direction in an inlet side header, whereas gas is accumulated in the upper part in the header. Therefore, there is a problem that refrigerant cannot be equally distributed to each flat tube, and the performance of the heat exchanger degrades.

[0003] So, when a heat exchanger is used as an evaporator, an inlet side header is required to have a function of equally distributing refrigerant. As a header having such a function, hitherto, there has been a header in which a looped flow passage that makes a U-turn in the vertical direction is formed in the header, and an incoming two-phase refrigerant flow is circulated and homogenized in the header, and is distributed to each of a plurality of heat transfer tubes (see, for example, Patent Literature 1).

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2011-85324 (Abstract, Fig. 1)

Summary of Invention

Technical Problem

[0005] However, in the header of Patent Literature 1, since refrigerant is passed through a looped flow passage, there is a problem that pressure loss occurs, and results in a degradation of the heat transfer performance of the heat exchanger.

[0006] In addition, in the header of Patent Literature 1, since it is necessary to separately form a looped flow passage inside the header, there is a problem that the complicated structure results in an increase in cost.

[0007] The present invention has been made in view of such points, and it is an object of the present invention to provide a heat exchanger header that can suppress pressure loss, can equally distribute refrigerant without degrading heat transfer performance of a heat exchanger, and has a simple structure, and a heat exchanger having the heat exchanger header.

Solution to Problem

[0008] A heat exchanger header according to the present invention is a heat exchanger header for a heat exchanger in which refrigerant is flowed in parallel through a plurality of heat transfer tubes disposed in parallel, wherein a plurality of through-holes to which ends of the plurality of heat transfer tubes are connected are arranged side by side in a longitudinal direction, wherein at least one chamber communicating with the plurality of through-holes and serving as a refrigerant flow passage is formed, and wherein each of the plurality of through-holes is an inlet side through-hole or an outlet side through-hole to which a refrigerant inlet side end or a refrigerant outlet side end of the plurality of heat transfer tubes is connected, and in a part of the chamber that faces the inlet side through-holes, a plurality of grooves extending in the longitudinal direction of the header are formed in a lateral direction perpendicular to the longitudinal direction.

Advantageous Effects of Invention

[0009] According to the present invention, a heat exchanger header that can suppress pressure loss, can equally distribute refrigerant without degrading heat transfer performance of a heat exchanger, and has a simple structure can be obtained. Brief Description of Drawings

[0010]

[Fig. 1] Fig. 1 is a schematic perspective view of a heat exchanger 1 employing a heat exchanger header according to Embodiment 1 of the present invention.

[Fig. 2] Fig. 2 is a perspective view showing one of the flat tubes 30 of Fig. 1.

[Fig. 3] Fig. 3 is an exploded perspective view of the inlet header 10 of Fig. 1.

[Fig. 4] Fig. 4 is a sectional view of the inlet header part of Fig. 1 taken along line A-A.

[Fig. 5] Fig. 5 is a diagram showing a refrigerant circuit of a refrigeration cycle apparatus 50 to which the heat exchanger 1 of Fig. 1 is applied.

[Fig. 6] Fig. 6 is a diagram showing the flow of refrigerant in the case where the heat exchanger 1 of Fig. 1 is used as an evaporator.

[Fig. 7] Fig. 7 is a diagram showing the flow state of refrigerant in the inlet header 10.

[Fig. 8] Fig. 8 is a sectional view taken along line B-

B of Fig. 7.

[Fig. 9] Fig. 9 shows the flow state of refrigerant in a header not provided with grooves as a comparative example.

[Fig. 10] Fig. 10 is a diagram showing Modification 1 of the grooves 14 of Fig. 3.

[Fig. 11] Fig. 11 is a diagram showing Modification 2 of the grooves 14 of Fig. 3.

[Fig. 12] Fig. 12 is a diagram showing a heat exchanger 1 A according to Embodiment 2 of the present invention.

[Fig. 13] Fig. 13 is an exploded perspective view of the header 70 of Fig. 1.

[Fig. 14] Fig. 14 shows modifications of the grooves 14 of Fig. 13.

[Fig. 15] Fig. 15 shows a heat exchanger 1 B according to Embodiment 3 of the present invention.

Description of Embodiments

Embodiment 1

[0011] Fig. 1 is a schematic perspective view of a heat exchanger employing a heat exchanger header according to Embodiment 1 of the present invention. In Fig. 1 and the other figures described later, the same reference signs are used for the same or corresponding components, and this is common throughout the specification. The forms of components described in the whole specification are illustrative only, and the present invention is not limited to these descriptions.

[0012] The heat exchanger 1 is a parallel flow heat exchanger in which refrigerant is flowed in parallel, particularly a one-way flow passage type heat exchanger in which refrigerant is flowed from one side to the other side in the whole heat exchanger 1. The heat exchanger 1 has a pair of headers 10 and 20 spaced from each other, a plurality of flat tubes (heat transfer tubes) 30 that are disposed in parallel between the pair of headers 10 and 20 and both ends of which are connected to the pair of headers 10 and 20, and a plurality of fins 40. The pair of headers 10 and 20, the flat tubes 30, and the fins 40 are all formed of aluminum or aluminum alloy.

[0013] The fins 40 are plate-like fins that are stacked at intervals between the pair of headers 10 and 20 and between which air passes, and the plurality of flat tubes 30 are passed therethrough. The fins 40 do not necessarily have to be plate-like fins, and only have to be fins 40 disposed such that air passes in the air passage direction. The fins 40 may be, for example, corrugated fins or the like alternately stacked with the flat tubes 30 in the vertical direction. In short, the fins 40 only have to be fins disposed such that air passes in the air passage direction.

[0014] The flat tubes 30 have a plurality of through-holes 30a serving as refrigerant flow passages as shown in Fig. 2. Heat transfer tubes are not limited to flat tubes, and circular tubes and tubes having any other shape can be used.

[0015] Of the pair of headers 10 and 20, the inlet header 10 on the refrigerant inlet side of the plurality of flat tubes 30 is connected to a refrigerant inlet pipe 10a, and the outlet header 20 on the refrigerant outlet side of the plurality of flat tubes 30 is connected to a refrigerant outlet pipe 20a.

[0016] The present invention has a characteristic in, of the pair of headers 10 and 20, particularly the header on the inlet side (hereinafter referred to as inlet header 10). The structure thereof will be described with reference to Fig. 3 below.

[0017] Fig. 3 is an exploded perspective view of the inlet header 10 of Fig. 1. Fig. 4 is a sectional view of the inlet header part of Fig. 1 taken along line A-A.

[0018] The inlet header 10 has a box-like header main body 11 with one side open, and a plate-like lid body 13 covering an opening 11 a of the header main body 11, and at least one chamber 10A serving as a refrigerant flow passage is formed therebetween. In a bottom surface 11 b of the header main body 11 that faces the opening 11 a, a plurality of through-holes 12 serving as inlet side through-holes are arranged side by side along the longitudinal direction of the header main body 11. The refrigerant inlet side ends of the plurality of flat tubes 30 are connected to the plurality of through-holes 12, and communicate with the chamber 10A. The refrigerant inlet pipe 10a is connected to the inlet header 10.

[0019] On a surface 13a of the lid body 13 that faces the through-holes 12 in the at least one chamber 10A, a plurality of grooves 14 extending in the longitudinal direction are formed over the entire length in the lateral direction perpendicular to the longitudinal direction. Specifically, the grooves 14 are formed by the gaps between a plurality of protrusions 15 protruding from the lid body 13. The grooves 14 are provided in order to draw refrigerant liquid flowing into the inlet header 10 into the grooves by the effect of surface tension and to thereby equally distribute the refrigerant from the inlet header 10 to each pass.

[0020] When manufacturing the inlet header 10 thus configured, the box-like header main body 11 is formed by cutting or the like, and the through-holes 12 are formed in the header main body 11. The lid body 13 is formed by cutting or the like. The lid body 13 is fittably configured so as to be able to be temporarily fastened to the opening 11 a of the header main body 11, and brazing filler metal is applied to the fitting parts.

[0021] When manufacturing the whole heat exchanger 1, the lid body 13 is fitted in and temporarily fastened to the opening 11a of the header main body 11, and, in a state where the outlet header 20, the flat tubes 30, and the fins 40 are all assembled, the whole is joined by brazing at the same time.

[0022] Fig. 5 is a diagram showing a refrigerant circuit of a refrigeration cycle apparatus 50 to which the heat exchanger 1 of Fig. 1 is applied.

[0023] The refrigeration cycle apparatus 50 includes a compressor 51, a condenser 52, an expansion valve 53 as a pressure reducing device, and a evaporator 54. The heat exchanger 1 is used as at least one of the condenser 52 and the evaporator 54. Gas refrigerant discharged from the compressor 51 flows into the condenser 52, exchanges heat with air passing through the condenser 52 to become high-pressure liquid refrigerant, and flows out. The high-pressure liquid refrigerant flowing out of the condenser 52 is reduced in pressure by the expansion valve 53 to become low-pressure two-phase gas-liquid refrigerant, and flows into the evaporator 54. The low-pressure two-phase gas-liquid refrigerant flowing into the evaporator 54 exchanges heat with air passing through the evaporator 54 to become low-pressure gas refrigerant, and is sucked into the compressor 51 again.

[0024] Fig. 6 is a diagram showing the flow of refrigerant in the case where the heat exchanger 1 of Fig. 1 is used as an evaporator.

[0025] Two-phase gas-liquid refrigerant flowing out of the expansion valve 53 flows through the refrigerant inlet pipe 10a into the inlet header 10. The refrigerant flowing into the inlet header 10 flows from one end to the other end of the flat tubes 30 constituting each pass of the heat exchanger 1, merges in the outlet header 20, and flows through the refrigerant outlet pipe 20a to the outside.

[0026] Next, the operation inside the inlet header will be described. Fig. 7 is a diagram showing the flow state of refrigerant in the inlet header 10. Fig. 8 is a sectional view taken along line B-B of Fig. 7, and is a schematic diagram showing a state where liquid refrigerant is accumulated between the grooves in the inlet header 10. Fig. 9 includes diagrams (a) and (b) showing the flow state of refrigerant in a header not provided with grooves 14 as a comparative example.

[0027] First, the flow state of refrigerant in the comparative example will be described with reference to Fig. 9. When the amount of refrigerant circulating in the refrigerant circuit is large, two-phase gas-liquid refrigerant flowing through the refrigerant inlet pipe 10a into the inlet header 10 accumulates in the upper part of the inlet header 10 owing to momentum at the time of inflow as shown in Fig. 9 (a). In contrast, when the amount of refrigerant circulating in the refrigerant circuit is small, two-phase gas-liquid refrigerant flowing through the refrigerant inlet pipe 10a into the inlet header 10 accumulates in the lower part of the inlet header 10 by the influence of gravity. As described above, in the case of a configuration in which an inlet header 10 is not provided with grooves 14, liquid refrigerant concentrates in the upper part or the lower part, and distribution to each pass is unequal.

[0028] Next, the flow state of refrigerant in the inlet header 10 of Embodiment 1 will be described with reference to Fig. 7 and Fig. 8. Two-phase gas-liquid refrigerant flowing through the refrigerant inlet pipe 10a into the inlet header 10 flows in the inlet header 10, and liquid refrigerant is drawn into the grooves 14 by the effect of surface tension. Thus, the liquid refrigerant is held equally in the longitudinal direction in the inlet header 10, and the amount of liquid refrigerant flowing into each flat tube 30 is equalized.

[0029] As described above, according to Embodiment 1, by providing the lid body 13 with a plurality of grooves 14 and causing surface tension to act, unevenness of liquid refrigerant can be suppressed, and refrigerant can be equally distributed to and caused to flow into each of the plurality of flat tubes 30. Thus, the heat exchange efficiency can be improved, and the capacity in the case where the heat exchanger 1 is used as an evaporator can be exerted to the maximum.

[0030] Since Embodiment 1 utilizes the action of surface tension of liquid refrigerant to prevent uneven refrigerant distribution, the pressure loss can be suppressed as compared to the conventional configuration, and the performance degradation in the case where the heat exchanger 1 is used as an evaporator can be suppressed.

[0031] Since the inlet header 10 of Embodiment 1 is composed of a header main body 11 and a lid body 13 having grooves 14, and has a simple structure, it is easy to manufacture, and can be reduced in cost.

[0032] The inlet header of the present invention is not limited to the structure shown in Fig. 3, and various modifications, such as the following (1) and (2), may be made without departing from of the scope of the present invention.

[0033] (1) Fig. 10 is a diagram showing Modification 1 of the grooves 14 of Fig. 3.

[0034] In the configuration of the grooves 14 of Embodiment 1 shown in Fig. 5, the protrusions 15 are all the same in height. As shown in Fig. 10, the height of the protrusions 15 may be <u>alternately large and small</u> in the lateral direction of the lid body 13 (the vertical direction in Fig. 10). In this case, the end faces (inclined surfaces) of the grooves 14 closest to the flat tubes 30 (shown by dashed line 14a in Fig. 10) are wide as compared to the configuration in which the protrusions 15 are all the same in height as shown in Fig. 5. Therefore, it can be expected that the effect of drawing liquid refrigerant is improved. The height of the protrusions 15 is not limited to the configuration in which the height of the protrusions 15 is alternately long and short. As long as every two of the protrusions 15 adjacent in the lateral direction of the lid body 13 differ in height, the same effects can be expected. The following Modification 2 is another example of the configuration in which every two of the protrusions 15 adjacent in the lateral direction of the lid body 13 differ in height.

[0035] (2) Fig. 11 is a diagram showing Modification 2 of the grooves 14 of Fig. 3.

[0036] The smaller the width (the length in the vertical direction in Fig. 11) of the grooves 14 and the larger the height of the grooves 14, the larger the refrigerant holding action in the grooves 14 due to surface tension. Liquid refrigerant flowing into the inlet header 10 tends to accumulate at both ends in the lateral direction of the lid body 13. So, in Modification 2, the height of the protrusions 15 increases from both ends toward the central part in the lateral direction and the height of the grooves 14 is adjusted so that the refrigerant holding force increases toward the central part in the lateral direction. Thus, unevenness of refrigerant is suppressed also in the lateral direction, and the amount of refrigerant in each groove 14 can be equalized in both the longitudinal direction and the lateral direction. As a result, it can be expected that refrigerant can be more equally distributed to each of the flat tubes 30. Although an example is shown here in which only the height of the grooves 14 is varied, the width of the grooves 14 may be decreased toward the central part.

[0037] As described above, the present invention is characterized in that the inlet header 10 is provided with a plurality of grooves 14. As a heat exchanger 1 to which the character is applied, in Embodiment 1, an example of a one-way flow passage type heat exchanger is shown in which refrigerant flows from one side to the other in the whole heat exchanger. The character can also be applied to a U-turn flow passage type heat exchanger in which refrigerant flows while making U-turns. The configuration in which the present invention is applied to a U-turn flow passage type heat exchanger will be described below with reference to the following Embodiment 2 and Embodiment 3.

Embodiment 2

[0038] Fig. 12 is a diagram showing a heat exchanger 1 A according to Embodiment 2 of the present invention.

[0039] The heat exchanger 1 A is a parallel flow heat exchanger in which refrigerant is flowed in parallel, particularly a U-turn flow passage type heat exchanger. Here, a configuration example is shown in which the number of passes is five.

[0040] The heat exchanger 1 A has a pair of headers 70 and 80 spaced from each other, a plurality of (20 here) flat tubes (heat transfer tubes) 30 that are disposed in parallel between the pair of headers 70 and 80 and both ends of which are connected to the pair of headers 70 and 80, and a plurality of fins 40. The pair of headers 70 and 80, the flat tubes 30, and the fins 40 are all formed of aluminum or aluminum alloy. The configurations of the flat tubes 30 and the fins 40 are the same as Embodiment 1.

[0041] Fig. 13 is an exploded perspective view of the header 70 of Fig. 1.

[0042] The header 70 has a box-like header main body 71 with one side open. In a bottom surface 71 b of the header main body 71 that faces the opening 71 a, a plurality of through-holes 72 to which a plurality of flat tubes 30 are connected are arranged side by side along the longitudinal direction of the header main body 71. Two partition plates 73 are provided inside the header main body 71, and three independent chambers A, B, and C that communicate with the plurality of through-holes 12 and serve as refrigerant flow passages are formed, and are covered by lid bodies 74A, 74B, and 74C, respectively.

[0043] The flow of refrigerant in the heat exchanger 1 A will be described later. A plurality of grooves 14 having the same function as Embodiment 1 are formed in parts of the lid bodies 74A, 74B, and 74C that face the refrigerant inlet side ends of the flat tubes 30. A specific description will be given below.

[0044] The chamber A is an inflow chamber into which refrigerant from the outside flows. The refrigerant inlet side ends of the flat tubes 30 are connected to the plurality of through-holes 72 communicating with the chamber A, and therefore grooves 14 are formed on the whole of the lid body 74A. The chamber B is a U-turn chamber serving as a U-turn flow passage. Of the plurality of through-holes 72 communicating with the chamber B, the upper half is connected to the refrigerant inlet side ends of the flat tubes 30, and the lower half is connected to the refrigerant outlet side ends of the flat tubes 30, and therefore grooves 14 are formed on the upper half of the lid body 74B. The chamber C is an outflow chamber from which refrigerant flows to the outside. The plurality of through-holes 72 communicating with the chamber C are connected to the refrigerant outlet side ends of the flat tubes 30, and therefore grooves 14 are not formed on the lid body 74C. Hereinafter, of the plurality of through-holes 72, the through-holes to which the refrigerant inlet side ends of the flat tubes 30 are connected may be referred to as inlet side through-holes, and the through-holes to which the refrigerant outlet side ends of the flat tubes 30 are connected may be referred to as outlet side through-holes.

[0045] On the other hand, the header 80 is provided with one partition plate 83 as shown in Fig. 12, and the inside thereof is divided into two chambers D and E. As with the header 70, the chambers D and E are covered by lid bodies 84D and 84E, respectively. Similarly to the above, a plurality of grooves 14 are formed in parts of the lid bodies 84D and 84E that face the inlet side through-holes of the flat tubes 30. Specifically, in each of the lid bodies 84D and 84E, a plurality of grooves 14 are formed on the upper half thereof.

[0046] When manufacturing the header 70 thus configured, the header main body 71 is formed by cutting or the like, and the through-holes 72 are formed in the header main body 71. The lid bodies 74A, 74B, and 74C are formed by cutting or the like. The lid bodies 74A, 74B, and 74C are fittably configured so as to be able to be temporarily fastened to the openings of the chambers A, B, and C of the header main body 11, and brazing filler metal is applied to the fitting parts. The header 80 can be manufactured in the same manner.

[0047] When manufacturing the whole heat exchanger 1 B, the lid bodies 74A, 74B, and 74C are fitted in and temporarily fastened to the openings of the chambers A, B, and C, respectively, of the header 70, and similarly, the lid bodies 84D and 84E are fitted in and temporarily fastened to the openings of the chambers D and E, respectively, of the header 80. In a state where the flat tubes 30 and the fins 40 are all assembled, the whole is joined by brazing at the same time.

[0048] The flow of refrigerant in the heat exchanger 1 will be described with reference to Fig. 12 below. Here, the flow of refrigerant in the case where the heat exchanger 1 is used as an evaporator. In Fig. 12, the solid arrows show the flow of refrigerant.

[0049] Two-phase gas-liquid refrigerant flowing through the refrigerant inlet pipe 10a flows into the chamber A, flows from one end to the other end of a flat tube group connected to the chamber A, and flows into the chamber D. The refrigerant flowing into the chamber D makes a U-turn here, flows from one end to the other end of another flat tube group connected to the chamber D, and flows into the chamber B. The refrigerant flowing into the chamber B makes a U-turn here, flows from one end to the other end of another flat tube group connected to the chamber B, and flows into the chamber E. The refrigerant flowing into the chamber E makes a U-turn here, and flows from one end to the other end of another flat tube group connected to the chamber E. The refrigerant flowing out of this other end merges in the chamber C, and flows through the refrigerant outlet pipe 20a to the outside.

[0050] In the above flow of refrigerant, since grooves 14 are provided so as to face the refrigerant inlet side end of each flat tube group, as in Embodiment 1, an uneven flow of refrigerant is suppressed by the effect of surface tension of liquid refrigerant, and refrigerant is substantially equally distributed from each chamber to each pass.

[0051] As described above, according to Embodiment 2, also in a U-turn flow passage type heat exchanger, the same advantageous effects as Embodiment 1 can be obtained.

[0052] In Embodiment 2, in the plurality of protrusions 15 formed on the lid bodies 74B, 84D, and 84E of the chambers B, D, and E serving as U-turn chambers, the positions of the ends closest to the border between the inlet side through-hole group and the outlet side through-hole group are all the same. However, they may be as shown in Fig. 14.

[0053] Fig. 14 shows modifications of the grooves 14 of Fig. 13 and includes views of the lid body 74B, 84D, 84E as viewed from the side of the surface on which grooves 14 are formed.

[0054] As shown in Fig. 14 (a), in the plurality of protrusions 15, the positions of the ends closest to the border between the inlet side through-hole group and the outlet side through-hole group may be alternately staggered in the lateral direction of the lid body. In this case, the end faces of the grooves 14 closest to the border are inclined surfaces, the end faces are wide as compared to a configuration in which the positions of the ends are all the same as shown in Fig. 13, and therefore it can be expected that the effect of drawing liquid refrigerant is improved. The positions of the ends of the protrusions 15 are not limited to such an alternately staggered configuration. As long as every two of the protrusions 15 adjacent in the lateral direction of the lid body differ in position, the same effect can be expected.

[0055] Fig. 14 (b) shows another example of the configuration in which every two of the protrusions 15 adjacent in the lateral direction of the lid body differ in position. As shown, the length in the longitudinal direction of the protrusions 15 may decrease toward the central part in the lateral direction, or, although not shown, the length in the longitudinal direction of the protrusions 15 may increase toward the central part in the lateral direction.

[0056] Modifications applied to the same component part as that of Embodiment 1 are also applied to Embodiment 2. Modifications described in Embodiment 2 may be combined with modifications described in Embodiment 1. The same can be said also in Embodiment 3 described later.

Embodiment 3

[0057] Embodiment 3 corresponds to a configuration in which a plurality of (two here) lines of U-turn flow passage type heat exchangers of Embodiment 2 are provided in the air passage direction.

[0058] Fig. 15 includes diagrams showing a heat exchanger according to Embodiment 3 of the present invention. Fig. 15 (a) is a schematic side view of the heat exchanger as viewed from a direction perpendicular to the air passage direction shown by dashed arrows. Fig. 15 (b) is a schematic sectional view of an upstream side heat exchanging unit 1Ba on the upstream side in the air passage direction. Fig. 15 (c) is a schematic sectional view of a downstream side heat exchanging unit 1 Bb on the downstream side in the air passage direction. Fig. 15 (d) is a plan view of the heat exchanger. Embodiment 3 will be described below focusing on differences from Embodiment 2.

[0059] The heat exchanger 1B has a heat exchanger 1A that is the same as Embodiment 2, as the upstream side heat exchanging unit 1Ba, and has the downstream side heat exchanging unit 1 Bb on the downstream side in the air passage direction. The upstream side heat exchanging unit 1Ba and the downstream side heat exchanging unit 1 Bb are connected by an inter-line pipe 90.

[0060] Whereas the upstream side heat exchanging unit 1Ba has five passes, the downstream side heat exchanging unit 1Bb has ten passes. The downstream side heat exchanging unit 1 Bb has more passes than the upstream side heat exchanging unit 1Ba. The reason that the number of passes differs between the upstream side heat exchanging unit 1Ba and the downstream side heat exchanging unit 1 Bb will be described later. The downstream side heat exchanging unit 1Bb is the same as the upstream side heat exchanging unit 1Ba except that it differs in the configuration of the header part from the upstream side heat exchanging unit 1Ba.

[0061] A header 700 to which the inter-line pipe 90 is connected in the downstream side heat exchanging unit 1 Bb differs in the number of partition plates from the upstream side heat exchanging unit 1Ba. The header

700 is provided with one partition plate 703, and two chambers F and G are formed therein. A header 800 is provided with no partition plate, and one chamber H is formed in the whole thereof. As in Embodiments 1 and 2, grooves 14 are provided in parts of the headers 700 and 800 of the downstream side heat exchanging unit 1 Bb that face the refrigerant inlet side end of each flat tube 30.

[0062] The flow of refrigerant in the heat exchanger 1 B will be described with reference to Fig. 15 below. Here, the flow of refrigerant in the case where the heat exchanger 1 is used as an evaporator. In Fig. 15, the solid arrows show the flow of refrigerant.

[0063] The flow of refrigerant in the upstream side heat exchanging unit 1Ba of the heat exchanger 1 B is the same as that in Embodiment 2. Refrigerant flowing out of the refrigerant outlet pipe 20a of the upstream side heat exchanging unit 1Ba flows through the inter-line pipe 90 and the refrigerant inlet pipe 100a into the chamber F of the downstream side heat exchanging unit 1 Bb. The refrigerant flowing into the chamber F flows from one end to the other end of a flat tube group communicating with the chamber F, and flows into the chamber H. The refrigerant flowing into the chamber H makes a U-turn here, flows from one end to the other end of another flat tube group connected to the chamber H. The refrigerant flowing out of this other end merges in the chamber G, and flows through the refrigerant outlet pipe 200a to the outside.

[0064] In the above flow of refrigerant, since grooves 14 are provided so as to face the refrigerant inlet side end of each flat tube group, as in Embodiments 1 and 2, an uneven flow of refrigerant is suppressed by the effect of surface tension of liquid refrigerant, and refrigerant is substantially equally distributed from each chamber to each pass.

[0065] Next, the reason that the number of passes differs between the upstream side heat exchanging unit 1Ba and the downstream side heat exchanging unit 1 Bb will be described.

[0066] When the heat exchanger 1 B is used as an evaporator, refrigerant inflows in a two-phase gas-liquid state, and finally outflows in a state of gas refrigerant. Therefore, the quality increases as refrigerant flows toward the second half of the flow passage. When the quality is low, the pressure loss during passing through the flow passage is small, and therefore it is preferable to increase the flow rate of refrigerant to increase the heat transfer coefficient. On the other hand, when the quality is high, the pressure loss during passing through the flow passage is large, and therefore it is preferable to decrease the flow rate of refrigerant. The larger the number of passes, the lower the flow rate of refrigerant.

[0067] In the upstream side heat exchanging unit 1Ba corresponding to the first half of the flow passage in the heat exchanger 1 B, the quality of refrigerant is low. Therefore, the number of passes is reduced to increase the flow rate of refrigerant, and to increase the heat transfer coefficient. On the other hand, in the downstream side heat exchanging unit 1 Bb corresponding to the second half of the flow passage, the quality is high. Therefore, the number of passes is increased to reduce the flow rate of refrigerant, and to reduce the pressure loss.

[0068] As described above, according to Embodiment 3, the same advantageous effects as Embodiment 1 and 2 can be obtained, and owing to the multi-line configuration, the heat exchange capacity can be improved. Since the number of passes on the upstream side in the air passage direction where the quality of passing refrigerant is low is reduced to increase the flow rate of refrigerant, and to increase the heat transfer coefficient, the heat exchange capacity can also be improved thereby.

[0069] Although a two-line configuration is described in Embodiment 3, a three or more-line configuration may be used.

[0070] Although, in Embodiments 1 to 3, examples are shown in which the outer shape of header is square, the outer shape of header is not limited to a square shape, and may be a cylindrical shape. In the case of a multi-line configuration as in Embodiment 3, a square shape is preferable in terms of securing the size required as a header and causing lines to interfere with each other.

Reference Signs List

[0071] 1 heat exchanger 1A heat exchanger 1B heat exchanger 1Ba upstream side heat exchanging unit 1Bb downstream side heat exchanging unit 10 header (inlet header) 10A chamber 10a refrigerant inlet pipe 11 header main body 11 a opening 11 b bottom surface 12 through-holes 13 lid body 13a surface 14 grooves 15 protrusions 20 header (outlet header) 20a refrigerant outlet pipe 30 flat tubes 30a through-holes 40 fins 50 refrigeration cycle apparatus 51 compressor 52 condenser 53 expansion valve 54 evaporator 70 header 71 header main body 71 a opening 71 b bottom surface 72 through-holes 73 partition plate 74A lid body 74B lid body 74C lid body 80 header 83 partition plate 84D lid body 84E lid body 90 inter-line pipe 100a refrigerant inlet pipe 200a refrigerant outlet pipe 700 header 703 partition plate 800 header A to H chambers

Claims

1. A heat exchanger header for a heat exchanger in which a refrigerant is flowed in parallel through a plurality of heat transfer tubes disposed in parallel,
   wherein a plurality of through-holes to which ends of the plurality of heat transfer tubes are connected are arranged side by side in a longitudinal direction,
   wherein at least one chamber communicating with the plurality of through-holes and serving as a refrigerant flow passage is formed, and
   wherein each of the plurality of through-holes is either of an inlet side through-hole and an outlet side

through-hole to which a refrigerant inlet side end and a refrigerant outlet side end, respectively, of the plurality of heat transfer tubes are connected, and in a part of the chamber that faces the inlet side through-holes, a plurality of grooves extending in the longitudinal direction of the header are formed in a lateral direction perpendicular to the longitudinal direction.

2. The heat exchanger header of claim 1,
wherein the at least one chamber comprises a plurality of chambers separated in the longitudinal direction of the header, each of the plurality of chambers is classified as any one of an inflow chamber into which the refrigerant from outside flows, a U-turn chamber serving as a U-turn flow passage, and an outflow chamber from which refrigerant flows to the outside,
wherein through-holes communicating with the inflow chamber are all inlet side through-holes, and the plurality of grooves are formed over an entire length in the longitudinal direction of the part forming the inflow chamber,
wherein through-holes communicating with the U-turn chamber are divided into an inlet side through-hole group and an outlet side through-hole group, and the plurality of grooves are formed in a part facing the inlet side through-hole group, and
wherein through-holes communicating with the outflow chamber are all outlet side through-holes, and the plurality of grooves are not formed in a part forming the outflow chamber.

3. The heat exchanger header of claim 2, wherein the plurality of grooves are formed by gaps between a plurality of protruding protrusions, and every two of the plurality of protrusions formed in the U-turn chamber that are adjacent in the lateral direction differ in a position of an end closest to a border between the inlet side through-hole group and the outlet side through-hole group.

4. The heat exchanger header of any one of claims 1 to 3, wherein the plurality of grooves are formed by gaps between a plurality of protruding protrusions, and every adjacent two of the plurality of protrusions differ in height.

5. The heat exchanger header of claim 4, wherein heights of the plurality of protrusions are alternately large and small in the lateral direction.

6. The heat exchanger header of claim 4, wherein heights of the plurality of protrusions are configured to be increasingly large toward a central part in the lateral direction.

7. The heat exchanger header of any one of claims 1 to 6, wherein the header includes a header main body that has a box-like shape with one side open and whose bottom surface facing the opening has the plurality of through-holes formed therein, and a lid body formed in a plate-like shape covering the opening.

8. The heat exchanger header of claim 7, wherein the grooves are formed in the lid body.

9. A heat exchanger comprising the heat exchanger header of any one of claims 1 to 8.

10. A heat exchanger comprising, in an air passing direction, at least two heat exchanging units including a pair of the heat exchanger headers of claim 2 or 3 spaced from each other in a direction perpendicular to the air passage direction, a plurality of heat transfer tubes disposed in parallel between the pair of heat exchanger headers and both ends of which are connected to the plurality of through-holes of the pair of heat exchanger headers, and a plurality of fins disposed such that air passes in the air passage direction, wherein the heat exchanging units are connected by an inter-line pipe, and a refrigerant flow passage is formed in which the refrigerant flows through the plurality of heat transfer tubes of the heat exchanging unit on an upstream side in the air passage direction, from the inflow chamber to the outflow chamber while making a U-turn in the U-turn chamber, then flows through the inter-line pipe into the heat exchanging unit on a downstream side in the air passage direction, and flows from the inflow chamber to the outflow chamber of the heat exchanger header while making a U-turn in the U-turn chamber, and
wherein when the heat exchanger is used as an evaporator, a number of refrigerant passes of the refrigerant flowing through the heat exchanging unit on the upstream side is less than a number of refrigerant passes of the refrigerant flowing through the heat exchanging unit on the downstream side.

11. The heat exchanger of claim 9 or 10, wherein the heat transfer tubes are flat tubes having a plurality of through-holes serving as refrigerant flow passages.

FIG. 1

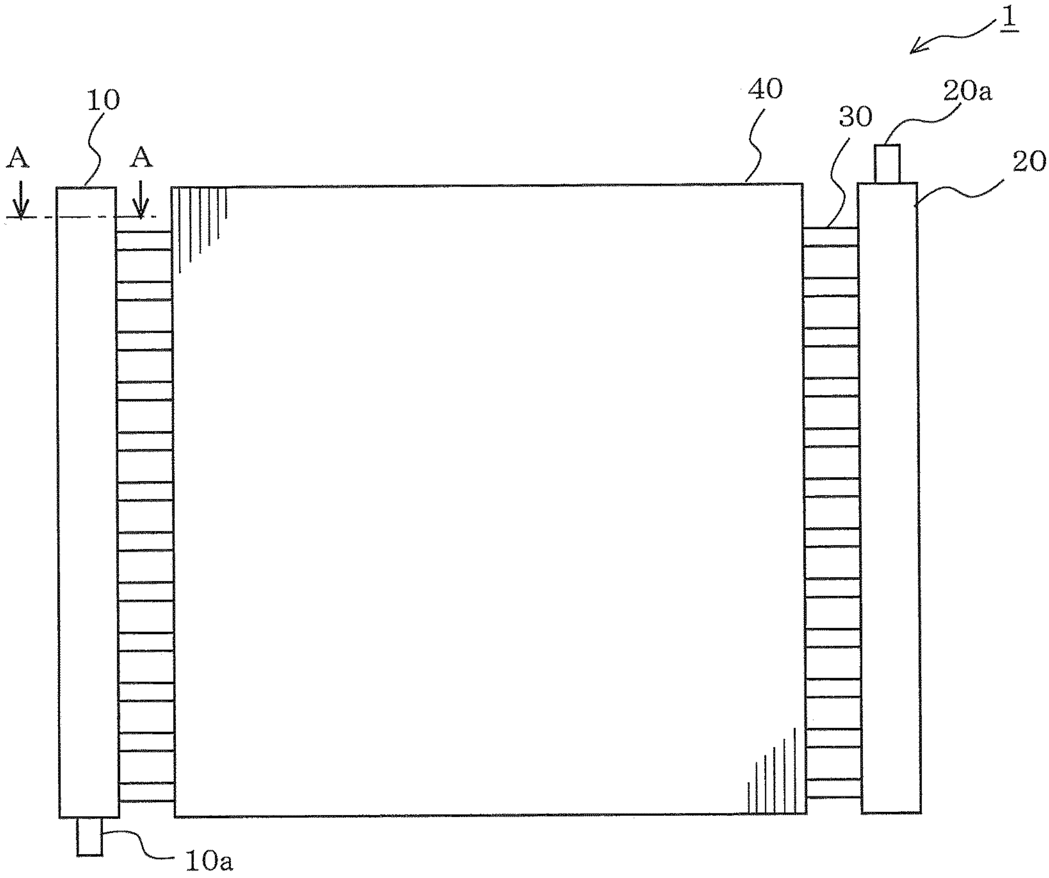


FIG. 2

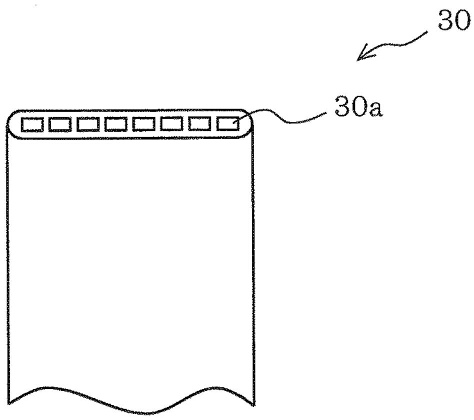


FIG. 3

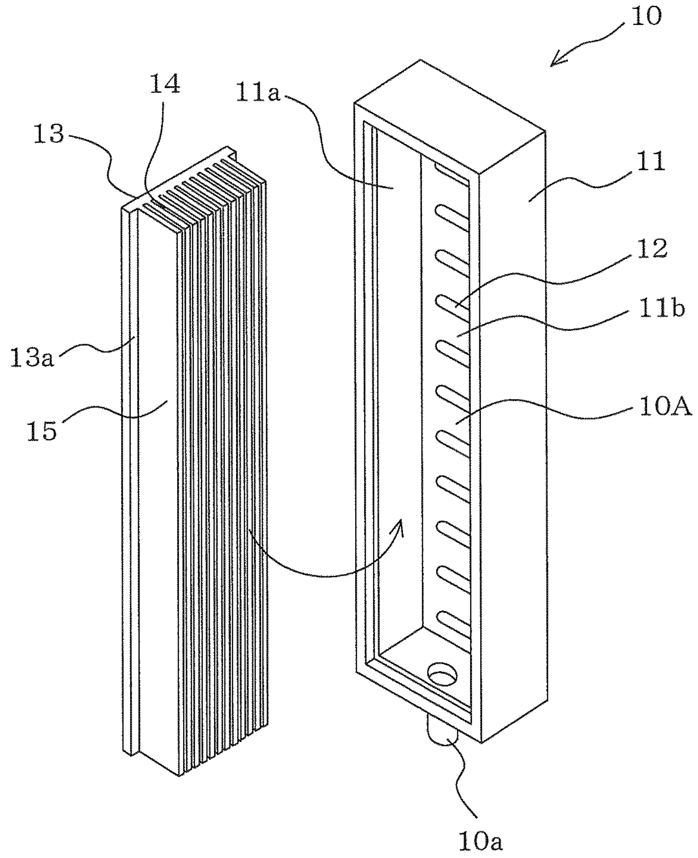


FIG. 4

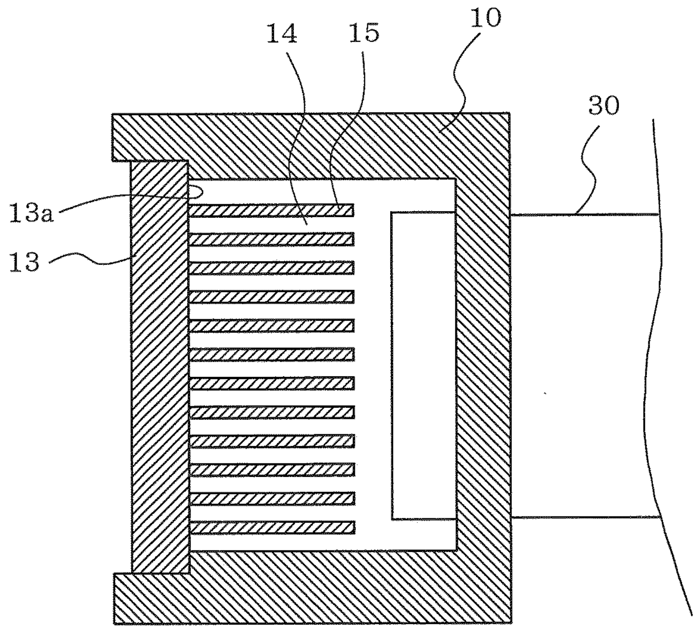


FIG. 5

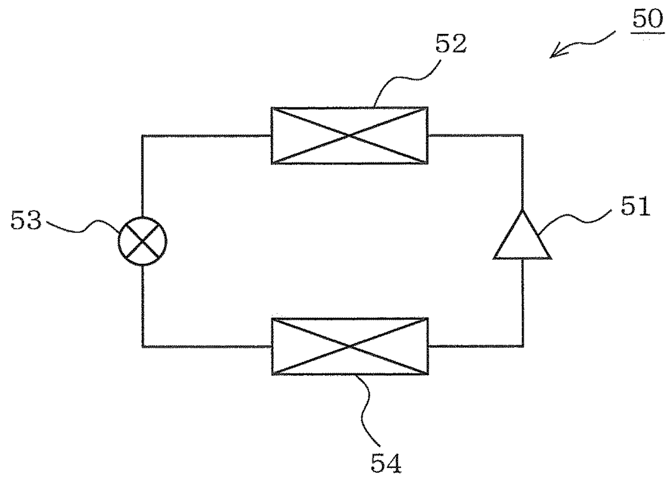
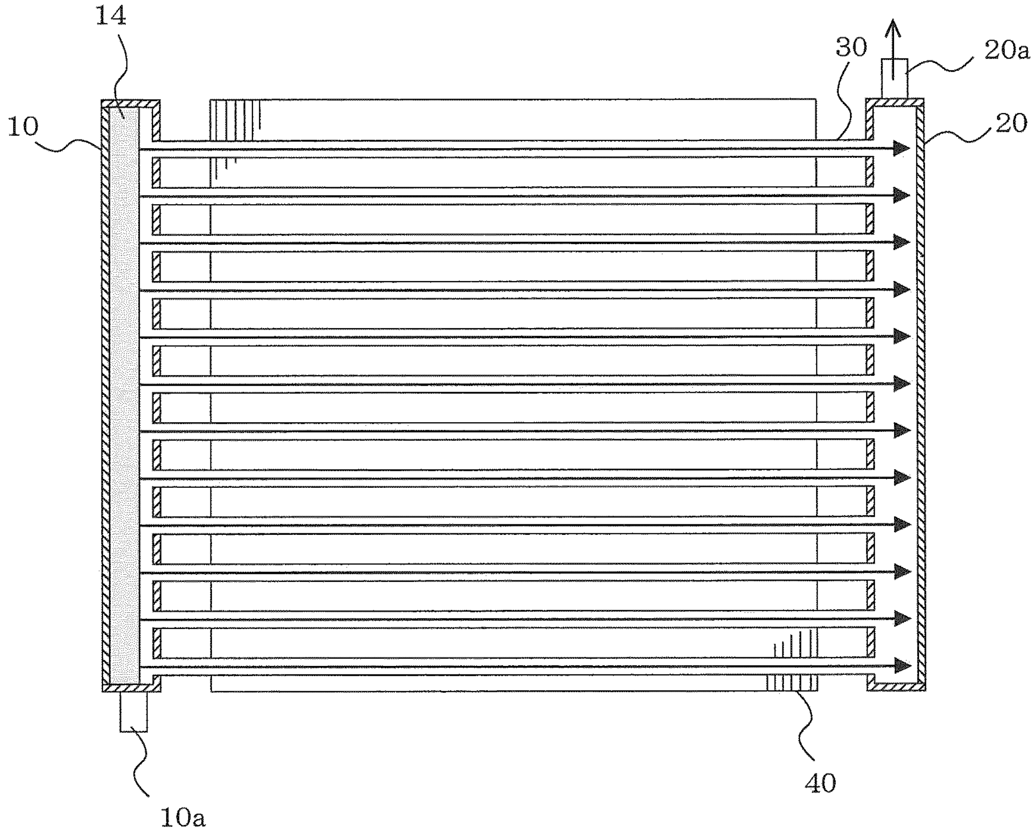
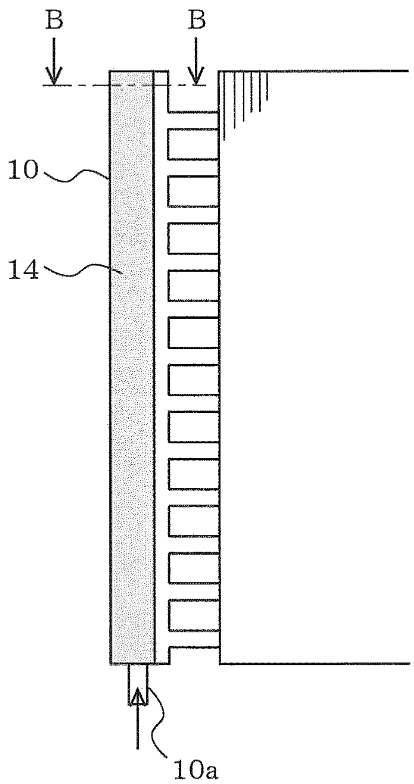


FIG. 6



F I G. 7



F I G. 8

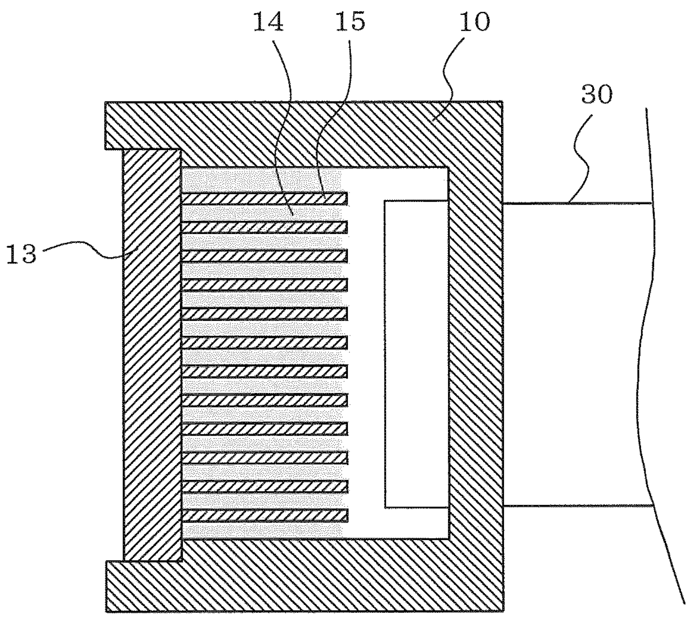


FIG. 9

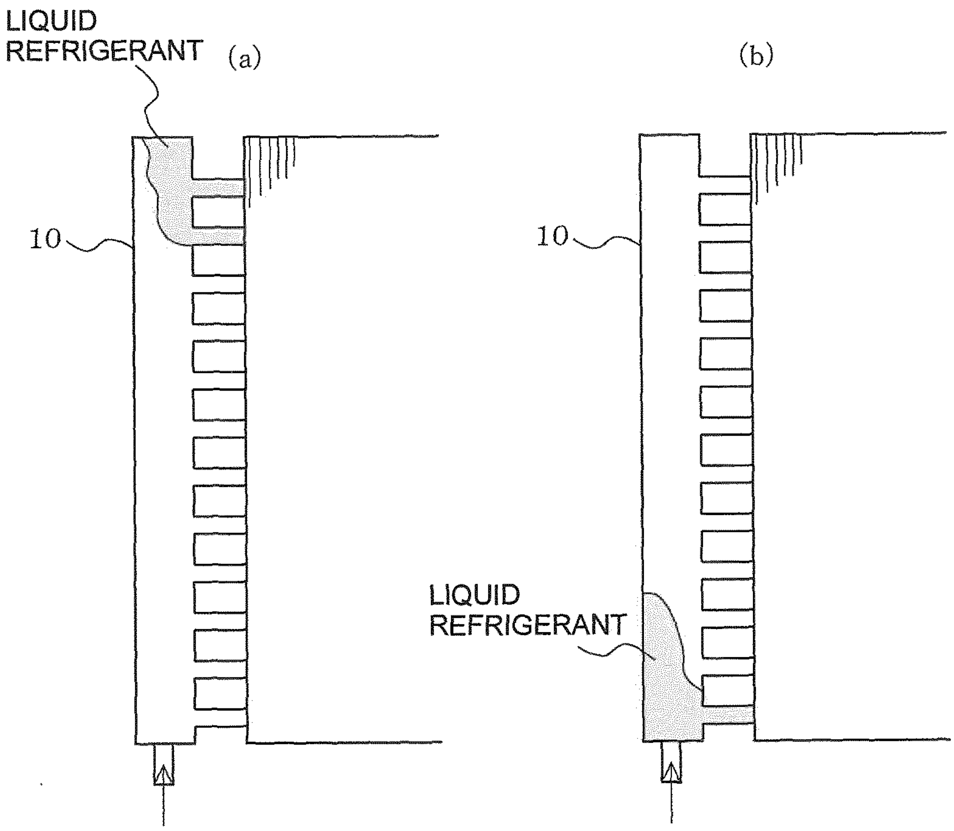

LIQUID
REFRIGERANT
(a)
(b)
10
10
LIQUID
REFRIGERANT

FIG. 10

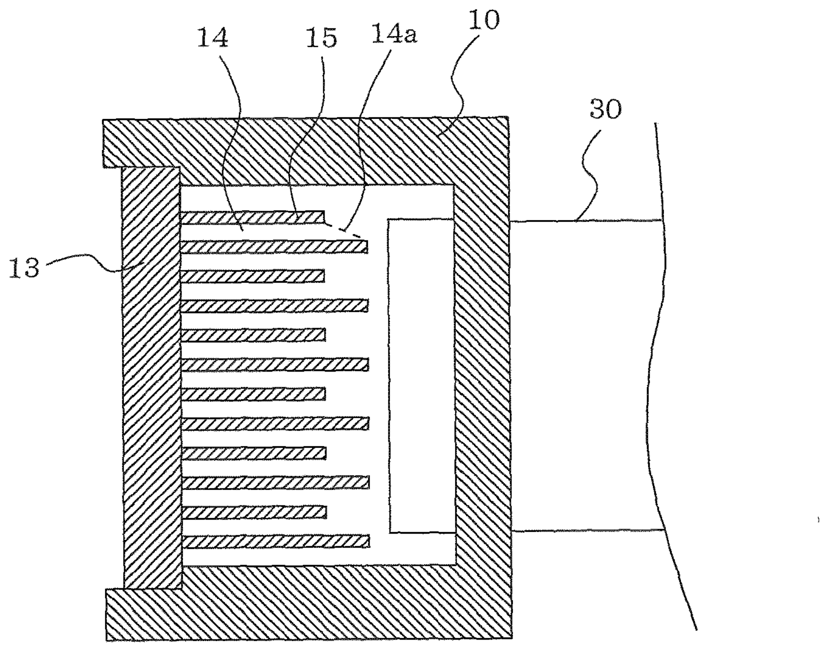

14
15
14a
10
30
13

FIG. 11

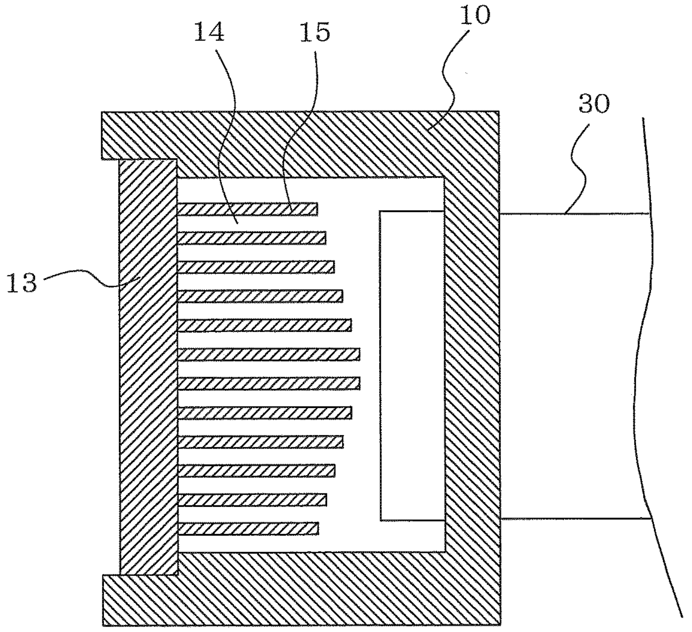

14
15
10
30
13

FIG. 12

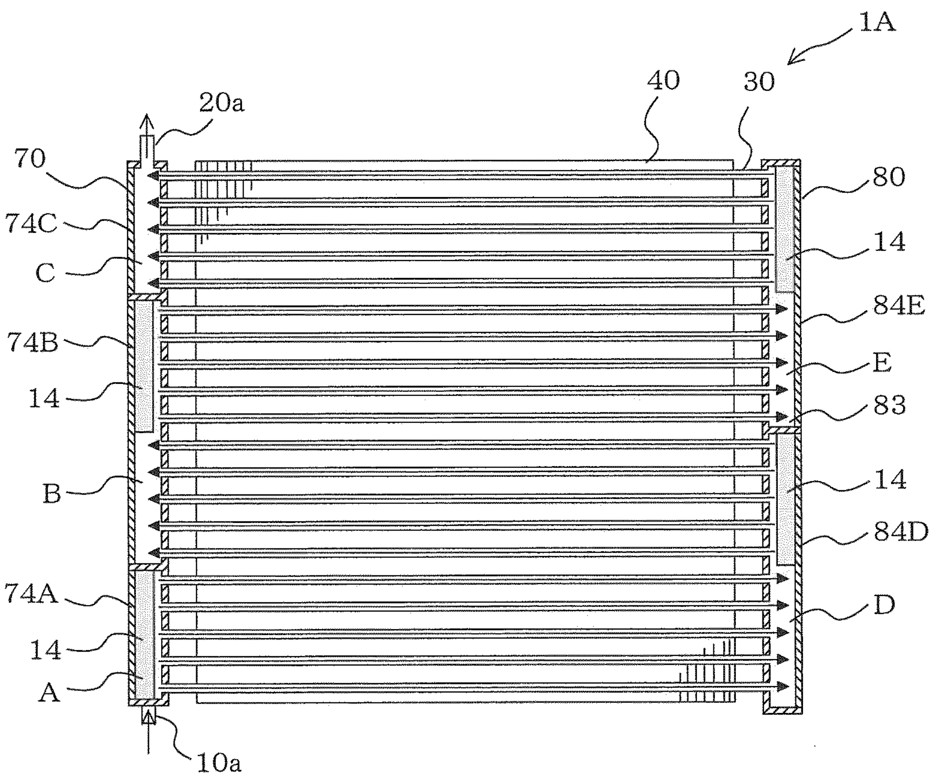

1A
40
30
20a
70
80
74C
14
C
84E
74B
E
14
83
B
14
84D
74A
D
14
A
10a

FIG. 13

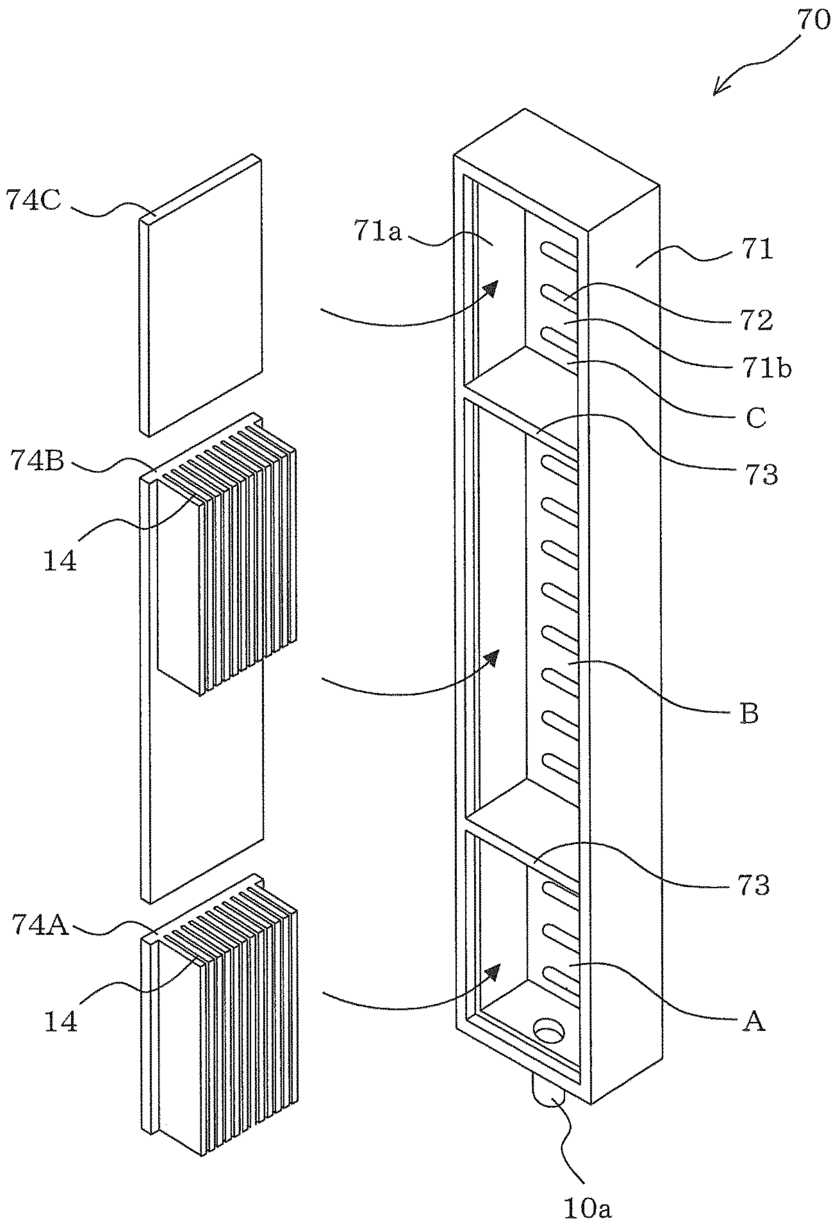


FIG. 14

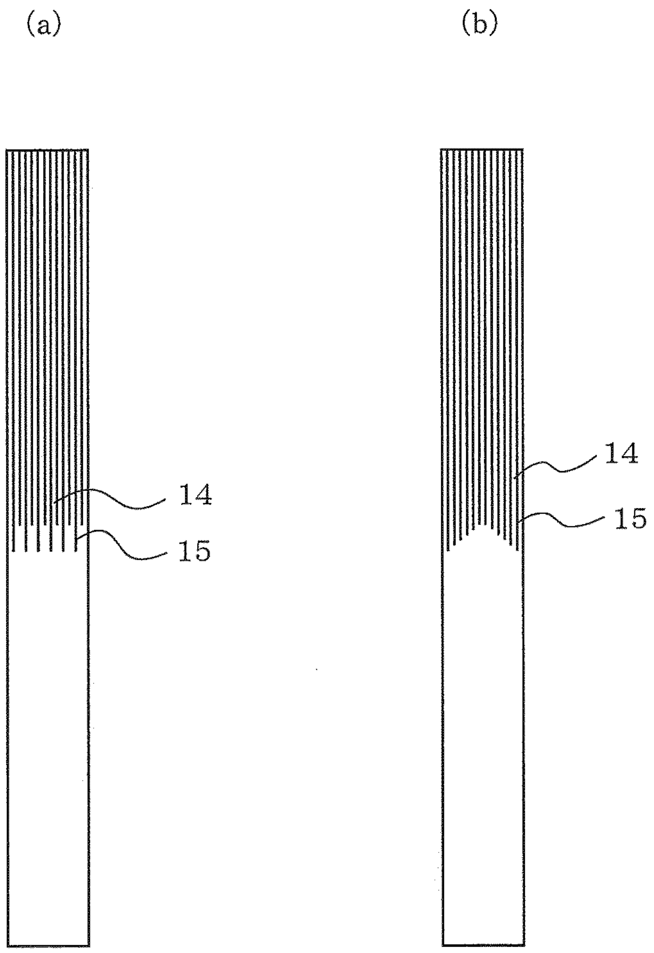
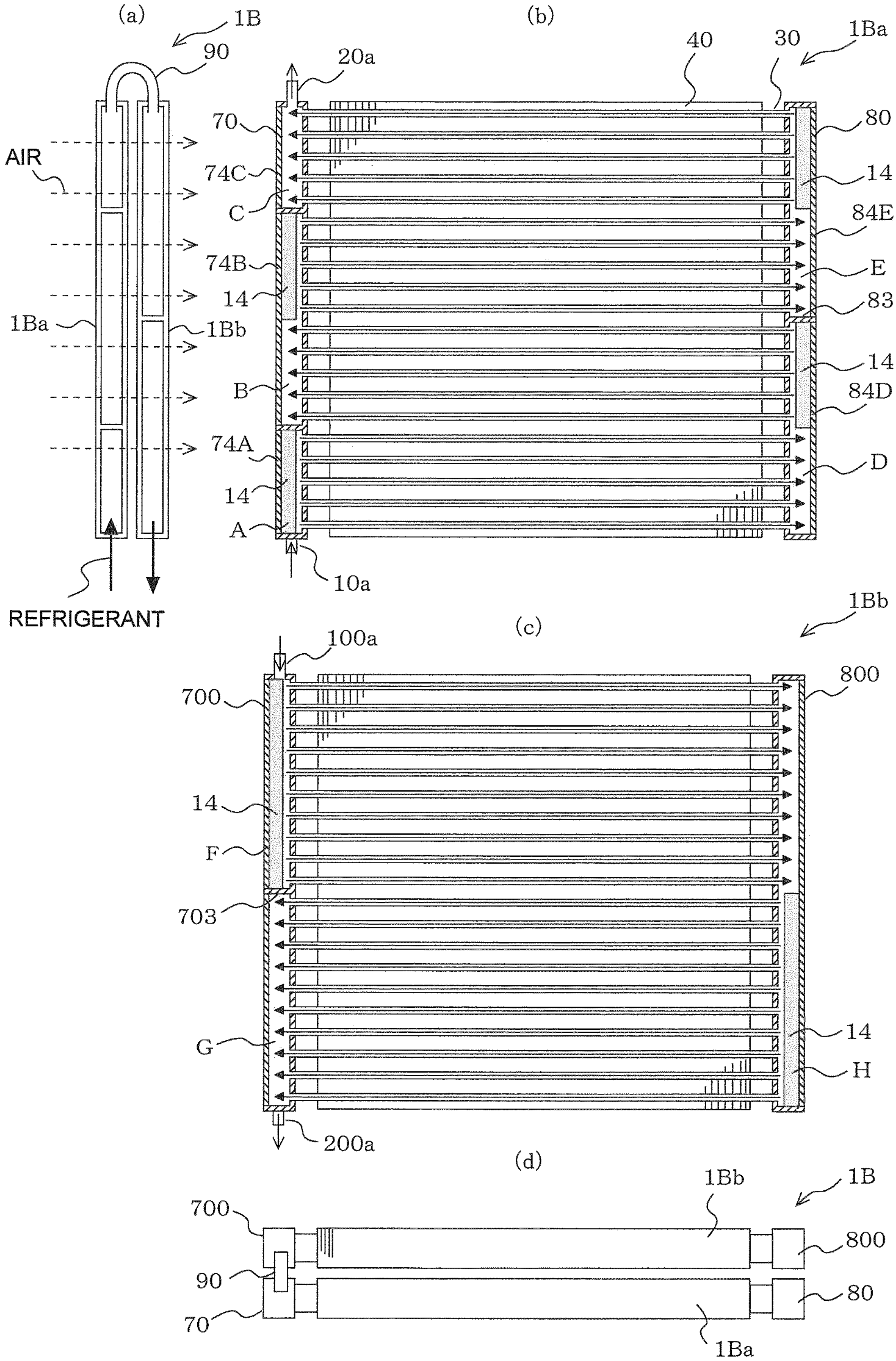


FIG. 15


(a)
1B
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AIR
1Ba
1Bb
REFRIGERANT
(b)
1Ba
40
30
20a
70
80
74C
14
C
84E
74B
E
14
83
B
14
84D
74A
D
14
A
10a
(c)
1Bb
100a
700
800
14
F
703
G
14
H
200a
(d)
1Bb
1B
700
800
90
80
70
1Ba

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2013/061858

A. CLASSIFICATION OF SUBJECT MATTER
F28F9/02(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

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	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 7-260392 A (Zexel Corp.), 13 October 1995 (13.10.1995), entire text; all drawings (particularly, paragraphs [0015] to [0017]; fig. 1 to 5) (Family: none)	1,8,9,11 7 2-6,10
Y	JP 2009-270781 A (Mitsubishi Electric Corp.), 19 November 2009 (19.11.2009), entire text; all drawings (particularly, paragraph [0015]; fig. 2) (Family: none)	7

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 July, 2013 (04.07.13)	16 July, 2013 (16.07.13)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2013/061858

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2008-256234 A (Showa Denko Kabushiki Kaisha), 23 October 2008 (23.10.2008), entire text; all drawings (particularly, fig. 3) (Family: none)	1-11
A	JP 2011-237062 A (Mitsubishi Electric Corp.), 24 November 2011 (24.11.2011), entire text; all drawings (Family: none)	1-11
A	JP 11-325785 A (Zexel Corp.), 26 November 1999 (26.11.1999), entire text; all drawings (particularly, fig. 9, 10, 14) (Family: none)	1-11

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011085324 A **[0004]**