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(54) **REFRIGERANT EVAPORATOR AND AIR-CONDITIONING DEVICE UTILIZING THE SAME**

KÜHLMITTELVERDAMPFER UND KLIMAANLAGENVORRICHTUNG DAMIT

ÉVAPORATEUR DE FRIGORIGÈNE ET DISPOSITIF DE CONDITIONNEMENT D'AIR L'UTILISANT

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(73) Proprietor: **Mitsubishi Heavy Industries, Ltd.**
Tokyo 108-8215 (JP)

(72) Inventors:
- **JOBOJI, Yasunobu**
  Kiyosu-shi
  Aichi 452-8561 (JP)
- **ITO, Jun**
  Kiyosu-shi
  Aichi 452-8561 (JP)
- **HIMENO, Takamitsu**
  Nagoya-shi
  Aichi 453-8515 (JP)
- **TAMAKI, Hitoshi**
  Nagoya-shi
  Aichi 453-8515 (JP)

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

(56) References cited:
WO-A1-2004/059235
WO-A1-2007/129851
WO-A1-2008/038948
JP-A- 6 026 780
JP-A- H0 626 780
JP-A- 2001 074 388
JP-A- 2004 144 395

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Description

{Technical Field}

[0001] The present invention relates to a refrigerant evaporator provided in a refrigeration cycle, and in particular, to an aluminum-alloy refrigerant evaporator suitable for applying to a vehicle air conditioner and an air conditioner employing the same.

{Background Art}

[0002] As a refrigerant evaporator employed in a refrigeration cycle of a vehicle air conditioner, there is a known all-aluminum-alloy refrigerant evaporator, which is configured including numerous refrigerant tubes that have refrigerant channels for flowing refrigerant in a vertical direction, that are numerously arranged in parallel in a direction orthogonal to a flow direction of the air flowing outside of the refrigerant channel, and that are also arranged in a plurality of rows, front-to-back, parallel to the flow direction of the air; and a pair of top and bottom tanks that are arranged in a direction orthogonal to the flow direction of the air, that are connected to the numerous refrigerant tubes at both top and bottom ends thereof, and whose interior is partitioned by a partition wall into a first tank portion and a second tank portion in a row direction, corresponding to the plurality of rows of the refrigerant tubes, thereby performing distribution and collection of the refrigerant, wherein the refrigerant that has flowed in from a refrigerant inlet sequentially flows through the refrigerant tubes in a plurality of blocks divided by partition plates provided at a plurality of locations in the tanks so as to perform heat exchange with the air to cool the air.

[0003] JP 3637314 B discloses a refrigerant evaporator having the above-described configuration, in which one of the plurality of blocks is a U-turn block portion wherein the refrigerant flows into the first tank portion of the top tank from a direction parallel to the partition wall, flows to the second tank portion from this first tank portion via a side refrigerant channel, and further flows while being distributed to the plurality of refrigerant tubes from the first tank portion and the second tank portion, respectively. In addition, in the disclosure in JP 3391339 B, a plurality of communication holes are bored in the partition wall to allow the refrigerant collected in the second tank portion of the top tank upon flowing through the plurality of refrigerant tubes to directly flow into the first tank portion separated by the partition wall.

[0004] JP H06 26780 A discloses a refrigerant evaporator made of aluminum alloy comprising a plurality of refrigerant tubes that have refrigerant channels for flowing refrigerant in a vertical direction, that are arranged in parallel and in a plurality of rows, front-to-back, and a pair of top and bottom tanks that are arranged in the direction orthogonal to the refrigerant tubes and are connected to top and bottom ends of the refrigerant tubes. The top tank is provided with an inlet and with an outlet for the refrigerant. The interior of the top and bottom tanks is partitioned into a plurality of sections by a longitudinal partition wall and by a plurality of transverse partition walls. The wall portions of the partition walls delimiting the sections are either closed or provided with a central elongated hole so as to define a flow pattern for the refrigerant from the inlet through the sections in the top and bottom tanks and through the plurality of refrigerant channels before it flows out from the outlet.

{Summary of Invention}

{Technical Problem}

[0005] However, with the refrigerant evaporator disclosed in JP 3637314 B described above, in the U-turn block portion of the top tank located at the top, liquid refrigerant is prone to flow into the refrigerant tubes on the front side with respect to an inflow direction of the refrigerant due to inertia, and thus, in some cases, the liquid refrigerant that has flowed into the second tank portion from the first tank portion cannot adequately reach the back-most end thereof. Consequently, there is a problem in that the liquid refrigerant is unevenly distributed to the plurality of refrigerant tubes connected to the second tank portion, creating portions where effective heat exchange does not occur with the air flowing outside of the refrigerant tubes, which thereby deteriorates the heat-exchange performance.

[0006] On the other hand, in the refrigerant evaporator disclosed in JP 3391339 B described above, although the plurality of communication holes are bored in the partition wall partitioning the first tank portion and the second tank portion, these are for allowing the refrigerant collected in the second tank portion of the top tank to flow directly to the first tank portion separated by the partition wall, and there is no suggestion that, in the U-turn block portion of the top tank, the liquid refrigerant that has flowed into the first tank portion of the top tank from a direction parallel to the partition wall is evenly distributed over the entire region in the length direction of both the first tank portion and the second tank portion constituting the U-turn block portion.

[0007] Furthermore, when boring the plurality of communication holes in the partition wall that partitions between the tanks, stress exerted inside the tanks due to refrigerant pressure acts on wall surfaces between the plurality of communication holes, and this affects the pressure-withstanding strength of the tanks. Therefore, in order to ensure the pressure-withstanding strength of the tanks, it is necessary to form communication holes in the partition walls with restrictive conditions, such as the inability to increase the plate thickness, ensuring a function for evenly distributing refrigerant, ensuring adequate opening area, etc., while preventing an increase in pressure loss of the refrigerant.

[0008] The present invention has been conceived in light of the above-described circumstances, and an object thereof is to provide a refrigerant evaporator that is capable of enhancing heat-exchange performance by achieving an even distribution of liquid refrigerant to a plurality of refrigerant tubes connected to a first tank portion and a second tank portion of a U-turn block portion and also capable of ensuring adequate pressure-withstanding strength of the tank portions, as well as an air conditioner employing the same.

{Solution to Problem}

[0009] To solve the above-described problems, a refrigerant evaporator of the present invention has the features of claim 1 and an air conditioner employing the same has the features of claim 6.

[0010] That is, a refrigerant evaporator according to a first aspect of the present invention is a refrigerant evaporator made of aluminum alloy including numerous refrigerant tubes that have refrigerant channels for flowing refrigerant in a vertical direction, that are numerously arranged in parallel in a direction orthogonal to a flow direction of an external fluid that flows outside of the refrigerant channels, and that are arranged in a plurality of rows, front-to-back, parallel to the flow direction of the external fluid; and a pair of top and bottom tanks that are arranged in the direction orthogonal to the flow direction of the external fluid and connected at top and bottom ends of the numerous refrigerant tubes, the interior of which is partitioned in a row direction corresponding to the plurality of rows of the refrigerant tubes into a first tank portion and a second tank portion by a partition wall, and that distribute or collect the refrigerant, the tanks being provided with a refrigerant inlet and a refrigerant outlet, and the refrigerant that has flowed in from the refrigerant inlet sequentially flowing through the refrigerant tubes of a plurality of blocks divided by partition plates provided in a plurality of locations in the tanks, after which the refrigerant flows out from the refrigerant outlet, wherein one of the plurality of blocks is a U-turn block portion in which the refrigerant flows into the first tank portion or the second tank portion of the top tank from a direction parallel to the partition wall and, from there, flows into the other tank portion, thereby being distributed to the plurality of refrigerant tubes from the first tank portion and the second tank portion, respectively, on the partition walls that partition the first tank portions and the second tank portions of the top and bottom tanks in the U-turn block portion, a plurality of refrigerant-distribution holes, which communicate between the first tank portions and the second tank portions, are provided parallel to the length direction of the partition walls, and for the refrigerant-distribution holes, assuming the distance between the plurality of holes as b, the hole length in the hole-row direction as a, and the thickness of the partition wall as t, a/b is set to $a/b <= -0.0697 * t^2 + 0.3274 * t + 0.4594$, where t = 1 to 2 mm.

[0011] With the first aspect of the present invention, because, in the U-turn block portion, liquid refrigerant in gas-liquid two-phase refrigerant that has flowed into the first tank portion or the second tank portion from a direction parallel to the partition wall can be flowed into both of the first tank portion and the second tank portion of the U-turn block portion substantially evenly over the entire region thereof in the refrigerant inflow direction, while being sequentially distributed into the other tank portion by the plurality of refrigerant-distribution holes provided in the direction parallel to the length direction of the partition walls, it becomes possible to substantially evenly distribute the liquid refrigerant to the plurality of refrigerant tubes connected to the first tank portion and the second tank portion.

[0012] Therefore, the liquid refrigerant, which mainly contributes to the cooling of the external fluid, is more evenly distributed, thereby making it possible to enhance the heat-exchange performance of the refrigerant evaporator. In addition, assuming the distance between the plurality of holes of the refrigerant-distribution holes as b, hole length in the hole-row direction as a, and thickness of the partition wall as t, a/b is set to $a/b <= -0.0697 * t^2 + 0.3274 * t + 0.4594$, where t = 1 to 2 mm; thus, it is possible to set the inter-hole distance of the plurality of refrigerant-distribution holes provided in the partition walls to a size at which at least a pressure-withstanding pressure of 2.55 MPa or greater can be satisfied. Therefore, it becomes possible to readily increase the pressure-withstanding strength of the tank portions against the internal pressure by optimizing various sizes of the refrigerant-distribution holes in the partition walls, which have restricted configurations.

[0013] Furthermore, in the above-described refrigerant evaporator, it is desirable that a/b of the refrigerant-distribution hole be set to $a/b <= -0.0744 * t^2 + 0.3577 * t + 0.3786$, where t = 1 to 2 mm.

[0014] According to this configuration, because a/b of the refrigerant-distribution holes is set to $a/b <= -0.0744 * t^2 + 0.3577 * t + 0.3786$, where t = 1 to 2, the inter-hole distance between the plurality of refrigerant-distribution holes can be set to a size that makes it possible to satisfy at least 3.3 MPa or greater break-down pressure. Therefore, it is possible to readily further increase the pressure-withstanding strength of the tank portions against the internal pressure by optimizing various sizes of the refrigerant-distribution holes.

[0015] Furthermore, in the above-described refrigerant evaporator, it is desirable that a/b of the refrigerant-distribution holes be set to $a/b <= -0.0763 * t^2 + 0.3810 * t + 0.2847$, where t = 1 to 2 mm.

[0016] According to this configuration, because a/b of the refrigerant-distribution holes is set to $a/b <= -0.0763 * t^2 + 0.3810 * t + 0.2847$, where t = 1 to 2, the inter-hole distance between the plurality of refrigerant-distribution holes can be set to a size that makes it possible to satisfy at least 4.5 MPa or greater break-down pressure, even if the variability thereof is taken into consideration. Therefore, it is possible to readily and assuredly ensure the pressure-withstanding strength of the tank portions against the internal pressure by optimizing various sizes of the group of refrigerant-distribution holes.

[0017] In addition, in any one of the refrigerant evaporators mentioned above, the refrigerant-distribution holes are elongated holes made longer in a direction orthogonal to the hole-row direction of the refrigerant-distribution holes.

[0018] According to this configuration, because the refrigerant-distribution holes are elongated holes made longer in the direction orthogonal to the hole-row direction of the refrigerant-distribution holes, it is possible to set the opening area of the refrigerant-distribution holes to a size allowing passage of the refrigerant without increasing the pressure loss thereof, while ensuring the pressure-withstanding strength of the tank portions by making a/b of the plurality of refrigerant-distribution holes small. Therefore, the pressure-withstanding strength of the tank portions can be increased while eliminating the influence on the heat-exchange performance by suppressing an increase in pressure loss of the refrigerant due to the refrigerant-distribution holes.

[0019] Furthermore, a refrigerant evaporator according to a second aspect of the present invention and corresponding to claim 1 is a refrigerant evaporator made of aluminum alloy including numerous refrigerant tubes that have refrigerant channels for flowing refrigerant in a vertical direction, that are numerously arranged in parallel in a direction orthogonal to a flow direction of an external fluid that flows outside of the refrigerant channels, and that are arranged in a plurality of rows, front-to-back, parallel to the flow direction of the external fluid; and a pair of top and bottom tanks that are arranged in the direction orthogonal to the flow direction of the external fluid and connected at top and bottom ends of the numerous refrigerant tubes, the interior of which is partitioned in a row direction corresponding to the plurality of rows of the refrigerant tubes into a first tank portion and a second tank portion by a partition wall, and that distribute or collect the refrigerant, the tanks being provided with a refrigerant inlet and a refrigerant outlet, and the refrigerant that has flowed in from the refrigerant inlet sequentially flowing through the refrigerant tubes of a plurality of blocks divided by partition plates provided in a plurality of locations in the tanks, after which the refrigerant flows out from the refrigerant outlet, wherein one of the plurality of blocks is a U-turn block portion in which the refrigerant flows into the first tank portion or the second tank portion of the top tank from a direction parallel to the partition wall and, from there, flows into the other tank portion, thereby being distributed to the plurality of refrigerant tubes from the first tank portion and the second tank portion, respectively, on the partition walls that partition the first tank portions and the second tank portions of the top and bottom tanks in the U-turn block portion, a plurality of refrigerant-distribution holes, which communicate between the first tank portion and the second tank portion, are provided parallel to the length direction of the partition wall, and the refrigerant-distribution holes are elongated holes made longer in a direction orthogonal to the hole-row direction of the refrigerant-distribution holes.

[0020] With the second aspect of the present invention, because, in the U-turn block portion, liquid refrigerant in gas-liquid two-phase refrigerant that has flowed into the first tank portion or the second tank portion from a direction parallel to the partition wall can be flowed into both of the first tank portion and the second tank portion of the U-turn block portion substantially evenly over the entire region thereof in the refrigerant inflow direction, while being sequentially distributed into the other tank portion by the plurality of refrigerant-distribution holes provided in the direction parallel to the length direction of the partition walls, it becomes possible to substantially evenly distribute the liquid refrigerant to the plurality of refrigerant tubes connected to the first tank portion and the second tank portion.

[0021] Therefore, the liquid refrigerant, which mainly contributes to the cooling of the external fluid, is more evenly distributed, thereby making it possible to enhance the heat-exchange performance of the refrigerant evaporator. Furthermore, because the refrigerant-distribution holes are elongated holes made longer in the direction orthogonal to the hole-row direction of the refrigerant-distribution holes, it is possible to set the inter-hole distance of the plurality of refrigerant distribution holes to a size that satisfies adequate pressure-withstanding pressure or break-down pressure, while setting the opening area of the plurality of refrigerant-distribution holes to a size allowing passage of the refrigerant without increasing the pressure loss thereof. Therefore, it is possible to readily increase the pressure-withstanding strength of the tank portions against the internal pressure by optimizing the hole shape of the refrigerant-distribution holes while suppressing the increase in pressure loss of the refrigerant in the partition walls, which have restricted configurations.

[0022] Furthermore, in any one of the refrigerant evaporators mentioned above, it is desirable that the elongated holes be elliptical holes or elongated circular holes.

[0023] According to this configuration, because the elongated holes are elliptical holes or elongated circular holes, it is possible to set the inter-hole distance of the refrigerant distribution holes to a size that satisfies adequate pressure-withstanding pressure or break-down pressure, while setting the opening area of the plurality of refrigerant-distribution holes to a size allowing passage of the refrigerant without increasing the pressure loss thereof. Therefore, it is possible to readily increase the pressure-withstanding strength of the tank portions against the internal pressure by optimizing the hole shape of the refrigerant-distribution holes, while eliminating the influence on the heat-exchange performance by suppressing an increase in pressure loss of the refrigerant due to the refrigerant-distribution holes.

[0024] Furthermore, in an air conditioner according to a third aspect of the present invention, any one of the above-described refrigerant evaporators is employed as a refrigerant evaporator provided in a refrigeration cycle.

[0025] According to the third aspect of the present invention, the refrigerant evaporator provided in the refrigeration cycle is one of the above-described refrigerant evaporators, the performance of the air conditioner can be enhanced by performance enhancement of the refrigerant evaporator, and, simultaneously, the reliability of the air conditioner can be enhanced by increasing the pressure-withstanding strength of the refrigerant evaporator.

[0026] According to the refrigerant evaporators of the present invention, because liquid refrigerant in gas-liquid two-phase refrigerant that has flowed in from a direction parallel to the partition wall can be flowed into both of the first tank portion and the second tank portion of the U-turn block portion formed in the top tank, nearly evenly distributed over the entire region thereof in the refrigerant inflow direction, the liquid refrigerant is more evenly distributed to the plurality of refrigerant tubes connected to the first tank portion and the second tank portion, thereby making it possible to enhance the heat-exchange performance of the evaporator. In addition, because it is possible to set the inter-hole distance of the plurality of refrigerant-distribution holes provided in the partition walls to a size at which at least a pressure-withstanding pressure of 2.55 MPa or greater can be satisfied, it becomes possible to readily ensure the pressure-withstanding strength of the tank portions against the internal pressure by optimizing various sizes of the refrigerant-distribution holes in the partition walls, which have restricted configurations.

[0027] In addition, according to the refrigerant evaporators of the present invention, by configuring the refrigerant-distribution holes provided in the partition walls as elongated holes made longer in the direction orthogonal to the hole-row direction of the refrigerant-distribution holes, it is possible to set the inter-hole distance of the plurality of refrigerant distribution holes to a size that satisfies adequate pressure-withstanding pressure or break-down pressure, while setting the opening area of the plurality of refrigerant-distribution holes to a size allowing passage of the refrigerant without increasing the pressure loss thereof; therefore, it is possible to readily increase the pressure-withstanding strength of the tank portions against the internal pressure by optimizing the hole shape of the refrigerant-distribution holes while suppressing the increase in pressure loss of the refrigerant in the partition walls, which have restricted configurations.

[0028] Furthermore, according to the air conditioner of the present invention, the performance of the air conditioner can be enhanced by enhancing the performance of the refrigerant evaporator, and, simultaneously, the reliability of the air conditioner can be enhanced by increasing the pressure-withstanding strength of the refrigerant evaporator.

{Brief Description of Drawings}

[0029]

Fig. 1 is a perspective view of a refrigerant evaporator according to a first example serving to explain features of the present invention.

Fig. 2 is an exploded perspective view of the refrigerant evaporator shown in Fig. 1.

Fig. 3A is a front view of the refrigerant evaporator shown in Fig. 1.

Fig. 3B is a right side view of the refrigerant evaporator shown in Fig. 1.

Fig. 4 is a side view of a partition wall to be provided in a top tank and a bottom tank of the refrigerant evaporator shown in Fig. 1.

Fig. 5 is a plan view showing the refrigerant distribution in a U-turn block portion in the refrigerant evaporator shown in Fig. 1.

Fig. 6 is a plan view showing the refrigerant distribution in a U-turn block portion in a refrigerant evaporator according to an embodiment of the present invention.

Fig. 7 is an analytical graph showing the relationship between the break-down pressure P of tank partition portions and a ratio a/b of hole length a in the hole-row direction of a plurality of refrigerant-distribution holes to distance b between the plurality of holes provided in a partition wall of the refrigerant evaporator according to the present invention.

Fig. 8 is a graph in which the graph shown in Fig. 7 is converted so as to express thickness t of the partition wall on the horizontal axis and the ratio a/b on the vertical axis.

{Description of Embodiments}

[0030] Examples and embodiments according to the present invention will be described below, with reference to the drawings.

{First Example}

[0031] A first example serving to explain features of the present invention will be described below, using Figs. 1 to 5 and Figs. 7 and 8. Fig. 1 shows a perspective view of a refrigerant evaporator 1 according to the first example, Fig. 2 shows an exploded perspective view thereof, and Figs. 3A and 3B show a front view and a right side view thereof. In addition, Fig. 4 shows a side view of a partition wall to be provided inside tanks.

[0032] The refrigerant evaporator 1 is provided with numerous refrigerant tubes 2 having a plurality of refrigerant channels 2A parallel to the length direction. These refrigerant tubes 2 can be formed of aluminum-alloy flat tubes that are manufactured, for example, by extrusion molding or pultrusion molding, or that are manufactured by molding a plate material into an elliptical tube-shape into which inner fins are inserted to be installed therein.

[0033] The refrigerant tubes 2 are numerously arranged in parallel in a stack in a direction orthogonal to the flow direction of an external fluid (air) A flowing outside thereof. In addition, the refrigerant tubes 2 are arranged in a plurality of rows (two rows) front-to-back relative to the flow direction of the air A. For example, heat-conducting fins 3, which are formed by applying corrugation molding to aluminum-alloy thin plates to impart a wave shape thereto, are interposed between the numerous refrigerant tubes 2 that are numerously arranged in parallel in a stack in the direction orthogonal to the flow direction of the air A, and are bonded to external surfaces of the refrigerant tubes 2 by brazing using a known method.

[0034] At a top end and a bottom end of the numerous refrigerant tubes 2, a top tank 4 and a bottom tank 5, each having a substantially elongated-circular cross section, are bonded thereto by brazing. These top tank 4 and bottom tank 5 are formed of top members 4A and 5A and bottom members 4B and 5B that are split into two vertically; partition walls 4C and 5C which partition the inside of the top tank 4 and the bottom tank 5 into a first tank portion 5 and a second tank portion 7 and a first tank portion 8 and a second tank portion 9, respectively, in the row direction corresponding to the plurality of rows of the refrigerant tubes 2; and cap members 4D and 4E and 5D and 5E which close off the two ends of the top tank 4 and the bottom tank 5, respectively. The top members 4A and 5A, the bottom members 4B and 5B, the partition walls 4C and 5C, and the cap members 4D, 5D, 4E, and 5D are formed of press molded pieces of aluminum alloy and are integrally bonded by brazing using a known method.

[0035] In the bottom members 4B and 5B that constitute the top tank 4 and the bottom tank 5, numerous tube insertion holes 4F and 5F are provided corresponding to the rows of the refrigerant tubes 2 in order for the ends of the numerous refrigerant tubes 2 to be inserted thereinto for bonding by brazing. The cap member 5E of the bottom tank 5 is provided with a refrigerant inlet 5G, which communicates with the first tank portion 8, and a refrigerant-inlet header 10 is bonded thereto by brazing so as to communicate with the refrigerant inlet 5G of the cap member 5E. In addition, the cap member 4E of the top tank 4 is provided with a refrigerant outlet 4G, which communicates with the second tank portion 7, and a refrigerant-outlet header 11 is bonded thereto by brazing so as to communicate with the refrigerant outlet 4G of the cap member 4E. The refrigerant-inlet header 10 and the refrigerant-outlet header 11 are connected to a refrigerant-inlet pipe 12 and a refrigerant-outlet pipe 13, respectively.

[0036] Partition plates 4H and 5H that respectively partition the second tank portion 7 of the top tank 4 and the first tank portion 8 of the bottom tank 5 into two regions on the right and left in a direction parallel to the direction orthogonal to the flow direction of the air A (length direction of the tanks) are provided in the top tank 4 and the bottom tank 5. In this example, the partition plates 4H and 5H are provided at positions where the ratio of the number of the refrigerant tubes 2 in the left region and the right region of the two regions separated into left and right in the figure is about 1:2. In addition, in the second tank portion 9 of the bottom tank 5, two throttle plates 5I and 5J having throttle holes 5K and 5L that gradually narrow toward the end with the cap member 5E are provided at two appropriate locations in the length direction of the tank in the right region in the figure, separated by a predetermined gap therebetween.

[0037] Furthermore, in the left region in the figure partitioned by the partition plates 4H and 5H, the partition walls 4C and 5C of the top tank 4 and the bottom tank 5 have a plurality of refrigerant-distribution holes 4M and 5M, which communicate between the first tank portion 6 and the second tank portion 7 of the top tank 4 and between the first tank portion 8 and the second tank portion 9 of the bottom tank 5, respectively, provided in the length direction of the partition walls 4C and 5C. The refrigerant-distribution holes 4M and 5M have a function of causing the liquid refrigerant in a gas-liquid two-phase refrigerant flowing into the first tank portion 6 of the top tank 4 parallel to the length direction of the partition wall 4C from the right region to the left region in the figure to flow in while distributing the refrigerant nearly evenly in the length direction of the left region of the second tank portion 7 in the figure.

[0038] In addition, by providing the partition plate 5H in the first tank portion 8 of the bottom tank 5 that is connected to the refrigerant-inlet header 10 and by providing the partition plate 4H in the second tank portion 7 of the top tank 4 that is connected to the refrigerant-outlet header 11, a refrigerant flow pathway in the refrigerant evaporator 1 is divided into three blocks, that is, a first block 14, a second block (U-turn block) 15, and a third block 16, to be described below. The first block 14 is a block that causes the refrigerant that flows into the first tank portion 8 of the bottom tank 5 from the refrigerant-inlet header 10 to flow to the first tank portion 6 of the top tank 4 via the plurality of refrigerant tubes 2 connected in the right region with respect to the partition plate 5H.

[0039] In addition, the second block (U-turn block) 15, which is also referred to as a U-turn block, is a block that causes the refrigerant that flows into the first tank portion 6 of the top tank 4 to flow along the partition wall 4C toward the left region in the figure, from where it is distributed nearly evenly to the left region with respect to the partition plate 4H of the second tank portion 7 parallel to the length direction thereof via the plurality of refrigerant-distribution holes 4M, and then causes the refrigerant to flow down through the plurality of refrigerant tubes 2 from both the first tank portion 6 and the second tank portion 7 to the first tank portion 8 and the second tank portion 9 of the bottom tank 5. The refrigerant that has flowed down to the first tank portion 8 and the second tank portion 9 of the bottom tank 5 is collected in the second tank portion 9 via the refrigerant-distribution holes 5M.

[0040] Furthermore, the third block 16 is a block that causes the refrigerant collected in the second tank portion 9 to flow toward the right region along the partition wall 5C, and then causes it to flow to the second tank portion 7 of the top tank 4 via the plurality of refrigerant tubes 2. The refrigerant that has flowed to the second tank portion 7 of the top tank 4 in this third block 16 flows out to the refrigerant-outlet pipe 13 via the outlet header 11.

[0041] As shown in Fig. 4, the plurality of refrigerant-distribution holes 4M and 5M provided in the above-described partition walls 4C and 5C are constituted of elongated holes 4m and 5m, which are elliptical holes or elongated circular holes, etc. made longer in a direction orthogonal to the hole-row direction, so that it is possible to ensure an adequate opening area to prevent an increase in pressure loss of the flowing refrigerant, and so that it is also possible to ensure adequate pressure-withstanding strength by alleviating stress concentration due to internal pressure. In addition, assuming the distance between the plurality of elongated holes (pitch of the holes) as b, the hole length in the hole-row direction as a, and the thickness of the partition walls 4C and 5C as t, the elongated holes 4m and 5m are configured as follows in order to enhance the pressure-withstanding strength of the top tank 4 and the bottom tank 5.

[0042] Fig. 7 shows analysis results based on experiments and FEM regarding the relationship between the break-down pressure P [MPa] of the tank partition portions (vertical axis) and the ratio a/b (horizontal axis) when the thickness t of the partition walls 4C and 5C are set at 1 mm, 1.3 mm, and 2 mm, and Fig. 8 shows a graph in which the thickness t of the partition walls 4C and 5C is set as the horizontal axis and a/b as the vertical axis, and the graph shown in Fig. 7 is converted to a polynomial expression that expresses ranges of a/b within which it is possible to ensure required break-down pressure P of the tank partition portions (P = 2.55, P = 3.3, and P = 4.5), taking the thickness t of the partition walls into consideration.

[0043] These analysis results indicate that, in order to satisfy at least 2.55 MPa (P = 2.55) or greater pressure-withstanding pressure, setting the above-described a/b to a polynomial expression of P = 2.55, that is, $a/b <= -0.0697 * t^2 + 0.3274 * t + 0.4594$, where t = 1 to 2 mm, satisfies the pressure-withstanding pressure of 2.55 MPa or greater, and thus, it is possible to ensure the required pressure-withstanding strength. Note that, the partition walls 4Ca and 5C are clad materials, whose core material is A3003-H14 and whose surface material is A4343, and the plate thickness t is normally set between 1 and 2 mm because too low a thickness causes deficient strength and too high a thickness increases the tank size in the thickness direction or decreases the channel area in the tank.

[0044] In addition, for the elongated holes 4m and 5m, it is desirable to set the above-described a/b to $a/b <= -0.0744 * t^2 + 0.3577 * t + 0.3786$, where t = 1 to 2 mm, to satisfy at least 3.3 MPa or greater break-down pressure, and, furthermore, it is more desirable to set it to $a/b <= -0.0763 * t^2 + 0.3810 * t + 0.2847$, where t = 1 to 2 mm, so that a break-down pressure of 4.5 MPa or greater can be satisfied even if variability in inter-hole distance of the plurality of elongated holes 4m and 5m, etc. is taken into consideration.

[0045] According to this example described above, the following operational advantages are afforded.

[0046] The gas-liquid two-phase refrigerant that has flowed into the first tank 8 of the bottom tank 5 from the refrigerant-inlet pipe 12 via the refrigerant-inlet header 10 undergoes heat exchange with the air A via the heat-conducting fins 3 while flowing in the plurality of refrigerant tubes 2 in the first block 14 toward the first tank portion 6 of the top tank 4, and thus part of the refrigerant evaporates. The refrigerant collected in the first tank portion 6 of the top tank 4 flows through the first tank portion 6 to the left region thereof to enter the second block (U-turn block) 15. While flowing through the first tank portion 6, the gas-liquid two-phase refrigerant that has flowed into the second block (U-turn block) 15 is evenly distributed to the second tank portion 7 by the refrigerant-distribution holes 4M constituted of the elongated holes 4m provided in the partition wall 4C.

[0047] The refrigerant evenly distributed to the first tank portion 6 and the second tank portion 7 of the top tank 4 in the second block (U-turn block) 15 further evaporates upon undergoing heat exchange with the air A via the heat-conducting fins 3 while flowing down the plurality of refrigerant tubes 2 in the second block (U-turn block) 15 toward the first tank portion 8 and the second tank portion 9 of the bottom tank 5. The refrigerant that has flowed down to the first tank portion 8 and the second tank portion 9 of the bottom tank 5 is collected in the second tank portion 9 by the refrigerant-distribution holes 5M (the elongated holes 5m) provided in the partition wall 5C and flows through the second tank portion 9 to the right region thereof to enter the third block 16. This refrigerant rises through the plurality of refrigerant tubes 2 in the third block 16 toward the second tank portion 7 of the top tank 4, during which heat exchange with the air A occurs, thereby being entirely gasified and collected in the second tank portion 7. The air A cooled by the heat exchange with the refrigerant is supplied to the vehicle interior to be used for air conditioning, whereas the gasified refrigerant is sucked into a compressor from the outlet header 11 via the refrigerant-outlet pipe 13, thereby being circulated in the refrigeration cycle.

[0048] As described above, in the second block (U-turn block) 15 where the refrigerant makes a U-turn in the top tank, as shown in Fig. 5, the gas-liquid two-phase refrigerant that has flowed into the first tank portion 6 of the top tank 4 along the partition wall 4C is sequentially distributed to the second tank portion 7 from the front side by the plurality of refrigerant-distribution holes 4M constituted of the elongated holes 4m made longer in the longitudinal direction and provided in the length direction of the partition wall 4C; therefore, it is possible to make the liquid refrigerant flow into the second tank portion 7 nearly evenly over the entire region in the length direction thereof. Accordingly, it is possible to nearly evenly distribute the liquid refrigerant to the plurality of refrigerant tubes 2 connected to the first tank portion 6 and the second tank portion 7 in the second block.

[0049] Therefore, according to the above-described refrigerant evaporator 1, the distribution of the liquid refrigerant is enhanced, in particular, between the first tank portion 6 and the second tank portion 7 of the U-turn block 15, thereby making it possible for the liquid refrigerant that contributes to cooling of the air A, which is the external fluid, to be more evenly distributed to the plurality of refrigerant tubes 2; therefore, it is possible to enhance the heat-exchange performance of the refrigerant evaporator by making the heat-conducting area function effectively.

[0050] On the other hand, it is necessary to increase the pressure-withstanding strength of the top tank 4 and the bottom tank 5 against the refrigerant to be used. In particular, in the top tank 4 and the bottom tank 5, where the refrigerant-distribution holes 4M and 5M are provided in the partition walls 4C and 5C, stress due to the internal pressure concentrates on hole-row portions of the refrigerant-distribution holes 4M and 5M. Accordingly, the refrigerant-distribution holes 4M and 5M are constituted of the elongated holes 4m and 5m, which are elliptical holes or elongated circular holes, etc. made longer in a direction orthogonal to the hole-row direction, so that it is possible to ensure an adequate opening area to prevent an increase in pressure loss of the flowing refrigerant and to ensure adequate pressure-withstanding strength by alleviating stress concentration due to the internal pressure.

[0051] Accordingly, it is possible to set the opening area of the refrigerant-distribution holes 4M and 5M (elongated holes 4m and 5m) to a size allowing passage of the refrigerant without increasing the pressure loss thereof and to set the inter-hole distance of the plurality of refrigerant-distribution holes 4M and 5M (elongated holes 4m and 5m) at a size that makes it possible to satisfy adequate pressure-withstanding pressure or break-down pressure. Therefore, it becomes possible to readily increase the pressure-withstanding strength of the top tank 4 and the bottom tank 5 by optimizing the hole shape of the refrigerant-distribution holes 4M and 5M, while suppressing an increase in pressure loss of the refrigerant in the partition walls 4C and 5C, which have restricted configurations.

[0052] In addition, regarding the plurality of refrigerant-distribution holes 4M and 5M (elongated holes 4m and 5m), because a/b is set to $a/b <= -0.0697 * t^2 + 0.3274 * t + 0.4594$, where t = 1 to 2 mm, assuming the distance between the plurality of elongated holes as b, the hole length in the hole-row direction as a, and the thickness of the partition walls as t, it is possible to set the inter-hole distance of the plurality of refrigerant-distribution holes 4M and 5M (elongated holes 4m and 5m) provided in the partition walls 4C and 5C to a size at which at least a pressure-withstanding pressure of 2.55 MPa or greater can be satisfied.

[0053] Fig. 7 shows analysis results regarding the relationship between the break-down pressure P [MPa] of the tank partition portions (vertical-axis) and the above-described a/b (horizontal axis) when the thickness t of the partition walls 4C and 5C is set at 1 mm, 1.3 mm, and 2 mm, and Fig. 8 shows a graph in which the thickness t of the partition walls 4C and 5C is set as the horizontal axis and a/b as the vertical axis, and the graph shown in Fig. 7 is converted to a polynomial expression that expresses ranges of a/b within which it is possible to ensure the required break-down pressure P of the tank partition portions, taking the thickness t of the partition walls into consideration. From these results, it is clear that, in order to satisfy at least 2.55 MPa or greater pressure-withstanding pressure, setting a/b to $a/b <= -0.0697 * t^2 + 0.3274 * t + 0.4594$, where t = 1 to 2 mm, satisfies this pressure-withstanding pressure, and thus, it is possible to ensure the required pressure-withstanding strength.

[0054] Similarly, by setting the above-described a/b to $a/b <= - 0.0744 * t^2 + 0.3577 * t + 0.3786$, where t = 1 to 2 mm, at least 3.3 MPa or greater break-down pressure can be satisfied, and, furthermore, by setting it to $a/b <= -0.0763 * t^2 + 0.3810 * t + 0.2847$, where t = 1 to 2 mm, 4.5 MPa or greater break-down pressure can be satisfied even if variability in the inter-hole distance of the plurality of elongated holes 4m and 5m, etc. is taken into consideration. Thus, it is clear that the required pressure-withstanding strengths can be adequately ensured.

[0055] Therefore, according to this example, with the partition walls 4C and 5C which have restrictive conditions, such as the inability to increase the plate thickness because the tank size would be increased, the inability to decrease the number of holes to ensure the function thereof for evenly distributing refrigerant, the need for the opening area to be made large to suppress pressure loss of the refrigerant passing therethrough, etc., it is possible to readily ensure the pressure-withstanding strength of the tank portions against the internal pressure by optimizing various sizes of the refrigerant-distribution holes 4M and 5M (the elongated holes 4m and 5m).

[0056] Note that, as shown in Figs. 3A and 3B, in the above-described example, numerous ribs 4N and 5N may be integrally molded on surfaces of the top members 4A and 5A of the tanks 4 and 5. In addition, individual component parts of the refrigerant evaporator 1 shown in Fig. 2 are not separately joined by brazing, but, as is known, after all component parts are pre-assembled, they can be placed in an oven to be heated and be manufactured into an integrated piece by brazing in the oven.

[0057] Furthermore, the above-described aluminum-alloy refrigerant evaporator 1 is particularly suitable for a refrigerant evaporator that forms a refrigeration cycle of a vehicle air conditioner where it is necessary to achieve low weight and compactness, and, by applying the refrigerant evaporator 1 thereto, the performance of the air conditioner can be enhanced, and, simultaneously, the reliability of the air conditioner can be enhanced by increasing the pressure-withstanding strength of the refrigerant evaporator 1.

{Embodiment}

[0058] Next, an embodiment of the present invention will be described using Fig. 6.

[0059] This embodiment differs from the first example described above in the manner of providing the refrigerant-distribution holes 4M and 5M (elongated holes 4m and 5m) to be provided in the partition walls 4C and 5C. Because other components are the same as those of the first example, descriptions thereof will be omitted.

[0060] In this embodiment, assuming the entire length of the top tank 4 constituting the second block (U turn block) 15 in the refrigerant inflow direction (the distance between the left end of the top tank 4 and the partition plate 4H) as L2, as shown in Fig. 6, the plurality of refrigerant-distribution holes 4M and 5M (elongated holes 4m and 5m) provided in the partition walls 4C and 5C in the second block (U-turn block) 15 are configured to be provided in a plurality in a back-side region within the length L1, excluding a portion of the region on the front side in the refrigerant inflow direction.

[0061] The above-described back-side-region length L1 is the length from the back-most ends of the first tank portion 6 and the second tank portion 7 to the position of the refrigerant-distribution holes 4M on the front-most side; it is effective to set this length L1 of the back-side region within a range of $0.7 < L1/L2 < 0.9$, relative to the entire length L2, and it is most preferable that L1/L2 be about 0.8. By employing such a configuration, in comparison with the case of the first embodiment, the refrigerant distribution can be further improved, thereby making it possible to further enhance the heat-exchange performance of the refrigerant evaporator 1. Note that when L1/L2 becomes less than 0.7, the distribution of liquid refrigerant in a region close to the partition plate 4H in the second tank portion 7 becomes slightly deficient, whereas when L1/L2 exceeds 0.9, conversely, the distribution of liquid refrigerant in a region on the back-most side thereof becomes slightly deficient; and, from this, it is most preferable that L1/L2 be about 0.8.

[0062] Note that, the present invention is not limited to the invention according to the above-described embodiment, and appropriate modifications are permissible. For example, although all of the plurality of refrigerant-distribution holes 4M and 5M (elongated holes 4m and 5m) provided in the length direction of the partition walls 4C and 5C are made in equal sizes in the example and embodiment described above, the sizes of the refrigerant-distribution holes 4M and 5M (elongated holes 4m and 5m) may be gradually increased from the front side toward the back side in the refrigerant inflow direction. Accordingly, the liquid refrigerant, more of which is readily distributed to the refrigerant-distribution holes 4M (elongated holes 4m) on the front side due to inertia, is sequentially shifted to the larger refrigerant-distribution holes 4M (elongated holes 4m) on the back side, by which the distribution in the refrigerant inflow direction is improved for the liquid refrigerant flowing from the first tank portion 6 to the second tank portion 7, thereby making it possible to distribute the liquid refrigerant nearly evenly over the entire region in the refrigerant inflow direction in the first tank portion 6 and the second tank portion 7; therefore, it is possible to further enhance the heat-exchange performance of the refrigerant evaporator 1 by achieving an even distribution of the liquid refrigerant to the plurality of refrigerant tubes 2.

[0063] In addition, in the above-described example and embodiment, the U-turn block 15 in which the refrigerant flows from the first tank portion 6 to the second tank portion 7 has been described as an example; however, a configuration such as one in which the refrigerant flows in reverse from the second tank portion to the first tank portion 6 is of course also possible. Furthermore, although an example of dividing the refrigerant flow pathway into three blocks has been described, the number of blocks is not limited to three blocks. In addition, the inlet and outlet of the refrigerant for the refrigerant evaporator 1 may be provided anywhere at the top, bottom, left, and right.

{Reference Signs List}

[0064]

1: refrigerant evaporator
2: refrigerant tube
2A: refrigerant channel
4: top tank
5: bottom tank
4C, 5C: partition wall
4G: refrigerant outlet
4H, 5H: partition plate
4M, 5M: refrigerant-distribution hole
4m, 5m: elongated hole
5G: refrigerant inlet
6, 8: first tank portion
7, 9: second tank portion
14: first block
15: second block (U-turn block)
16: third block
a: hole length of refrigerant-distribution hole (elongated hole) in hole-row direction
b: distance between plurality of refrigerant-distribution holes (elongated holes).

Claims

1. A refrigerant evaporator (1) made of aluminum alloy comprising:

a plurality of refrigerant tubes (2) that have refrigerant channels (2A) for flowing refrigerant in a vertical direction, that are arranged in parallel such that the refrigerant tubes (2) can be arranged in a direction orthogonal to a flow direction of an external fluid (A) that flows outside of the refrigerant channels (2A), and that are arranged in a plurality of rows, front-to-back, parallel to the flow direction of the external fluid (A); and

a pair of top and bottom tanks (4,5) that are arranged in the direction orthogonal to the flow direction of the external fluid (A) and are connected at top and bottom ends of the plurality of refrigerant tubes (2), the interior of which is partitioned in a row direction corresponding to the plurality of rows of the refrigerant tubes (2) into a first tank portion (6;8) and a second tank portion (7;9) by a partition wall (4C;5C), and that are configured to distribute or collect the refrigerant,

wherein the tanks (4,5) are provided with a refrigerant inlet (5G) and a refrigerant outlet (4G), and the arrangement is such that the refrigerant that has flowed in from the refrigerant inlet (5G) sequentially flows through the refrigerant tubes (2) of a plurality of blocks (14,15,16) divided by partition plates (4H;5H) provided in a plurality of locations in the tanks (4;5), after which the refrigerant flows out from the refrigerant outlet (4G),

wherein one of the plurality of blocks (14,15,16) is a U-turn block portion (15) in which the refrigerant flows into the first tank portion (6) or the second tank portion (7) of the top tank (4) from a direction parallel to the partition wall (4C) and, from there, flows into the other tank portion (7,6), thereby being distributed to the plurality of refrigerant tubes (2) from the first tank portion (6) and the second tank portion (7), respectively,

wherein, on the partition walls (4C;5C) that partition the first tank portions (6;8) and the second tank portions (7;9) of the top and bottom tanks (4,5) in the U-turn block portion (15), a plurality of refrigerant-distribution holes (4M;5M), which communicate between the first tank portions (6;8) and the second tank portions (7;9), are provided in the length direction of the partition walls (4C;5C);

characterized in that the plurality of refrigerant-distribution holes (4M;5M) are provided in a backside-region of the U-turn block portion (15), excluding a portion of the region on the front side in the refrigerant inflow direction, wherein a length L1 of the backside-region in the refrigerant inflow direction is the length from back-most ends of the first tank portion (6) and the second tank portion (7) to the position of the refrigerant-distribution hole (4M) on a front-most side and the length L1 is within a range of 0.7 < L1/L2 < 0.9 relative to the entire length L2 of the U-turn block portion (15) in the refrigerant inflow direction, and

in that the refrigerant-distribution holes (4M;5M) are elongated holes (4m;5m) made longer in a direction orthogonal to the hole-row direction of the refrigerant-distribution holes (4M;5M).

2. A refrigerant evaporator (1) according to Claim 1, wherein for the refrigerant-distribution holes (4M;5M), assuming the distance between the plurality of holes as b, the hole length in the hole-row direction as a, and the thickness of the partition wall (4C;5C) as t, a/b is set to a/b <= -0.0697 * t<2> + 0.3274 * t + 0.4594, where t = 1 to 2 mm.

3. A refrigerant evaporator (1) according to Claim 2, wherein a/b of the refrigerant-distribution hole (4M;5M) is set to a/b <= -0.0744 * t<2> + 0.3577 * t + 0.3786, where t = 1 to 2 mm.

4. A refrigerant evaporator (1) according to Claim 2, wherein a/b of the refrigerant-distribution hole (4M;5M) is set to a/b <= -0.0763 * t<2> + 0.3810 * t + 0.2847, where t = 1 to 2 mm.

5. A refrigerant evaporator (1) according to any of claims 1 to 4, wherein the elongated holes (4m;5m) are elliptical holes or elongated circular holes.

6. An air conditioner comprising a refrigerant evaporator (1) according to any of Claims 1 to 5, employed as a refrigerant evaporator provided in a refrigeration cycle.

Patentansprüche

1. Ein Kühlmittelverdampfer (1), der aus einer Aluminiumlegierung hergestellt ist, mit:

einer Vielzahl von Kühlmittelrohren (2), die Kühlmittelkanäle (2A) für ein Strömen eines Kühlmittels in einer Vertikalrichtung haben, die so parallel angeordnet sind, dass die Kühlmittelrohre (2) in einer Richtung angeordnet sein können, die orthogonal zu einer Strömungsrichtung eines externen Fluids (A) ist, das außerhalb der Kühlmittelkanäle (2A) strömt, und die in einer Vielzahl von Reihen von vorne nach hinten parallel zur Strömungsrichtung des externen Flu-

ids (A) angeordnet sind, und
einem Paar von oberen und unteren Tanks (4,5), die in der Richtung orthogonal zu der Strömungsrichtung des externen Fluids (A) angeordnet sind und mit oberen und unteren Enden der Vielzahl von Kühlmittelrohren (2) verbunden sind, deren Innenraum in einer Reihenrichtung korrespondierend zu der Vielzahl von Reihen der Kühlmittelrohre (2) innerhalb eines ersten Tankabschnitts (6;8) und eines zweiten Tankabschnitts (7;9) durch eine Trennwand (4C;5C) unterteilt sind, und die ausgestaltet sind, um das Kühlmittel zu verteilen oder zu sammeln,
wobei die Tanks (4,5) mit einem Kühlmitteleinlass (5G) und einem Kühlmittelauslass (4G) vorgesehen sind, und die Anordnung so ist, dass das Kühlmittel, das von dem Kühlmitteleinlass (5G) einströmte, durch die Kühlmittelrohre (2) von einer Vielzahl von Blöcken (14,15,16) fortlaufend strömt, die durch Trennplatten (4H;5H) unterteilt sind, die an einer Vielzahl von Stellen in den Tanks (4;5) vorgesehen sind, wonach das Kühlmittel von dem Kühlmittelauslass (4G) ausströmt,
wobei einer von der Vielzahl von Blöcken (14,15,16) ein Wendeblockabschnitt (15) ist, in dem das Kühlmittel in den ersten Tankabschnitt (6) oder den zweiten Tankabschnitt (7) des oberen Tanks (4) von einer zu der Trennwand (4C) parallelen Richtung einströmt und von dort in den anderen Tankabschnitt (7,6) hinein strömt, wodurch dieses jeweils auf die Vielzahl von Kühlmittelrohre (2) von dem ersten Tankabschnitt (6) und dem zweiten Tankabschnitt (7) aufgeteilt wird,
wobei an den Trennwänden (4C;5C), die die ersten Tankabschnitte (6;8) und die zweiten Tankabschnitte (7;9) der oberen und der unteren Tanks (4,5) in dem Wendeblockabschnitt (15) unterteilen, eine Vielzahl von Kühlmittelverteilungslöcher (4M;5M), welche mit den ersten Tankabschnitten (6;8) und den zweiten Tankabschnitten (7;9) in Verbindung stehen, in der Längenrichtung der Trennwände (4c;5C) vorgesehen sind,
dadurch gekennzeichnet, dass
die Vielzahl von Kühlmittelverteilungslöchern (4M;5M) an einem rückseitigen Bereich des Wendeblockabschnitts (15) vorgesehen sind, der einen Abschnitt des Bereichs an der Vorderseite in der Kühlmitteleinströmrichtung ausschließt, wobei eine Länge L1 des rückseitigen Bereichs in der Kühlmitteleinströmrichtung die Länge von den am weitesten rückseitigen Enden des ersten Tankabschnitts (6) und des zweiten Tankabschnitts (7) zu der Position des Kühlmittelverteilungslochs (4M) an einer am weitesten vorderen Seite ist und die Länge L1 innerhalb eines Bereichs von 0,7 < L1/L2 < 0,9 relativ zu der gesamten Länge L2 des Wendeblockabschnitts (15) in der Kühlmitteleinströmrichtung ist, und in dem die Kühlmittelverteilungslöcher (4M;5M) längliche Löcher (4m;5m) sind, die in einer zu der Lochreihenrichtung der Kühlmittelverteilungslöcher (4M;5M) orthogonalen Richtung länger ausgebildet sind.

2. Ein Kühlmittelverdampfer (1) gemäß Anspruch 1, wobei, wenn für die Kühlmittelverteilungslöcher (4M;5M) die Distanz zwischen der Vielzahl von Löchern als b, die Lochlänge in der Lochreihenrichtung als a und die Dicke der Trennwand (4C;5C) als t angenommen wird, a/b auf a/b <= -0,0697 * t<2> * 0,3274 * t + 0,4594 festgelegt ist, wobei t = 1 bis 2 mm.

3. Ein Kühlmittelverdampfer (1) gemäß Anspruch 2, wobei a/b des Kühlmittelverteilungslochs (4M;5M) auf a/b <= -0,0744 * t<2> + 0,3577 * t + 0,3786 festgelegt ist, wobei t = 1 bis 2 mm.

4. Ein Kühlmittelverdampfer (1) gemäß Anspruch 2, wobei a/b für das Kühlmittelverteilungsloch (4M;5M) auf a/b <= -0,0763 * t<2> + 0,3810 * t + 0,2847 festgelegt ist, wobei t = 1 bis 2 mm.

5. Ein Kühlmittelverdampfer (1) gemäß einem der Ansprüche 1 bis 4, wobei die länglichen Löcher (4m;5m) elliptische Löcher oder länglich kreisförmige Löcher sind.

6. Eine Klimaanlage mit einem Kühlmittelverdampfer (1) gemäß einem der Ansprüche 1 bis 5, der als ein Kühlmittelverdampfer eingesetzt wird, der in einem Kühlmittelkreislauf vorgesehen ist.

Revendications

1. Evaporateur (1) de réfrigérant, en un alliage d'aluminium, comprenant :

une pluralité de tubes (2) pour du réfrigérant, qui ont des canaux (2A) pour du réfrigérant, pour faire passer du réfrigérant dans une direction verticale, qui sont disposés en parallèle de manière à ce que les tubes (2) pour du réfrigérant puissent être disposés dans une direction orthogonale à une direction de passage d'un fluide (A) extérieur, qui passe à l'extérieur des canaux (2A) pour du réfrigérant et qui sont disposés suivant une pluralité de rangées, d'avant en arrière, parallèlement à la direction de passage du fluide (A) extérieur et
une paire de cuves (4, 5) de sommet et de fond, qui sont disposées dans la direction orthogonale

à la direction de passage du fluide (A) extérieur et qui communiquent avec des extrémités de sommet et de fond de la pluralité de tubes (2) pour du réfrigérant, dont l'intérieur est cloisonné dans une direction de rangée correspondant à la pluralité de rangées des tubes (2) pour du réfrigérant, en une première partie (6 ; 8) de cuve et en une deuxième partie (7 ; 9) de cuve, par une cloison (4C ; 5C), et qui sont configurées pour répartir ou collecter le réfrigérant,
dans lequel les cuves (4, 5) sont prévues en ayant une entrée (5G) de réfrigérant et une sortie (4G) de réfrigérant, et l'agencement est tel que le réfrigérant, qui vient de l'entrée (5G) de réfrigérant, passe séquentiellement dans les tubes (2) pour du réfrigérant d'une pluralité de blocs (14, 15, 16) subdivisés par des plaques (4H ; 5H) de cloisonnement prévues en une pluralité d'emplacements dans les cuves (4 ; 5), après quoi le réfrigérant sort par la sortie (4G) de réfrigérant,
dans lequel l'un de la pluralité de blocs (14, 15, 16) est une partie (15) de bloc en demi-tour, dans lequel le réfrigérant entre dans la première partie (6) et la deuxième partie (7) de la cuve (4) de sommet depuis une direction parallèle à la cloison (4C) et, de là, entre dans l'autre partie (7, 6) de cuve, en étant ainsi réparti sur la pluralité de tubes (2) de réfrigérant à partir de la première partie (6) de cuve et de la deuxième partie (7) de cuve, respectivement,
dans lequel, sur les cloisons (4C ; 5C), qui cloisonnent les premières parties (6 ; 8) et les deuxièmes parties (7 ; 9) des cuves (4, 5) de sommet et de fond dans la partie (15) de bloc en demi-tour, il est prévu une pluralité de trous (4M ; 5M) de répartition de réfrigérant, qui assurent une communication entre les premières parties (6 ; 8) de cuve et les deuxièmes parties (7 ; 9) de cuve dans la direction longitudinale des cloisons (4C ; 5C) ;
caractérisé en ce que la pluralité de trous (4M ; 5M) de répartition de réfrigérant sont prévus dans une région du côté arrière de la partie (15) du bloc en demi-tour, à l'exclusion d'une partie de la région du côté avant dans la direction d'afflux du réfrigérant, une longueur L1 de la région du côté arrière dans la direction d'afflux du réfrigérant étant la longueur allant des extrémités les plus en arrière de la première partie (6) de cuve et de la deuxième partie (7) de cuve à la position du trou (4M) de répartition du réfrigérant d'un côté le plus en avant et la longueur L1 étant dans une plage de 0,7 < L1/L2 < 0,9 par rapport à la longueur L2 totale de la partie (15) du bloc en demi-tour dans la direction d'afflux du réfrigérant et
en ce que les trous (4M ; 5M) de répartition du réfrigérant sont des trous (4m ; 5m) oblongs plus longs dans une direction orthogonale à la direction de rangées de trous des trous (4M ; 5M) de répartition de réfrigérant.

2. Evaporateur (1) de réfrigérant suivant la revendication 1, dans lequel, pour les trous (4M ; 5M) de répartition de réfrigérant, en désignant la distance entre la pluralité de trous par b, la longueur du trou, dans la direction de rangée de trous par a, et l'épaisseur de la cloison (4C ; 5C) par t, a/b est fixé à a/b <= -0,0697 * t<2> + 0,3274 * t + 0,4594, où t =1 à 2 mm.

3. Evaporateur (1) de réfrigérant suivant la revendication 2, dans lequel a/b du trou (4M ; 5M) de répartition de réfrigérant est fixé à a/b <= -0,0744 * t<2> + 0,3577 * t + 0,3786, où t = 1 à 2 mm.

4. Evaporateur (1) de réfrigérant suivant la revendication 2, dans lequel a/b du trou (4M ; 5M) de répartition du réfrigérant est fixé à a/b <= 0,0763 * t<2> + 0,3810 * t + 0,2847, où t = 1 à 2 mm.

5. Evaporateur (1) de réfrigérant suivant l'une quelconque des revendications 1 à 4, dans lequel les trous (4m ; 5m) oblongs sont des trous elliptiques ou des trous circulaires oblongs.

6. Conditionneur d'air comprenant un évaporateur (1) de réfrigérant suivant l'une quelconque des revendications 1 à 5, employé comme évaporateur de réfrigérant prévu dans un cycle de réfrigération.

FIG. 1

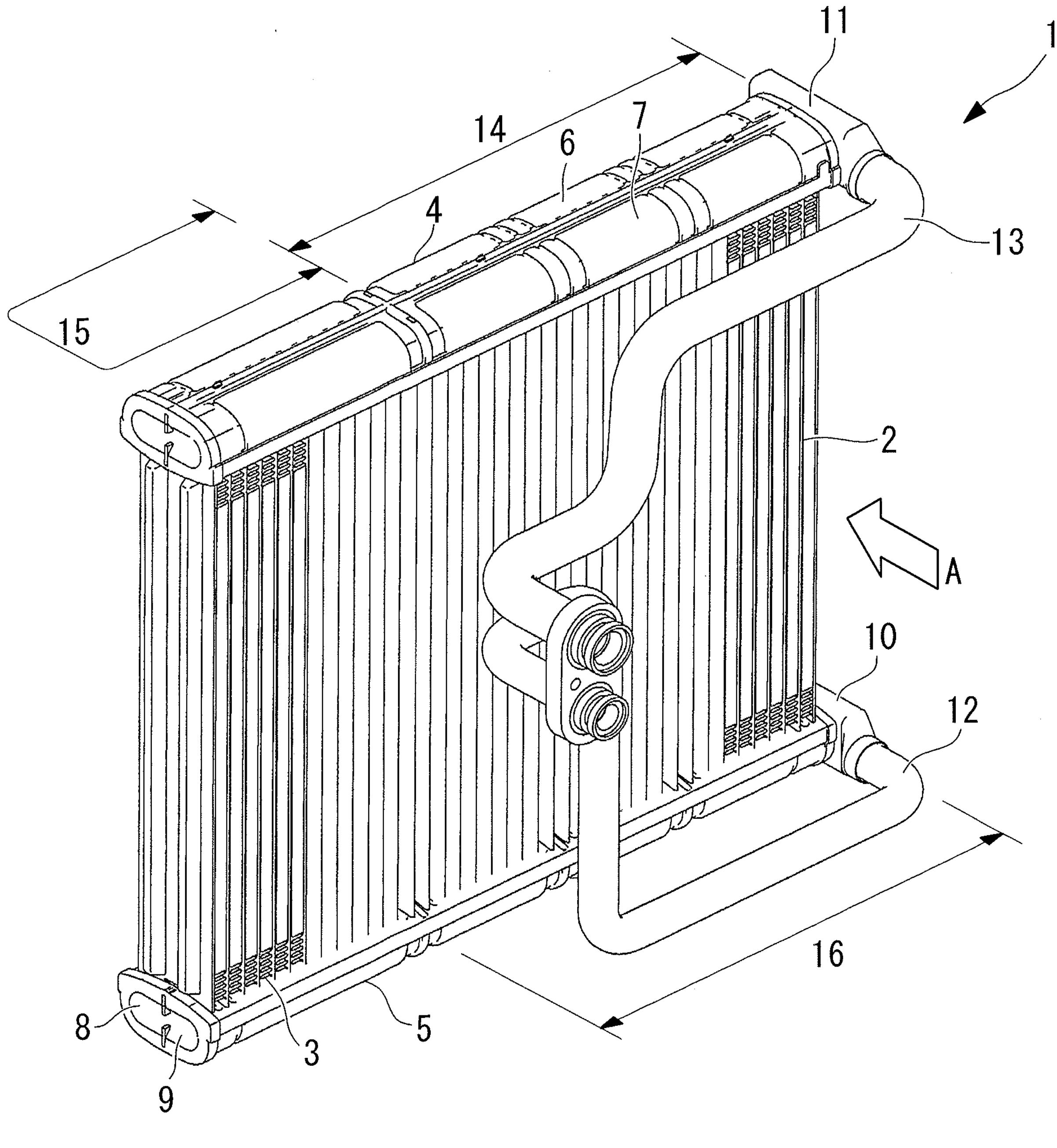


FIG. 2

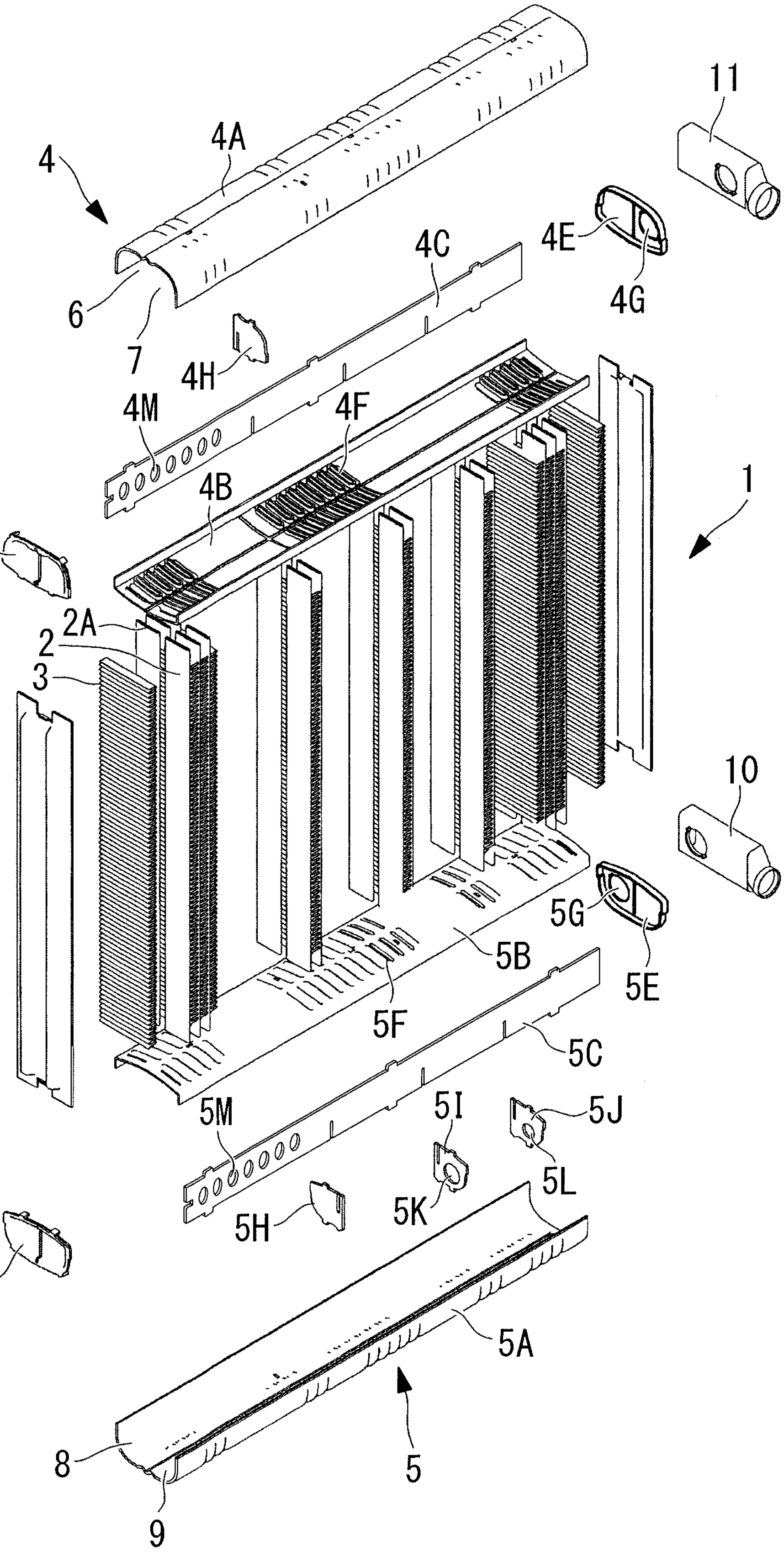

4
4A
11
4E
4C
6
4G
7
4H
4M
4F
4B
1
4D
2A
2
3
10
5G
5B
5E
5F
5C
5M
5I
5J
5L
5K
5H
5D
5A
8
5
9

FIG. 3A

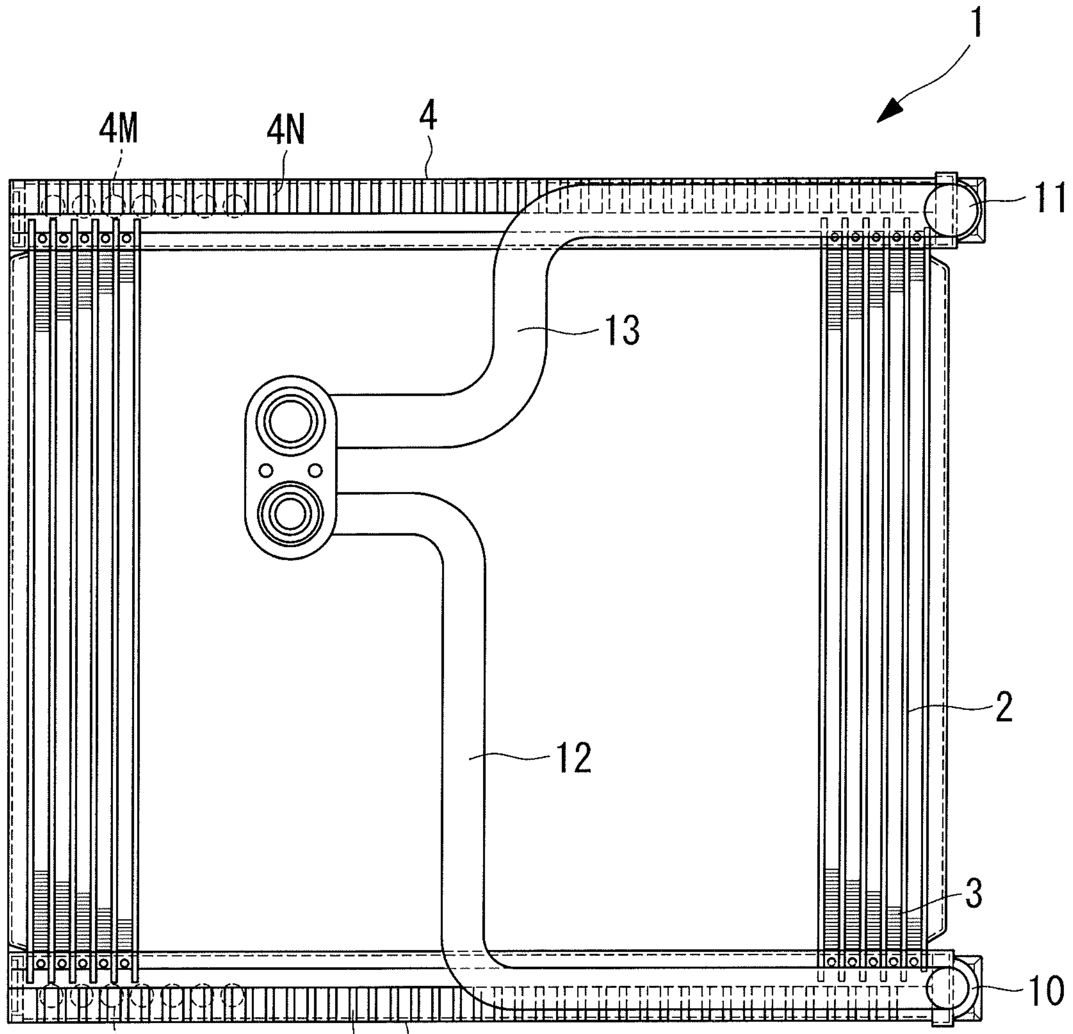


FIG. 3B

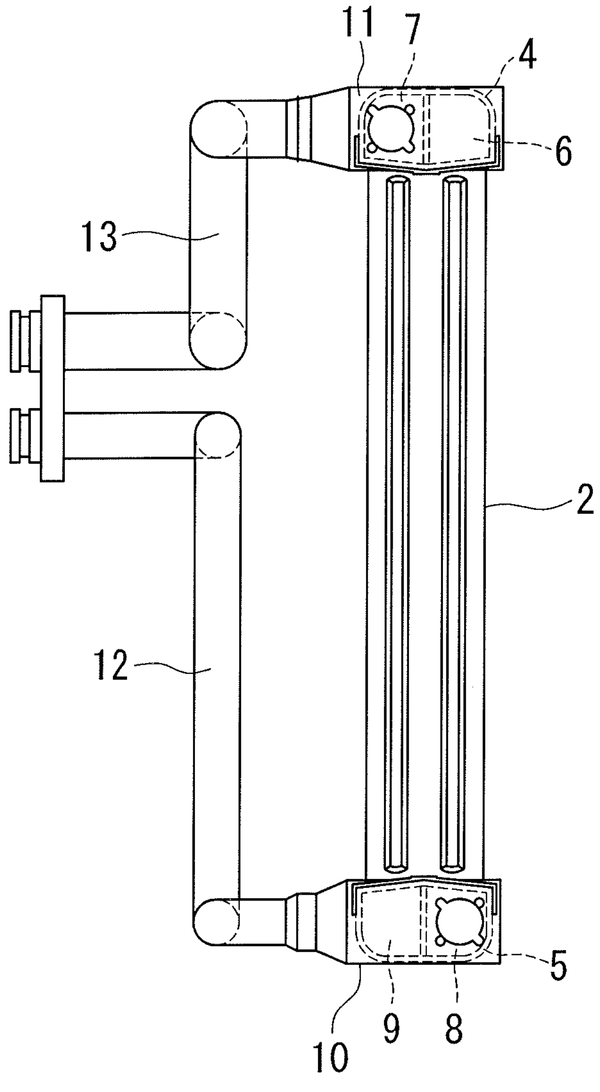


FIG. 4

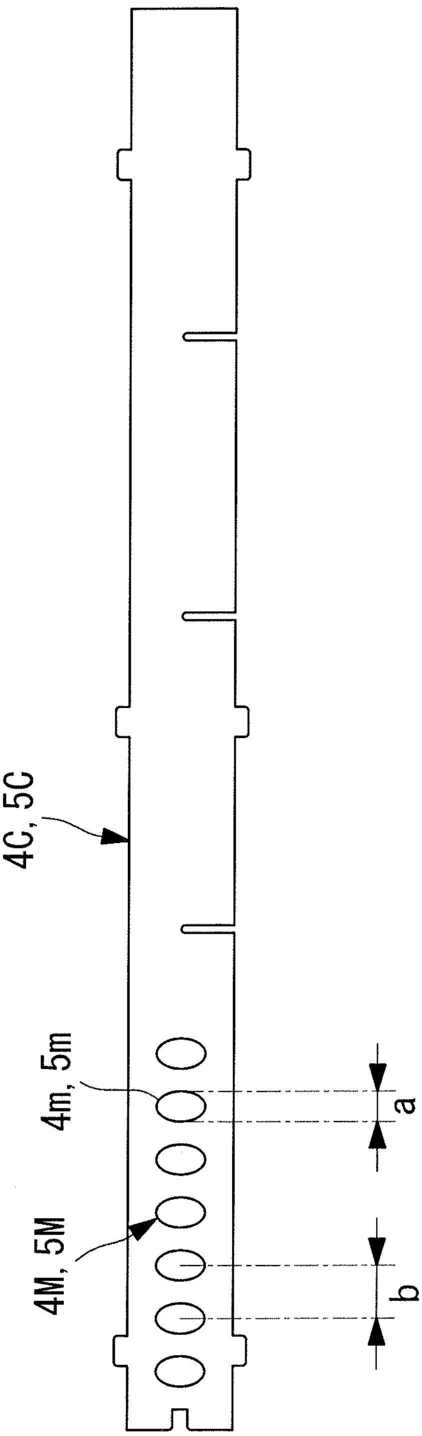


FIG. 5

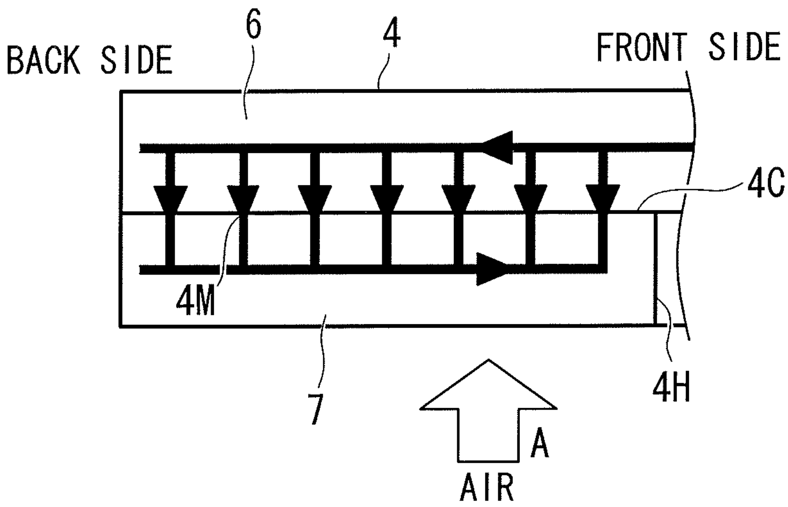

6
4
BACK SIDE
FRONT SIDE
4C
4M
7
4H
A
AIR

FIG. 6

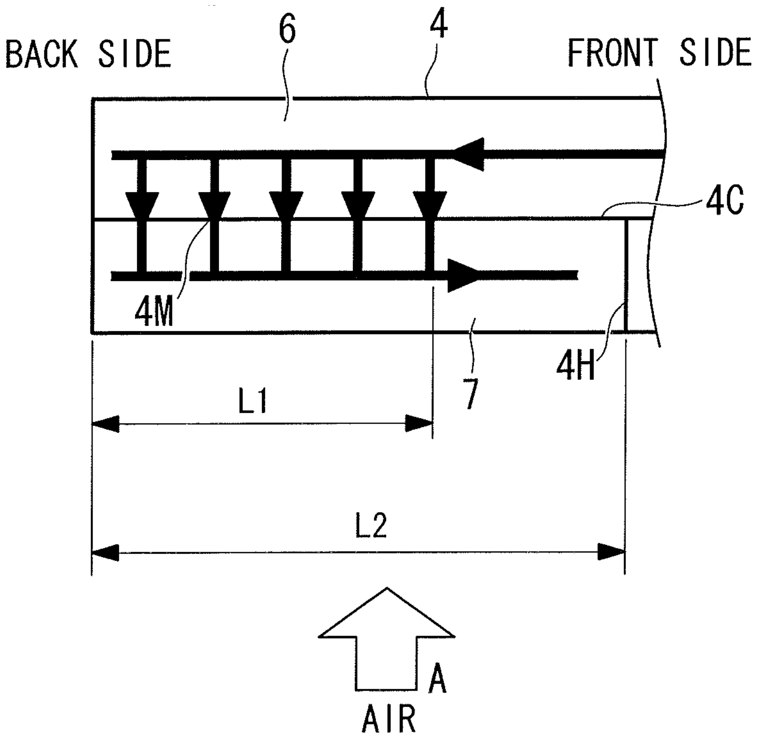

6
4
BACK SIDE
FRONT SIDE
4C
4M
4H
7
L1
L2
A
AIR

FIG. 7

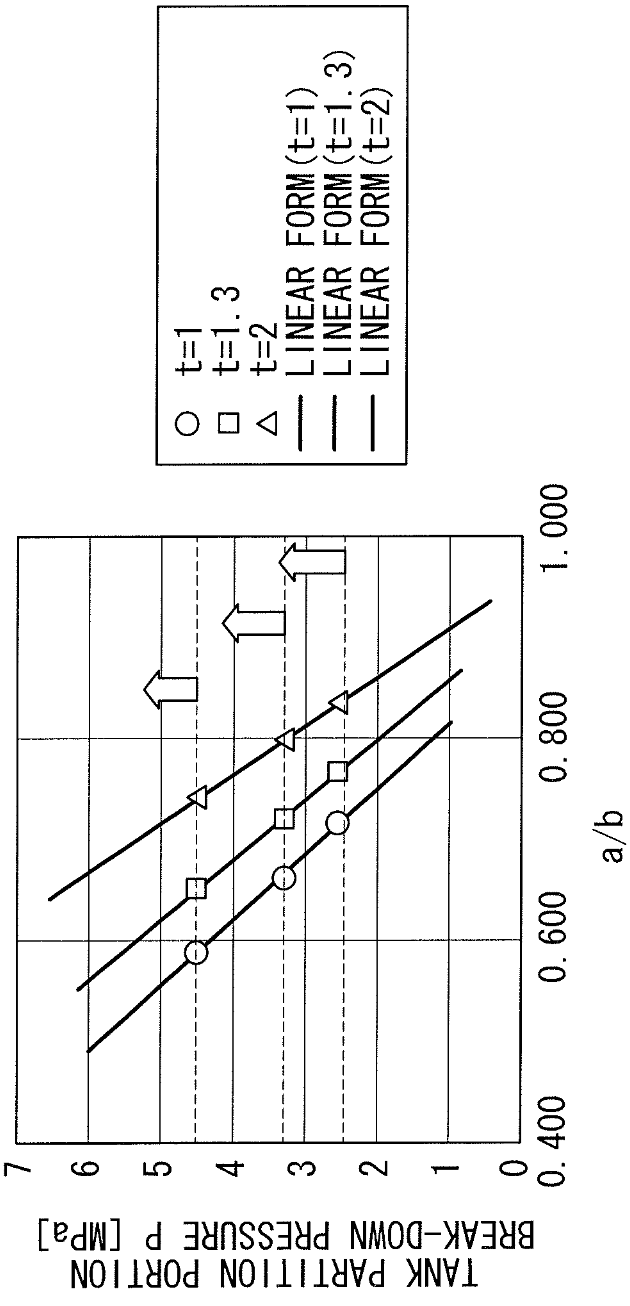
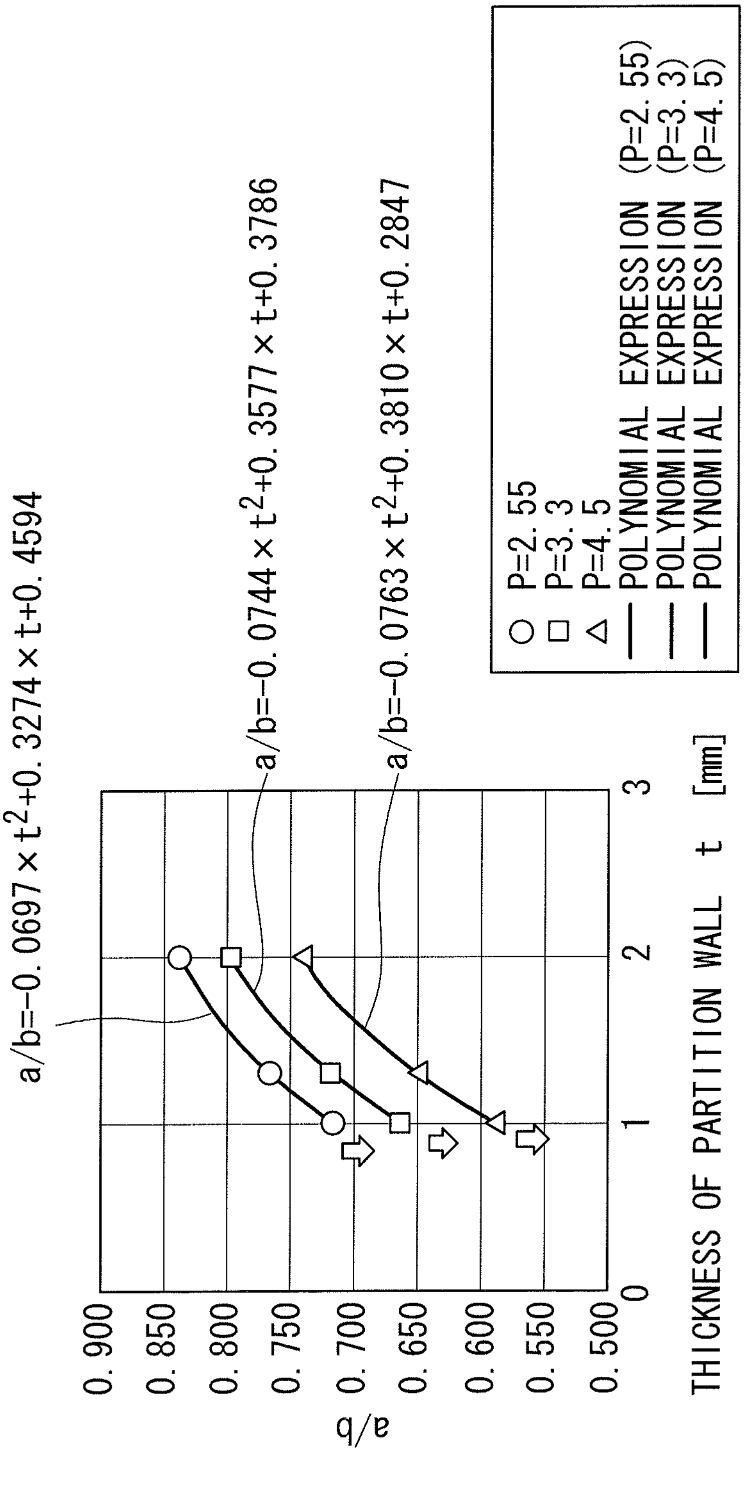

TANK PARTITION PORTION
BREAK-DOWN PRESSURE P [MPa]
0
1
2
3
4
5
6
7
0. 400
0. 600
0. 800
1. 000
a/b
○ t=1
□ t=1. 3
△ t=2
LINEAR FORM (t=1)
LINEAR FORM (t=1. 3)
LINEAR FORM (t=2)

FIG. 8


a/b=-0.0697×t²+0.3274×t+0.4594
a/b=-0.0744×t²+0.3577×t+0.3786
a/b=-0.0763×t²+0.3810×t+0.2847
a/b
0.900
0.850
0.800
0.750
0.700
0.650
0.600
0.550
0.500
0
1
2
3
THICKNESS OF PARTITION WALL t [mm]
P=2.55
P=3.3
P=4.5
POLYNOMIAL EXPRESSION (P=2.55)
POLYNOMIAL EXPRESSION (P=3.3)
POLYNOMIAL EXPRESSION (P=4.5)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3637314 B **[0003] [0005]**
- JP 3391339 B **[0003] [0006]**
- JP H0626780 A **[0004]**