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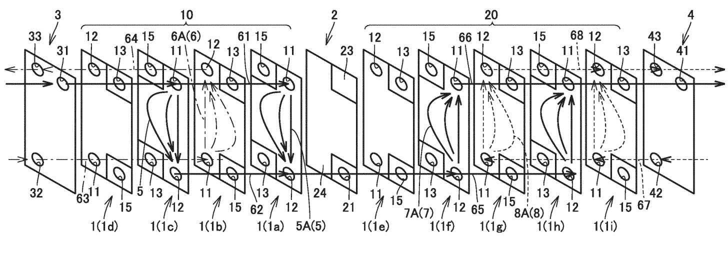
(54) PLATE-TYPE HEAT EXCHANGER AND REFRIGERATION CYCLE DEVICE

(57) A first heat exchanging unit (10), a second heat exchanging unit (20), and a partition plate (2) are provided. Each of the first heat exchanging unit (10) and the second heat exchanging unit (20) includes a plurality of heat transfer plates (1) stacked in a first direction. The partition plate (2) is disposed between the first heat exchanging unit (10) and the second heat exchanging unit (20) in the first direction. In the first heat exchanging unit (10), a first flow path (5) in which a first fluid flows and a second flow path (6) in which a second fluid flows are alternately provided in the first direction. In the second heat exchanging unit (20), a third flow path (7) in which the first fluid flows and a fourth flow path (8) in which a third fluid flows are alternately provided in the first direction. At least a portion of the first flow path (5) is located close to the partition plate (2) relative to the second flow path (6). At least a portion of the third flow path (7) is located close to the partition plate (2) relative to the fourth flow path (8).

FIG.3



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Description

TECHNICAL FIELD

[0001] The present invention relates to a plate-type heat exchanger and a refrigeration cycle apparatus, particularly, a plate-type heat exchanger having a plurality of heat exchange areas, as well as a refrigeration cycle apparatus including the plate-type heat exchanger.

BACKGROUND ART

[0002] A plate-type heat exchanger having a plurality of heat exchange areas has been known. Such a plate-type heat exchanger is described in, for example, Japanese Patent Laying-Open No. 2005-106385 (Patent Literature 1). The plate-type heat exchanger described in this publication has two heat exchange areas (a condensation portion and a supercooling portion) divided based on a state of refrigerant, and each of the two heat exchange areas is provided with a flow path for a heated fluid and a flow path for the refrigerant. The flow path for the refrigerant is provided with a liquid receiver located between the condensation portion and the supercooling portion and disposed external to the heat exchanger. The heated fluid exchanges heat, in the supercooling portion, with the refrigerant liquefied in the liquid receiver after being condensed by the condensation portion, and then exchanges heat, in the condensation portion, with the refrigerant that is in an overheated state before being supplied to the liquid receiver.

[0003] The above-described plate-type heat exchanger has a boundary plate (partition plate) for separating the condensation portion from the supercooling portion. The flow path for the heated fluid, which is located closest to the supercooling portion side in the condensation portion, is provided adjacent to the flow path for the refrigerant, which is located closest to the condensation portion side in the supercooling portion, with the boundary plate being interposed therebetween.

CITATION LIST

PATENT LITERATURE

[0004] PTL 1: Japanese Patent Laying-Open No. 2005-106385

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0005] However, in the above-described plate-type heat exchanger, a comparatively large differential pressure is formed between the heated fluid in the condensation portion and the refrigerant in the supercooling portion. When the maximum pressure of the refrigerant is maintained to be comparatively high without fluctuations, the differential pressure is always applied to the boundary plate. As a result, the partition plate thus always fed with the differential pressure is deformed gradually to result in breakage, disadvantageously.

[0006] Moreover, the above-described differential pressure may be repeatedly fluctuated depending on an operating condition of the refrigeration cycle apparatus. This is due to the following reason: pressure of the refrigerant may be fluctuated depending on the operating condition, load, and the like, whereas pressure of the heated fluid is less fluctuated depending on the operating condition than the pressure of the refrigerant. The partition plate repeatedly fed with the fluctuated differential pressure is slightly deformed repeatedly to result in breakage due to fatigue, disadvantageously.

[0007] That is, in the above-described plate-type heat exchanger, a risk of the partition plate being damaged is high, and therefore the plate-type heat exchanger does not have sufficiently high reliability, disadvantageously.

[0008] A main object of the present invention is to provide a plate-type heat exchanger and a refrigeration cycle apparatus, in each of which a partition plate is suppressed from being broken and each of which has sufficiently high reliability.

SOLUTION TO PROBLEM

[0009] A plate-type heat exchanger according to the present invention includes: a first heat exchanging unit and a second heat exchanging unit each having a plurality of heat transfer plates stacked in a first direction; and a partition plate disposed between the first heat exchanging unit and the second heat exchanging unit in the first direction, the partition plate having a first side and a second side in the first direction, the first side facing the heat transfer plates of the first heat exchanging unit, the second side facing the heat transfer plates of the second heat exchanging unit. The first heat exchanging unit has: a first flow path in which a first fluid flows in a second direction crossing the first direction; and a second flow path in which a second fluid flows in a third direction crossing the first direction. In the first heat exchanging unit, the first flow path or the second flow path is provided between heat transfer plates adjacent in the first direction among the plurality of heat transfer plates. The first flow path and the second flow path are provided alternately in the first direction. The second heat exchanging unit has: a third flow path in which the first fluid flows in a fourth direction crossing the first direction; and a fourth flow path in which a third fluid flows in a fifth direction crossing the first direction. In the second heat exchanging unit, the third flow path or the fourth flow path is provided between heat transfer plates adjacent in the first direction among the plurality of heat transfer plates. The third flow path and the fourth flow path are provided alternately in the first direction. The partition plate is provided with a flow port via which the first fluid flows from the first flow path to the third flow path. A distance from at least a portion of the first flow path to the partition plate is shorter than a distance from the second flow path to the partition plate. A distance from at least a portion of the third flow path to the partition plate is shorter than a distance from the fourth flow path to the partition plate.

ADVANTAGEOUS EFFECTS OF INVENTION

[0010] According to the present invention, there can be provided a plate-type heat exchanger and a refrigeration cycle apparatus, in each of which a partition plate is suppressed from being broken and each of which has sufficiently high reliability.

BRIEF DESCRIPTION OF DRAWINGS

[0011]

Fig. 1 (a) is a perspective view showing a plate-type heat exchanger according to a first embodiment when viewed from the side of one entrance/exit plate, and Fig. 1 (b) is a perspective view showing the plate-type heat exchanger according to the first embodiment when viewed from the side of the other entrance/exit plate.
Fig. 2 shows an exemplary flow path for each fluid in the plate-type heat exchanger according to the first embodiment.
Fig. 3 is an exploded view showing an exemplary configuration of the plate-type heat exchanger according to the first embodiment.
Fig. 4 is a plan view showing an exemplary first heat transfer plate of the plate-type heat exchanger according to the first embodiment.
Fig. 5 is a side view of the first heat transfer plate shown in Fig. 4.
Fig. 6 is a plan view showing an exemplary partition plate of the plate-type heat exchanger according to the first embodiment.
Fig. 7 is a side view of the partition plate shown in Fig. 6.
Fig. 8 is a partial cross sectional view along a long side direction of the partition plate, and shows the exemplary partition plate of the plate-type heat exchanger according to the first embodiment as well as an exemplary heat transfer plate disposed close to the partition plate.
Fig. 9 is a plan view showing an exemplary first entrance/exit plate of the plate-type heat exchanger according to the first embodiment.
Fig. 10 is a side view of the first entrance/exit plate shown in Fig. 9.
Fig. 11 is a plan view showing an exemplary second entrance/exit plate of the plate-type heat exchanger according to the first embodiment.
Fig. 12 is a side view of the first entrance/exit plate shown in Fig. 11.
Fig. 13 is a schematic view showing an exemplary refrigeration cycle apparatus including the plate-type heat exchanger according to the first embodiment.
Fig. 14 is an exploded view showing an exemplary configuration of a plate-type heat exchanger according to a second embodiment.
Fig. 15 is a cross sectional view showing an exemplary second flow path formed close to a first entrance/exit plate of the plate-type heat exchanger according to the second embodiment.
Fig. 16 is a cross sectional view showing an exemplary fourth flow path formed close to a second entrance/exit plate of the plate-type heat exchanger according to the second embodiment.
Fig. 17 is a cross sectional view showing an exemplary partition plate of a plate-type heat exchanger according to a third embodiment.
Fig. 18 is a cross sectional view showing an exemplary heat transfer plate of the plate-type heat exchanger according to the third embodiment.
Fig. 19 is a cross sectional view showing an exemplary first entrance/exit plate of the plate-type heat exchanger according to the third embodiment.
Fig. 20 is a cross sectional view showing an exemplary second entrance/exit plate of the plate-type heat exchanger according to the third embodiment.
Fig. 21 is a cross sectional view showing another exemplary partition plate of the plate-type heat exchanger according to the third embodiment.
Fig. 22 is a cross sectional view showing another exemplary first entrance/exit plate of the plate-type heat exchanger according to the third embodiment.
Fig. 23 is a cross sectional view showing another exemplary second entrance/exit plate of the plate-type heat exchanger according to the third embodiment.

DESCRIPTION OF EMBODIMENTS

[0012] The following describes embodiments of the present invention with reference to figures. It should be noted that in the below-described figures, the same or corresponding portions in the figures are given the same reference characters and are not described repeatedly.

First Embodiment.

<Plate-Type Heat Exchanger>

[0013] As shown in Fig. 1 to Fig. 3, a plate-type heat exchanger 100 according to a first embodiment will be described. Plate-type heat exchanger 100 includes: a first heat exchanging unit 10 and a second heat exchanging unit 20 each having a plurality of heat transfer plates 1 stacked in a first direction; and a partition plate 2.

[0014] First heat exchanging unit 10 is provided to allow for heat exchange between a first fluid and a second fluid via heat transfer plates 1. Between heat transfer plates 1 adjacent in the first direction in first heat exchanging unit 10, a first flow path 5 and a second flow path 6 are provided alternately. In first flow path 5, the first fluid flows in a second direction crossing the first direction, and in second flow path 6, the second fluid flows in a third direction crossing the first direction. In first heat exchanging unit 10, first flow path 5 and second flow path 6 are disposed to be adjacent to each other with one heat transfer plate 1 being interposed therebetween. A plurality of first flow paths 5 and a plurality of second flow paths 6 may be provided. When the plurality of first flow paths 5 are provided, the first fluid flows through below-described passage holes 11, 13 of heat transfer plates 1, flows through a distribution path 61 extending along the first direction, and is distributed to respective first flow paths 5. Further, the flows of the first fluid distributed to respective first flow paths 5 pass through below-described passage holes 12, 15 of heat transfer plates 1, and enter a distribution path 62 extending along the first direction and are therefore merged. When the plurality of second flow paths 6 are provided, the second fluid flows through below-described passage holes 11, 13 of heat transfer plates 1, flows through a distribution path 63 extending along the first direction, and is distributed to respective second flow paths 6. Further, the flows of the second fluid distributed to respective second flow paths 6 pass through below-described passage holes 12, 15 of heat transfer plates 1, and enter a distribution path 64 extending along the first direction and are therefore merged.

[0015] Second heat exchanging unit 20 is provided to allow for heat exchange between the first fluid and a third fluid via heat transfer plates 1. Between heat transfer plates 1 adjacent in the first direction in second heat exchanging unit 20, a third flow path 7 and a fourth flow path 8 are provided alternately. In third path 7, the first fluid flows in a fourth direction crossing the first direction, and in fourth flow path 8, the third fluid flows in a fifth direction crossing the first direction. In second heat exchanging unit 20, third flow path 7 and fourth flow path 8 are disposed to be adjacent to each other with one heat transfer plate 1 being interposed therebetween. A plurality of third flow paths 7 and a plurality of fourth flow paths 8 may be provided. When the plurality of third flow paths 7 are provided, the first fluid flows through below-described passage holes 12, 15 of heat transfer plates 1, flows through a distribution path 65 extending along the first direction, and is distributed to respective third flow paths 7. Further, the flows of the first fluid distributed to respective second flow paths 7 pass through below-described passage holes 11, 13 of heat transfer plates 1, and enter a distribution path 66 extending along the first direction and are therefore merged. When the plurality of fourth flow paths 8 are provided, the third fluid flows through below-described passage holes 11, 12, 13, 15 of heat transfer plates 1, flows through a distribution path 67 extending along the first direction, and is distributed to respective fourth flow paths 8. Further, the flows of the third fluid distributed to respective fourth flow paths 8 pass through below-described passage holes 11, 13 of heat transfer plates 1, and enter a distribution path 68 extending along the first direction and are therefore merged.

[0016] Partition plate 2 is disposed between first heat exchanging unit 10 and second heat exchanging unit 20 in the first direction. Partition plate 2 has a first side (hereinafter, referred to as "front side") and a second side (hereinafter, referred to as "back side") in the first direction, the first side facing heat transfer plates 1 of first heat exchanging unit 10, the second side facing heat transfer plates 1 of second heat exchanging unit 20. Partition plate 2 is provided with a flow port 21 (see Fig. 3) via which the first fluid flows from first flow path 5 in first heat exchanging unit 10 to third flow path 7 in second heat exchanging unit 20.

[0017] First flow path 5 has a first portion 5A located close to partition plate 2 relative to second flow path 6. First flow path 5 has first portion 5A located close to partition plate 2 relative to a second portion 6A of second flow path 6 closest to partition plate 2. In other words, as shown in Fig. 3, first portion 5A of first flow path 5 closest to partition plate 2 is close to partition plate 2 relative to second portion 6A of second flow path 6 closest to partition plate 2.

[0018] Third flow path 7 has a third portion 7A located close to partition plate 2 relative to fourth flow path 8. Third flow path 7 has third portion 7A located close to partition plate 2 relative to a fourth portion 8A of fourth flow path 8 closest to partition plate 2. In other words, third portion 7A of third flow path 7 closest to partition plate 2 is close to partition plate 2 relative to fourth portion 8A of fourth flow path 8 closest to partition plate 2.

[0019] First portion 5A of first flow path 5 closest to partition plate 2 is connected to third portion 7A of third flow path 7 closest to partition plate 2, via flow port 21 of partition plate 2.

[0020] In this way, a differential pressure between the first fluid flowing in first flow path 5 and the first fluid flowing in third flow path 7 is applied to partition plate 2 that partitions between first heat exchanging unit 10 and second heat exchanging unit 20. The first fluid flowing in third flow path 7 is the first fluid having flowed in first flow path 5, having passed through flow port 21 of partition plate 2, and having reached third flow path 7. Therefore, the differential pressure between the first fluid flowing in first flow path 5 and the first fluid flowing in third flow path 7 is smaller than a differential pressure between the first fluid and the second fluid, a differential pressure between the first fluid and the third fluid, and a differential pressure between the second fluid and the third fluid. Accordingly, partition plate 2 is suppressed from being broken in plate-type heat exchanger 100 and plate-type heat exchanger 100 has sufficiently high reliability. It should be noted that the first direction is a direction along a horizontal direction, for example. Each of the second direction, the third direction, the fourth direction, and the fifth direction is a direction along a vertical direction, for example.

<Exemplary Configurations of Plates>

[0021] Next, the following describes an exemplary configuration of each plate of plate-type heat exchanger 100. As shown in Fig. 3, plate-type heat exchanger 100 includes the plurality of heat transfer plates 1, partition plate 2, a first entrance/exit plate 3, and a second entrance/exit plate 4. First entrance/exit plate 3 is disposed to sandwich first heat exchanging unit 10 between first entrance/exit plate 3 and partition plate 2 in the first direction. Second entrance/exit plate 4 is disposed to sandwich second heat exchanging unit 20 between second entrance/exit plate 4 and partition plate 2 in the first direction. The planar shape of each of heat transfer plates 1, partition plate 2, first entrance/exit plate 3, and second entrance/exit plate 4 is a substantially rectangular shape, for example.

[0022] As shown in Fig. 3 to Fig. 5, four passage holes 11, 12, 13, 15, in each of which one of the first to third fluids flows, are provided at an outer peripheral portion (four corners) of each heat transfer plate 1. Each of passage holes 11, 12, 13, 15 extends through heat transfer plate 1 in the thickness direction (the first direction). Passage hole 11 and passage hole 12 are provided to face each other with a space therebetween in the long side direction of heat transfer plate 1, and passage hole 13 and passage hole 15 are provided to face each other with a space therebetween in the long side direction of heat transfer plate 1. Further, passage hole 11 and passage hole 15 are provided to face each other with a space therebetween in the short side direction of heat transfer plate 1, and passage hole 12 and passage hole 13 are provided to face each other with a space therebetween in the short side direction of heat transfer plate 1. Passage holes 13, 15 are provided in top surfaces of protrusions 14, 16 protruding in the thickness direction relative to surfaces in which passage holes 11, 12 are provided, respectively. The top surfaces of protrusions 14, 16 in heat transfer plate 1 are in contact with the other heat transfer plate 1, partition plate 2, or first entrance/exit plate 3, each of which is adjacent thereto at the front side in the first direction.

[0023] As shown in Fig. 4, in heat transfer plate 1, a heat transfer surface 17 having a wavelike cross sectional shape is provided internal to passage holes 11, 12, 13, 15, for example. When heat transfer surface 17 is viewed in a plan view, top portions 18 and bottom portions 19 of the wavelike structure of heat transfer surface 17 form a herringbone pattern, for example.

[0024] As shown in Fig. 3, first heat exchanging unit 10 includes heat transfer plates 1a, 1b, 1c, 1d in the order from the one closest to partition plate 2. Second heat exchanging unit 20 includes heat transfer plates 1e, If, 1g, 1h in the order from the one closest to partition plate 2. Each of heat transfer plates 1a, 1b, 1c, 1d, 1e, If, 1g, 1h has the same configuration.

[0025] As shown in Fig. 3, in first heat exchanging unit 10, the plurality of heat transfer plates 1 are stacked with the plurality of heat transfer plates 1 being disposed alternately upside down, for example. For example, passage hole 11 of certain heat transfer plate 1c is provided to overlap, in the first direction, with each passage hole 13 of heat transfer plates 1b, 1d adjacent to this heat transfer plate 1c. For example, passage hole 12 of certain heat transfer plate 1c is provided to overlap, in the first direction, with each passage hole 15 of heat transfer plates 1b, 1d adjacent to this heat transfer plate 1c. Similarly, in second heat exchanging unit 20, the plurality of heat transfer plates 1 are stacked with the plurality of heat transfer plates 1 being disposed alternately upside down, for example. Passage hole 12 of heat transfer plate 1a is provided to overlap, in the first direction, passage hole 15 of heat transfer plate 1e and flow port 21 of partition plate 2.

[0026] As shown in Fig. 3, heat transfer plates 1a, 1b, 1c, 1d are provided such that first flow path 5 is represented by each of a portion between heat transfer plate 1a and heat transfer plate 1b and a portion between heat transfer plate 1c and heat transfer plate 1d and second flow path 6 is represented by a portion between heat transfer plate 1b and heat transfer plate 1c. Heat transfer plates 1e, 1f, 1g, 1h are provided such that third flow path 7 is represented by each of a portion between heat transfer plate 1e and heat transfer plate If and a portion between heat transfer plate 1g and heat transfer plate 1h and fourth flow path 8 is represented by each of a portion between heat transfer plate If and heat transfer plate 1g and a portion between heat transfer plate 1h and heat transfer plate 1i.

[0027] As shown in Fig. 3 and Fig. 6, one flow port 21 via which the first fluid flows is provided at the outer peripheral portion of partition plate 2. As shown in Fig. 3, Fig. 6, and Fig. 7, a portion of partition plate 2 overlapping with heat transfer surface 17 of heat transfer plate 1 adjacent thereto in the first direction is provided as a flat portion 24. Flow port 21 is provided to overlap with each passage hole 12 of heat transfer plates 1a, 1e adjacent to partition plate 2. First flow path 5 of first heat exchanging unit 10 is connected to third flow path 7 of second heat exchanging unit 20 via flow port 21.

[0028] In partition plate 2, flow port 21 is provided in the top surface of a protrusion 22 protruding in the thickness direction (the first direction) thereof relative to flat portion 24. In partition plate 2, as with protrusion 22, a protrusion 23 protruding in the above-described thickness direction is provided at a side of the outer peripheral portion opposite to protrusion 22 in the above-described long side direction. Protrusion 23 is disposed at the upper side relative to protrusion 22. The top surface of protrusion 22 is in contact with a portion of heat transfer plate 1a adjacent thereto at the front side in the first direction, the portion of heat transfer plate 1a being provided with passage hole 12. The top surface of protrusion 23 is in contact with a portion of heat transfer plate 1a adjacent thereto at the front side in the first direction, the portion of heat transfer plate 1a being provided with passage hole 11.

[0029] As shown in Fig. 8, partition plate 2 is fixed to heat transfer plate 1a and heat transfer plate 1e. Bottom portion 19 of heat transfer plate 1a is fixed, for example, brazed to a surface of flat portion 24 of partition plate 2 at the front side. Top portion 18 of heat transfer plate 1e is fixed, for example, brazed to a surface of flat portion 24 of partition plate 2 at the back side. A space provided between top portion 18 of heat transfer plate 1a and flat portion 24 of partition plate 2 is closed and does not constitute first flow path 5 and second flow path 6. A space provided between bottom portion 19 of heat transfer plate 1e and flat portion 24 of partition plate 2 is closed and does not constitute third flow path 7 and fourth flow path 8.

[0030] As shown in Fig. 3 and Fig. 8, in first heat exchanging unit 10, the flow path provided closest to partition plate 2 is provided between heat transfer plate 1a facing partition plate 2 and heat transfer plate 1b adjacent to heat transfer plate 1a in the first direction. A portion between heat transfer plate 1a and heat transfer plate 1b is provided to serve as first portion 5A located closest to partition plate 2 in first flow path 5. A portion between heat transfer plate 1b and heat transfer plate 1c is provided to serve as second portion 6A located closest to partition plate 2 in second flow path 6.

[0031] As shown in Fig. 3 and Fig. 8, the flow path provided closest to partition plate 2 in second heat exchanging unit 20 is provided between heat transfer plate 1e facing partition plate 2 and heat transfer plate If adjacent to heat transfer plate 1e in the first direction. A portion between heat transfer plate 1e and heat transfer plate If is provided to serve as third portion 7A located closest to partition plate 2 in third flow path 7. A portion between heat transfer plate If and heat transfer plate 1g is provided to serve as fourth portion 8A located closest to partition plate 2 in fourth flow path 8.

[0032] As shown in Fig. 3 and Fig. 9, a first flow inlet 31, a second flow inlet 32, and a second flow outlet 33, via each of which the first fluid or the second fluid flows, are provided in the outer peripheral portion of first entrance/exit plate 3. Each of first flow inlet 31, second flow inlet 32, and second flow outlet 33 extends through first entrance/exit plate 3 in the thickness direction (the first direction). First flow inlet 31 and second flow outlet 33 are provided to face each other with a space interposed therebetween in the short side direction of heat transfer plate 1. Further, second flow inlet 32 and second flow outlet 33 are provided to face each other with a space interposed therebetween in the long side direction of heat transfer plate 1. First flow inlet 31 and second flow outlet 33 are preferably disposed at the upper side relative to second flow inlet 32. First flow inlet 31 is preferably provided at the upper side relative to flow port 21 of partition plate 2. As shown in Fig. 9 and Fig. 10, when viewed in a side view, the outer peripheral portion provided with first flow inlet 31, second flow inlet 32, and second flow outlet 33 and the central portion located internal to first flow inlet 31, second flow inlet 32, and second flow outlet 33 are provided to be flat in first entrance/exit plate 3. As shown in Fig. 9 and Fig. 10, a portion of first entrance/exit plate 3 overlapping with heat transfer surface 17 of heat transfer plate 1 adjacent thereto in the first direction is provided as a flat portion 34.

[0033] As shown in Fig. 3 and Fig. 11, a first flow outlet 41, a third flow inlet 42, and a third flow outlet 43, via each of which the first fluid or the third fluid flows, are provided in the outer peripheral portion of second entrance/exit plate 4. Each of first flow outlet 41, third flow inlet 42, and third flow outlet 43 extends through second entrance/exit plate 4 in the thickness direction (the first direction). First flow outlet 41 and third flow outlet 43 are provided to face each other with a space interposed therebetween in the short side direction of heat transfer plate 1. Further, third flow inlet 42 and third flow outlet 43 are provided to face each other with a space interposed therebetween in the long side direction of heat transfer plate 1. First flow outlet 41 and third flow outlet 43 are preferably disposed at the upper side relative to third flow inlet 42. First flow outlet 41 is preferably provided at the upper side relative to flow port 21 of partition plate 2. As shown in Fig. 11 and Fig. 12, when viewed in a side view, the outer peripheral portion provided with first flow outlet 41, third flow inlet 42, and third flow outlet 43 and the central portion located internal to first flow outlet 41, third flow inlet 42, and third flow outlet 43 are provided to be flat in second entrance/exit plate 4. As shown in Fig. 11 and Fig. 12, a portion of second entrance/exit plate 4 overlapping with heat transfer surface 17 of heat transfer plate 1 adjacent thereto in the first direction is provided as a flat portion 44.

[0034] In plate-type heat exchanger 100 described above, first entrance/exit plate 3 is preferably provided with: first flow inlet 31 via which the first fluid flows into first flow path 5; second flow inlet 32 via which the second fluid flows into second flow path 6; and second flow outlet 33 via which the second fluid flows out of second flow path 6. Second flow inlet 32 is preferably provided at the lower side relative to second flow outlet 33. In other words, in plate-type heat exchanger 100, the second direction is preferably a direction from the upper side toward the lower side, whereas the third direction is preferably a direction from the lower side toward the upper side.

[0035] In plate-type heat exchanger 100, the first fluid flowing in first flow path 5 exchanges heat with the second fluid flowing in second flow path 6 and is accordingly condensed (details will be described later). On this occasion, the first fluid having sufficiently exchanged heat with the second fluid has a higher density than that of the first fluid not having sufficiently exchanged heat with the second fluid yet. Hence, if the first fluid flows from the lower side to the upper side in first flow path 5, a flow (downward flow) of the first fluid having sufficiently exchanged heat with the second fluid is generated against this flow of the first fluid in first flow path 5. As a result, the flow of the first fluid in first flow path 5 is hindered by the downward flow, with the result that heat exchanging efficiency of the plate-type heat exchanger is decreased.

[0036] To address this, according to plate-type heat exchanger 100 described above, the first fluid is condensed when flowing from the upper side to the lower side in first flow path 5, whereby the flow of the first fluid in first flow path 5 is not hindered by the downward flow. As a result, the heat exchanging efficiency of plate-type heat exchanger 100 is suppressed from being decreased.

[0037] In plate-type heat exchanger 100 described above, second entrance/exit plate 4 is provided with: first flow outlet 41 via which the first fluid flows out of third flow path 7; third flow inlet 42 via which the third fluid flows into fourth flow path 8; and third flow outlet 43 via which the third fluid flows out of fourth flow path 8. Third flow inlet 42 is preferably provided at the lower side relative to third flow outlet 43. In other words, in plate-type heat exchanger 100, the fifth direction is preferably a direction from the lower side toward the upper side.

[0038] In plate-type heat exchanger 100, the third fluid flowing into each fourth flow path 8 is in a gas-liquid two-phase state (details will be described below). If the third fluid flows from the upper side to the lower side in fourth flow path 8, the third fluid is distributed, at the upper side relative to heat transfer surfaces 17 of heat transfer plates 1, to the portions located between the plurality of heat transfer surfaces 17 and constituting fourth flow paths 8. However, the refrigerant in the liquid phase in the third fluid has a density higher than that of the refrigerant in the gas phase and therefore is likely to flow to the lower side, with the result that the third fluid is unlikely to be equally distributed to the portions located between the plurality of heat transfer surfaces 17 and constituting fourth flow paths 8. In this case, in order to compensate heat transfer performance decreased because the third fluid is unlikely to be equally distributed to the portions located between the plurality of heat transfer surfaces 17, it may be considered to increase the number of heat transfer plates 1 so as to increase a heat transfer area.

[0039] To address this, according to plate-type heat exchanger 100, the third fluid having flowed into each fourth flow path 8 in the gas-liquid two-phase state flows from the lower side to the upper side in fourth flow path 8, whereby the third fluid can be equally distributed to the portions located between the plurality of heat transfer surfaces 17. Hence, according to plate-type heat exchanger 100, high heat transfer performance can be realized without increasing the number of heat transfer plates 1.

<Exemplary Configuration of Refrigeration Cycle Apparatus>

[0040] Plate-type heat exchanger 100 may be applied to a refrigeration cycle apparatus 200 shown in Fig. 13. Refrigeration cycle apparatus 200 includes: plate-type heat exchanger 100 configured as a condenser; a compressor 51; an expansion valve 52; an evaporator 53; an injection expansion valve 54; a pump 55; and a fan 56. Refrigeration cycle apparatus 200 includes a refrigerant circuit in which compressor 51, first flow path 5, third flow path 7, and fourth flow path 8 of plate-type heat exchanger 100, expansion valve 52, and evaporator 53 are connected in this order. Further, refrigeration cycle apparatus 200 includes an injection circuit, which is branched from the refrigerant circuit at a downstream relative to third flow path 7 and in which injection expansion valve 54, fourth flow path 8, and an intermediate pressure portion of compressor 51 are connected in this order. Further, refrigeration cycle apparatus 200 includes a heat medium circuit in which pump 55 and second flow path 6 are connected in this order. That is, in refrigeration cycle apparatus 200, each of the first fluid and the third fluid is refrigerant whereas the second fluid is a heat medium such as water or brine. The first fluid is a high-pressure gas refrigerant, and the third fluid is a low-pressure gas-liquid two-phase refrigerant.

[0041] As shown in Fig. 3, first flow inlet 31 of first entrance/exit plate 3 is provided as a flow inlet for the first fluid. Second flow inlet 32 of first entrance/exit plate 3 is provided as a flow inlet for the second fluid. Second flow outlet 33 of first entrance/exit plate 3 is provided as a flow outlet for the second fluid. First flow outlet 41 of second entrance/exit plate 4 is provided as a flow outlet for the first fluid. Third flow inlet 42 of second entrance/exit plate 4 is provided as a flow inlet for the third fluid. Third flow outlet 43 of second entrance/exit plate 4 is provided as a flow outlet for the third fluid.

[0042] The first fluid flows from first flow inlet 31 of first entrance/exit plate 3 into first heat exchanging unit 10, and flows from the upper side to the lower side between heat transfer plates 1a, 1b and between heat transfer plates 1c, 1d. The second fluid flows from second flow inlet 32 of first entrance/exit plate 3 into first heat exchanging unit 10, and flows from the lower side to the upper side between heat transfer plates 1b, 1c. Accordingly, in first heat exchanging unit 10, heat is exchanged between the first fluid and the second fluid via heat transfer plates 1b, 1c. The second fluid thus having exchanged heat with the first fluid flows out of first heat exchanging unit 10 via second flow outlet 33 of first entrance/exit plate 3. The first fluid having exchanged heat with the second fluid flows into second heat exchanging unit 20 via flow port 21 of partition plate 2.

[0043] The first fluid having flowed into second heat exchanging unit 20 flows from the lower side to the upper side between heat transfer plates 1e, If and between heat transfer plates 1g, 1h. The third fluid flows from third flow inlet 42 of second entrance/exit plate 4 into second heat exchanging unit 20 and flows from the lower side to the upper side between heat transfer plates 1f, 1g and between heat transfer plates 1h, 1i. Accordingly, in second heat exchanging unit 20, heat is exchanged between the first fluid and the third fluid via heat transfer plates 1f, 1g, 1g, 1i.

[0044] In such a refrigeration cycle apparatus 200, the refrigerant serving as the first fluid discharged from compressor 51 flows in first flow path 5 in first heat exchanging unit 10 of plate-type heat exchanger 100, whereby the refrigerant exchanges heat with the heat medium serving as the second fluid flowing in second flow path 6 and is accordingly condensed. The condensed refrigerant flows in third flow path 7 in second heat exchanging unit 20, whereby the refrigerant exchanges heat with the refrigerant serving as the third fluid flowing in fourth flow path 8 and is accordingly supercooled. Part of the supercooled refrigerant is decompressed by expansion valve 52. The decompressed refrigerant exchanges heat with gas supplied by fan 56 in evaporator 53 and is accordingly evaporated. The evaporated refrigerant is suctioned by compressor 51.

[0045] Moreover, in refrigeration cycle apparatus 200, the remainder of the refrigerant supercooled by flowing in third flow path 7, i.e., the other part of the refrigerant than the foregoing part flows into the above-described injection circuit. The refrigerant having flowed into the injection circuit is decompressed by injection expansion valve 54. The decompressed refrigerant flows in fourth flow path 8 in second heat exchanging unit 20 and is heated due to heat exchange with the refrigerant flowing in third flow path 7.

[0046] Since such a refrigeration cycle apparatus 200 includes the injection circuit, the temperature of the refrigerant discharged from compressor 51 can be suppressed from being increased. Moreover, refrigeration cycle apparatus 200 includes the refrigerant circuit for the heat exchange between the first fluid and the second fluid and the heat exchange between the first fluid and the third fluid; however, since the refrigerant circuit is constructed using plate-type heat exchanger 100, refrigeration cycle apparatus 200 can be downsized as compared with a conventional refrigeration cycle apparatus in which the refrigerant circuit is constituted of two heat exchangers. As a result, refrigeration cycle apparatus 200 can be manufactured readily with a reduced cost as compared with the conventional refrigeration cycle apparatus.

[0047] It should be noted that in plate-type heat exchanger 100 according to the first embodiment, the thickness of partition plate 2 in the first direction may be thinner than the thickness of heat transfer plate 1 in the first direction. Heat transfer plate 1 is fed with a differential pressure between the first fluid flowing in first flow path 5 and the second fluid flowing in second flow path 6. On the other hand, partition plate 2 is fed with a differential pressure between the first fluid flowing in first flow path 5 and the first fluid flowing in third flow path 7. Accordingly, the differential pressure applied to partition plate 2 is smaller than the differential pressure applied to heat transfer plate 1. As a result, even when the thickness of partition plate 2 in the first direction is thinner than the thickness of heat transfer plate 1 in the first direction, partition plate 2 can be suppressed from being broken, whereby plate-type heat exchanger 100 can have high reliability.

[0048] Moreover, in plate-type heat exchanger 100, when first heat exchanging unit 10 has only heat transfer plates 1a, 1b, 1c, first flow path 5 is formed only between heat transfer plates 1a, 1b. In this case, the whole of first flow path 5 is located at a location close to partition plate 2 relative to second flow path 6 formed between heat transfer plates 1b, 1c.

Second Embodiment.

[0049] Next, with reference to Fig. 14 to Fig. 16, a plate-type heat exchanger 101 according to a second embodiment will be described. Although plate-type heat exchanger 101 according to the second embodiment basically includes the same configuration as that of plate-type heat exchanger 100 according to the first embodiment, at least a portion of second flow path 6 is located at a location close to first entrance/exit plate 3 relative to first flow path 5 and at least a portion of fourth flow path 8 is located at a location close to second entrance/exit plate 4 relative to third flow path 7. In other words, second flow path 6 has a sixth portion 6B located close to first entrance/exit plate 3 relative to a fifth portion 5B of first flow path 5 located closest to first entrance/exit plate 3. Fourth flow path 8 has an eighth portion 8B located close to second entrance/exit plate 4 relative to a seventh portion 7B of third flow path 7 located closest to second entrance/exit plate 4.

[0050] As shown in Fig. 14 and Fig. 15, first entrance/exit plate 3 is fixed to a heat transfer plate 1j. Top portion 18 of heat transfer plate 1j is fixed, for example, brazed to a surface of flat portion 34 of first entrance/exit plate 3 at the back side. A space provided between flat portion 34 of first entrance/exit plate 3 and bottom portion 19 of heat transfer plate 1j is closed and does not constitute first flow path 5 and second flow path 6.

[0051] As shown in Fig. 14 and Fig. 16, second entrance/exit plate 4 is fixed to a heat transfer plate 1i. Bottom portion 19 of heat transfer plate 1i is fixed, for example, brazed to a surface of flat portion 44 of second entrance/exit plate 4 at the front side. A space provided between flat portion 44 of second entrance/exit plate 4 and top portion 18 of heat transfer plate 1i is closed and does not constitute third flow path 7 and fourth flow path 8.

[0052] As shown in Fig. 14 and Fig. 15, in first heat exchanging unit 10, the flow path provided closest to first entrance/exit plate 3 is provided between heat transfer plate 1j and heat transfer plate 1d. A portion between heat transfer plate 1j and heat transfer plate 1d is provided to serve as sixth portion 6B of second flow path 6 located closest to first entrance/exit plate 3. A portion between heat transfer plate 1d and heat transfer plate 1c is provided to serve as fifth portion 5B of first flow path 5 located closest to first entrance/exit plate 3.

[0053] As shown in Fig. 14 and Fig. 15, in second heat exchanging unit 20, the flow path provided closest to second entrance/exit plate 4 is provided between heat transfer plate 1h and heat transfer plate 1i. A portion between heat transfer plate 1h and heat transfer plate 1i is provided to serve as eighth portion 8B of fourth flow path 8 located closest to second entrance/exit plate 4. A portion between heat transfer plate 1g and heat transfer plate 1h is provided to serve as seventh portion 7B of third flow path 7 located closest to second entrance/exit plate 4.

[0054] Since plate-type heat exchanger 101 thus configured according to the second embodiment includes basically the same configuration as that of plate-type heat exchanger 100 according to the first embodiment, plate-type heat exchanger 101 can exhibit the same effect as that of plate-type heat exchanger 100.

[0055] Further, plate-type heat exchanger 101 further includes: first entrance/exit plate 3 disposed to sandwich first heat exchanging unit 10 between first entrance/exit plate 3 and partition plate 2 in the first direction; and second entrance/exit plate 4 disposed to sandwich second heat exchanging unit 20 between second entrance/exit plate 4 and partition plate 2 in the first direction. Second flow path 6 has a sixth portion 6B located close to first entrance/exit plate 3 relative to a fifth portion 5B of first flow path 5 located closest to first entrance/exit plate 3. Fourth flow path 8 has an eighth portion 8B located close to second entrance/exit plate 4 relative to a seventh portion 7B of third flow path 7 located closest to second entrance/exit plate 4.

[0056] Therefore, first entrance/exit plate 3 of plate-type heat exchanger 101 is fed with a differential pressure between the pressure of the second fluid flowing in second flow path 6 and the pressure (for example, atmospheric pressure) of surrounding gas outside plate-type heat exchanger 101. When plate-type heat exchanger 101 is included in refrigeration cycle apparatus 200 shown in Fig. 13, the pressure of the second fluid flowing in second flow path 6 is lower than the pressure of the first fluid flowing in first flow path 5. Hence, according to plate-type heat exchanger 101, the differential pressure applied to first entrance/exit plate 3 can be reduced as compared with a case where first entrance/exit plate 3 is fed with the differential pressure between the pressure of the first fluid flowing in first flow path 5 and the pressure (for example, atmospheric pressure) of the surrounding gas outside plate-type heat exchanger 101. As a result, since a risk of first entrance/exit plate 3 being damaged is reduced in plate-type heat exchanger 101, plate-type heat exchanger 101 has high reliability.

[0057] Moreover, second entrance/exit plate 4 of plate-type heat exchanger 101 is fed with a differential pressure between the pressure of the third fluid flowing in fourth flow path 8 and the pressure (for example, atmospheric pressure) of the surrounding gas outside plate-type heat exchanger 101. When plate-type heat exchanger 101 is included in refrigeration cycle apparatus 200 shown in Fig. 13, the pressure of the third fluid flowing in fourth flow path 8 is lower than the pressure of the first fluid flowing in third flow path 7. Hence, according to plate-type heat exchanger 101, the differential pressure applied to second entrance/exit plate 4 can be reduced as compared with a case where second entrance/exit plate 4 is fed with the differential pressure between the pressure of the first fluid flowing in third flow path 7 and the pressure (for example, atmospheric pressure) of the surrounding gas outside plate-type heat exchanger 101. As a result, since a risk of second entrance/exit plate 4 being damaged is reduced in plate-type heat exchanger 101, plate-type heat exchanger 101 has high reliability.

[0058] From a different viewpoint, it can be said that plate-type heat exchanger 101 is provided to minimize a total of the differential pressure applied to partition plate 2, the differential pressure applied to first entrance/exit plate 3, and the differential pressure applied to second entrance/exit plate 4. As described above, in plate-type heat exchanger 101, the differential pressure applied to partition plate 2 is a differential pressure between the first fluid and the first fluid, which is smaller than the differential pressure between the first fluid and the second fluid, the differential pressure between the first fluid and the third fluid, and the differential pressure between the second fluid and the third fluid. Moreover, in plate-type heat exchanger 101, the differential pressure applied to first entrance/exit plate 3 is a differential pressure between the second fluid and the surrounding gas outside plate-type heat exchanger 101, which is smaller than the differential pressure between the first fluid and the surrounding gas outside plate-type heat exchanger 101. Moreover, in plate-type heat exchanger 101, the differential pressure applied to second entrance/exit plate 4 is a differential pressure between the third fluid and the surrounding gas outside plate-type heat exchanger 101, which is smaller than the differential pressure between the first fluid and the surrounding gas outside plate-type heat exchanger 101. Hence, according to plate-type heat exchanger 101, since partition plate 2, first entrance/exit plate 3, and second entrance/exit plate 4 are suppressed from being broken as described above, plate-type heat exchanger 101 has sufficiently high reliability.

Third Embodiment.

[0059] Next, with reference to Fig. 17 to Fig. 20, a plate-type heat exchanger according to a third embodiment will be described. The plate-type heat exchanger according to the third embodiment includes basically the same configuration as that of plate-type heat exchanger 100 according to the first embodiment, but is specified to be different therefrom in that the thickness of at least one of partition plate 2, first entrance/exit plate 3, and second entrance/exit plate 4 is thicker than that of heat transfer plate 1 in the first direction. For example, the thickness of each of partition plate 2, first entrance/exit plate 3, and second entrance/exit plate 4 is thicker than that of heat transfer plate 1 in the first direction.

[0060] Here, it is assumed that the thickness of heat transfer plate 1 represents a thickness T1 (see Fig. 18) of heat transfer surface 17 of heat transfer plate 1. It should be noted that heat transfer plate 1 is formed by, for example, performing press-forming to a plate-like member and the thickness of heat transfer surface 17 is equal to the thickness of each of protrusions 14, 16. Similarly, it is assumed that the thickness of partition plate 2 represents a thickness T2 (see Fig. 17) of flat portion 24 of partition plate 2. It should be noted that partition plate 2 is formed by, for example, performing press-forming to a plate-like member and the thickness of flat portion 24 is equal to the thickness of each of protrusions 22, 23. It is assumed that the thickness of first entrance/exit plate 3 represents a thickness T3 (see Fig. 19) of flat portion 34 of first entrance/exit plate 3. It is assumed that the thickness of second entrance/exit plate 4 represents a thickness T4 (see Fig. 20) of flat portion 44 of second entrance/exit plate 4. It should be noted that each of first entrance/exit plate 3 and second entrance/exit plate 4 is formed by, for example, performing press-forming to a plate-like member. Thickness T1 of heat transfer plate 1 is provided so as not to hinder the heat exchange between the first fluid and the second fluid and so as to endure the differential pressure between the first fluid and the second fluid.

[0061] As shown in Fig. 17 and Fig. 18, thickness T2 of partition plate 2 in the first direction is thicker than thickness T1 of heat transfer plate 1 in the first direction. In this way, partition plate 2 has a sufficiently high strength for the differential pressure, which may be applied to partition plate 2, between the pressure of the first fluid flowing in first flow path 5 and the pressure of the first fluid flowing in third flow path 7. Hence, since partition plate 2 is suppressed from being broken in the plate-type heat exchanger according to the third embodiment, the plate-type heat exchanger has high reliability.

[0062] As shown in Fig. 19 to Fig. 21, thickness T3 of first entrance/exit plate 3 in the first direction and thickness T4 of second entrance/exit plate 4 in the first direction are thicker than thickness T1 of heat transfer plate 1 in the first direction. In this way, first entrance/exit plate 3 has a sufficiently high strength for the differential pressure that may be applied to first entrance/exit plate 3, i.e., the differential pressure between the first fluid flowing in first flow path 5 and the surrounding gas outside the plate-type heat exchanger or the differential pressure between the second fluid flowing in second flow path 6 and the surrounding gas outside the plate-type heat exchanger. Second entrance/exit plate 4 has a sufficiently high strength for the differential pressure that may be applied to second entrance/exit plate 4, i.e., the differential pressure between the first fluid flowing in third flow path 7 and the surrounding gas outside the plate-type heat exchanger or the differential pressure between the third fluid flowing in fourth flow path 8 and the surrounding gas outside the plate-type heat exchanger. Hence, since first entrance/exit plate 3 and second entrance/exit plate 4 are suppressed from being broken in the plate-type heat exchanger according to the third embodiment, the plate-type heat exchanger has high reliability.

[0063] As shown in Fig. 17, partition plate 2 may be constituted of one member. Alternatively, as shown in Fig. 21, partition plate 2 may be constituted of a plurality of members. Partition plate 2 may be formed by adhering a first member 25 to a second member 26. A material of second member 26 has a higher strength than a material of heat transfer plate 1, for example. For example, the material of heat transfer plate 1 is stainless steel, copper (Cu), aluminum (Al) or the like, whereas the material of second member 26 is titanium (Ti) or an alloy such as stainless steel or duralumin, for example. Thickness T2 of partition plate 2 in the first direction corresponds to a total of thickness T5 of first member 25 in the first direction and thickness T6 of second member 26 in the first direction. Thickness T6 of second member 26 in the first direction may be thinner than thickness T1 of heat transfer plate 1.

[0064] Also in this way, partition plate 2 has a sufficiently high strength for the differential pressure, which may be applied to partition plate 2, between the pressure of the first fluid flowing in first flow path 5 and the pressure of the first fluid flowing in third flow path 7.

[0065] As shown in Fig. 19 and Fig. 20, each of first entrance/exit plate 3 and second entrance/exit plate 4 may be constituted of one member. Alternatively, as shown in Fig. 22 and Fig. 23, each of first entrance/exit plate 3 and second entrance/exit plate 4 may be constituted of a plurality of members. First entrance/exit plate 3 may be formed by adhering a third member 35 to a fourth member 36. Second entrance/exit plate 4 may be formed by adhering a fifth member 45 to a sixth member 46. The material of each of fourth member 36 and sixth member 46 has a higher strength than the material of heat transfer plate 1, for example. The material of heat transfer plate 1 may be any material having high thermal conductivity, such as stainless steel, copper (Cu), or aluminum (Al). On the other hand, the material of each of fourth member 36 and sixth member 46 is, for example, titanium (Ti) or an alloy such as stainless steel or duralumin. Thickness T3 of first entrance/exit plate 3 in the first direction corresponds to a total of thickness T7 of third member 35 in the first direction and thickness T8 of fourth member 36 in the first direction. Thickness T4 of second entrance/exit plate 4 in the first direction corresponds to a total of thickness T9 of fifth member 45 in the first direction and thickness T10 of sixth member 46 in the first direction. Respective thicknesses T8, T10 of fourth member 36 and sixth member 46 in the first direction may be thinner than thickness T1 of heat transfer plate 1.

[0066] Also in this way, first entrance/exit plate 3 has a sufficient high strength for the differential pressure that may be applied to first entrance/exit plate 3. Second entrance/exit plate 4 has a sufficiently high strength for the differential pressure that may be applied to second entrance/exit plate 4.

[0067] It should be noted that in the plate-type heat exchanger according to the third embodiment, the thickness of one of partition plate 2, first entrance/exit plate 3 and second entrance/exit plate 4 may be thicker than that of heat transfer plate 1 in the first direction. In the plate-type heat exchanger thus configured, since the plate having a thicker thickness than that of heat transfer plate 1 in the first direction is suppressed from being broken, the plate-type heat exchanger has high reliability.

Fourth Embodiment.

[0068] Next, a plate-type heat exchanger according to a fourth embodiment will be described. The plate-type heat exchanger according to the fourth embodiment includes basically the same configuration as that of plate-type heat exchanger 100 according to the first embodiment, but is specified to be different therefrom in that at least one of partition plate 2, first entrance/exit plate 3, and second entrance/exit plate 4 contains a material having a higher strength than that of the material of heat transfer plate 1. For example, each of partition plate 2, first entrance/exit plate 3, and second entrance/exit plate 4 contains a material having a higher strength than that of the material of heat transfer plate 1.

[0069] The material of heat transfer plate 1 may be any material having high thermal conductivity, such as stainless steel, copper (Cu), or aluminum (Al). The material of partition plate 2 may be any material having a higher strength than that of the material of heat transfer plate 1, such as titanium (Ti) or an alloy such as stainless steel or duralumin, for example. The material of each of first entrance/exit plate 3 and second entrance/exit plate 4 may be any material having a higher strength than that of the material of heat transfer plate 1, such as titanium (Ti) or an alloy such as stainless steel or duralumin, for example.

[0070] In this way, partition plate 2 has a sufficiently high strength for the differential pressure, which may be applied to partition plate 2, between the pressure of the first fluid flowing in first flow path 5 and the pressure of the first fluid flowing in third flow path 7. First entrance/exit plate 3 has a sufficiently high strength for the differential pressure that may be applied to first entrance/exit plate 3. Second entrance/exit plate 4 has a sufficiently high strength for the differential pressure that may be applied to second entrance/exit plate 4. Accordingly, in the plate-type heat exchanger according to the fourth embodiment, since partition plate 2, first entrance/exit plate 3, and second entrance/exit plate 4 are suppressed from being broken, the plate-type heat exchanger has high reliability.

[0071] It should be noted that in the above-described embodiment, heat transfer plate 1a and heat transfer plate 1e are fixed to partition plate 2; however, the configuration is not limited to this. Partition plate 2 may be provided such that partition plate 2 and heat transfer plate 1 adjacent thereto in the first direction form the flow path for the first fluid. From a different viewpoint, it can be said that the partition plate according to the present embodiment may be configured as a complex body in which a plate having a configuration similar to that of the heat transfer plate and a flat plate are joined.

[0072] The embodiments disclosed herein are illustrative and non-restrictive in any respect. The scope of the present invention is defined by the terms of the claims, rather than the embodiments described above, and is intended to include any modifications within the scope and meaning equivalent to the terms of the claims.

INDUSTRIAL APPLICABILITY

[0073] The present invention is applied particularly advantageously to a plate-type heat exchanger in which heat exchange can be performed among three fluids.

REFERENCE SIGNS LIST

[0074] 1, 1a, 1b, 1c, 1d, 1e, If, 1g, 1h, 1i, 1j: heat transfer plate; 2: partition plate; 3: first entrance/exit plate; 4: second entrance/exit plate; 5: first flow path; 6: second flow path; 7: third flow path; 8: fourth flow path; 10: first heat exchanging unit; 17: heat transfer surface; 18: top portion; 19: bottom portion; 20: second heat exchanging unit; 21: flow port; 24, 34, 44: flat portion; 25: first member; 26: second member; 31: first flow inlet; 32: second flow inlet; 33: second flow outlet; 35: third member; 36: fourth member; 41: first flow outlet; 42: third flow inlet; 43: third flow outlet; 45: fifth member; 46: sixth member; 51: compressor; 52: expansion valve; 53: evaporator; 54: injection expansion valve; 55: pump; 56: fan; 100, 101: plate-type heat exchanger; 200: refrigeration cycle apparatus.

Claims

1. A plate-type heat exchanger comprising:

a first heat exchanging unit and a second heat exchanging unit each having a plurality of heat transfer plates stacked in a first direction; and
a partition plate disposed between the first heat exchanging unit and the second heat exchanging unit in the first direction, the partition plate having a first side and a second side in the first direction, the first side facing the heat transfer plates of the first heat exchanging unit, the second side facing the heat transfer plates of the second heat exchanging unit,
the first heat exchanging unit having

a first flow path in which a first fluid flows in a second direction crossing the first direction, and
a second flow path in which a second fluid flows in a third direction crossing the first direction, the first flow path or the second flow path being provided between heat transfer plates adjacent in the first direction among the plurality of heat transfer plates,

the first flow path and the second flow path being provided alternately in the first direction,

the second heat exchanging unit having

a third flow path in which the first fluid flows in a fourth direction crossing the first direction, and
a fourth flow path in which a third fluid flows in a fifth direction crossing the first direction, the third flow path or the fourth flow path being provided between heat transfer plates adjacent in the first direction among the plurality of heat transfer plates, the third flow path and the fourth flow path being provided alternately in the first direction,

the partition plate being provided with a flow port via which the first fluid flows from the first flow path to the third flow path,
a distance from at least a portion of the first flow path to the partition plate being shorter than a distance from the second flow path to the partition plate,
a distance from at least a portion of the third flow path to the partition plate being shorter than a distance from the fourth flow path to the partition plate.

2. The plate-type heat exchanger according to claim 1, further comprising:

a first entrance/exit plate disposed to sandwich the first heat exchanging unit between the first entrance/exit plate and the partition plate in the first direction; and
a second entrance/exit plate disposed to sandwich the second heat exchanging unit between the second entrance/exit plate and the partition plate in the first direction, wherein
a distance from at least a portion of the second flow path to the first entrance/exit plate is shorter than a distance from the first flow path to the first entrance/exit plate, and
a distance from at least a portion of the fourth flow path to the second entrance/exit plate is shorter than a distance from the third flow path to the second entrance/exit plate.

3. The plate-type heat exchanger according to claim 2, wherein a thickness of at least one of the partition plate, the first entrance/exit plate, and the second entrance/exit plate is thicker than a thickness of the heat transfer plate in the first direction.

4. The plate-type heat exchanger according to claim 2 or claim 3, wherein at least one of the partition plate, the first entrance/exit plate, and the second entrance/exit plate contains a material having a higher strength than a strength of a material of the heat transfer plate.

5. The plate-type heat exchanger according to any one of claim 1 to claim 4, wherein
the second direction is a direction from an upper side toward a lower side in a gravity direction, and
the third direction is a direction from the lower side toward the upper side in the gravity direction.

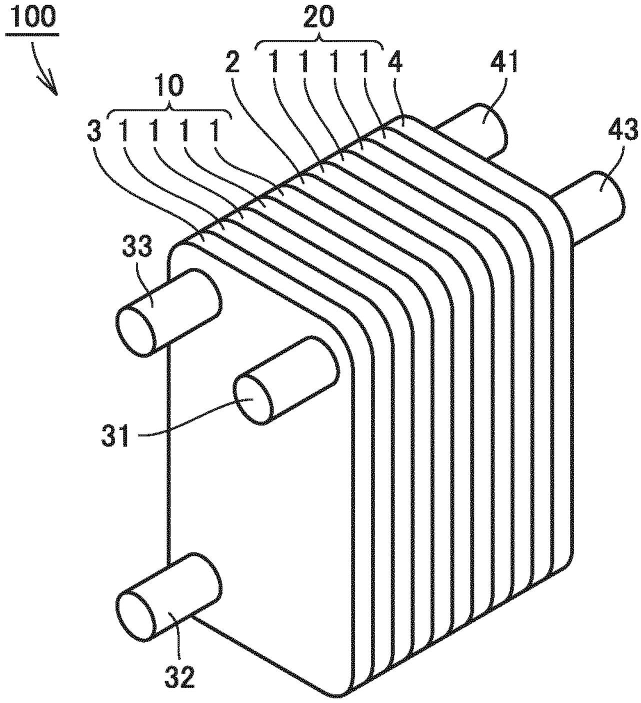
6. The plate-type heat exchanger according to any one of claim 1 to claim 5, wherein the fifth direction is a direction from a lower side toward an upper side in a gravity direction.

7. A refrigeration cycle apparatus comprising:

the plate-type heat exchanger recited in any one of claim 1 to claim 6; and
a compressor configured to discharge the first fluid to the first flow path of the plate-type heat exchanger.

FIG.1

(a)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10
3
1
1
1
1
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31
32

(b)

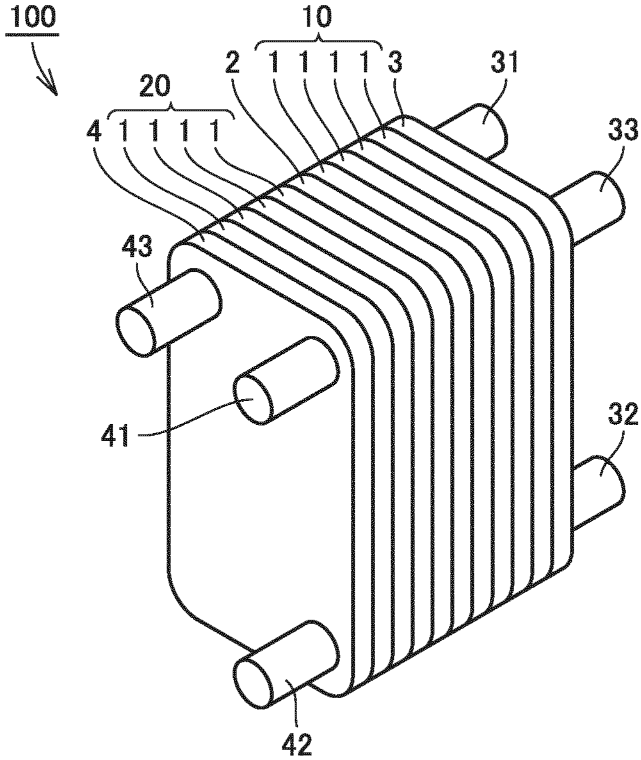
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FIG.2

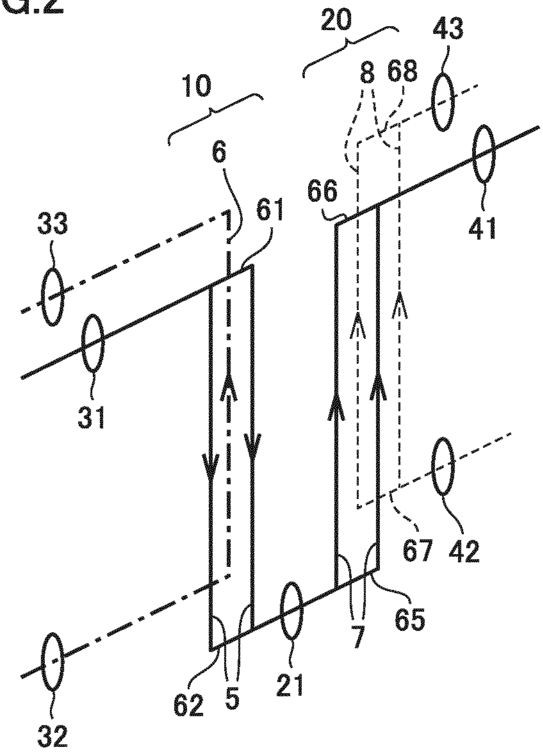
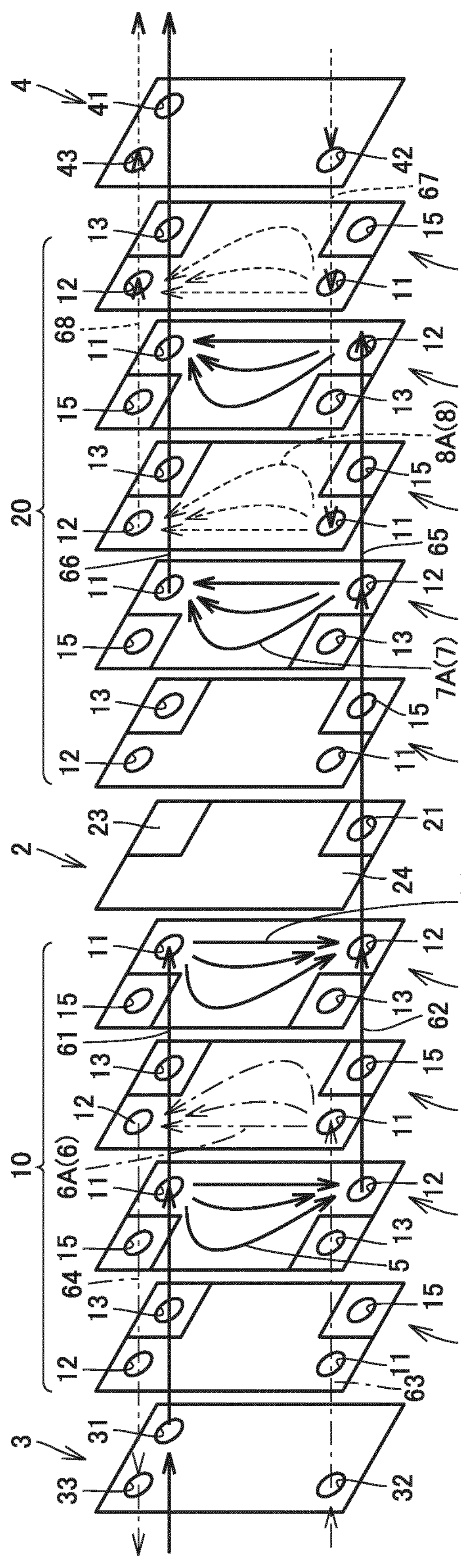


FIG.3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31
33
32
63
64
10
6A(6)
61
62
5
5A(5)
2
23
24
21
20
7A(7)
66
65
8A(8)
68
67
4
41
43
42
11
12
13
15
1(1a)
1(1b)
1(1c)
1(1d)
1(1e)
1(1f)
1(1g)
1(1h)
1(1i)

FIG.4

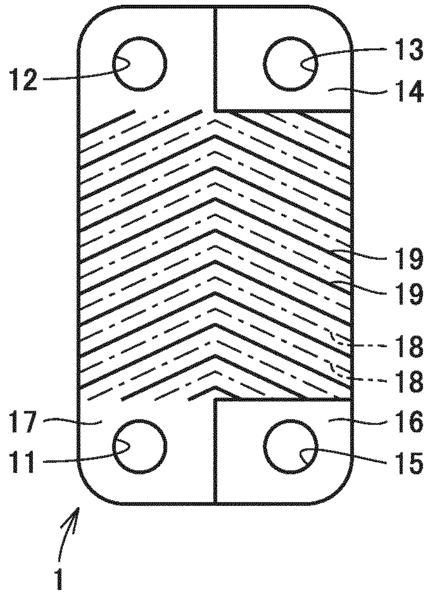


FIG.5

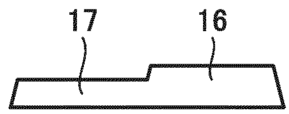


FIG.6

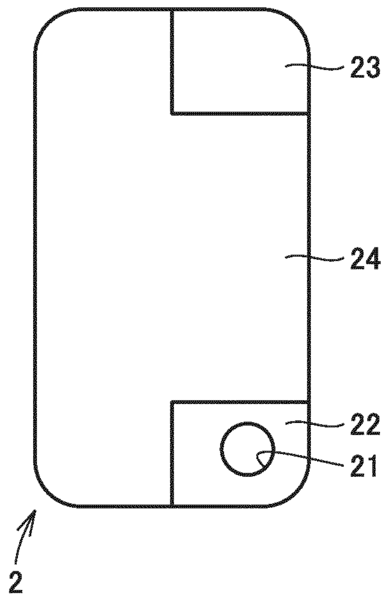


FIG.7

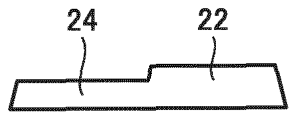


FIG.8

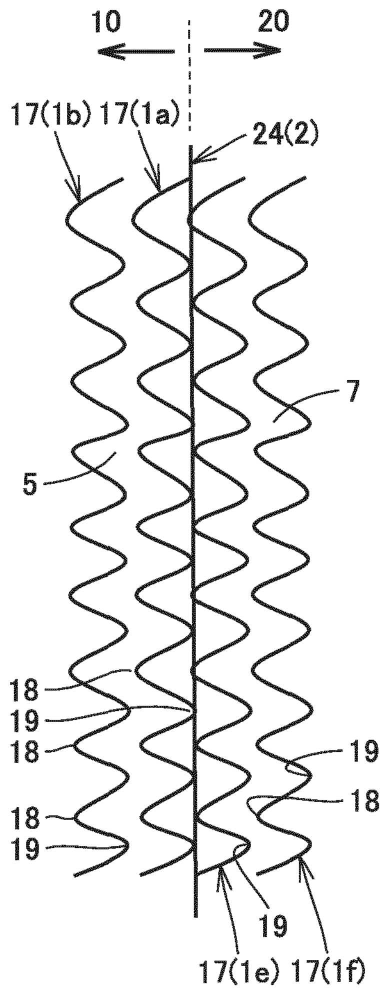


FIG.9

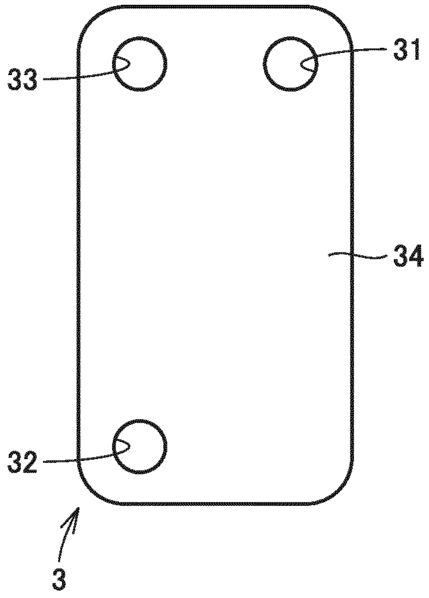


FIG.10

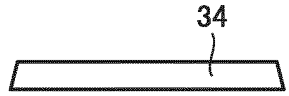


FIG.11

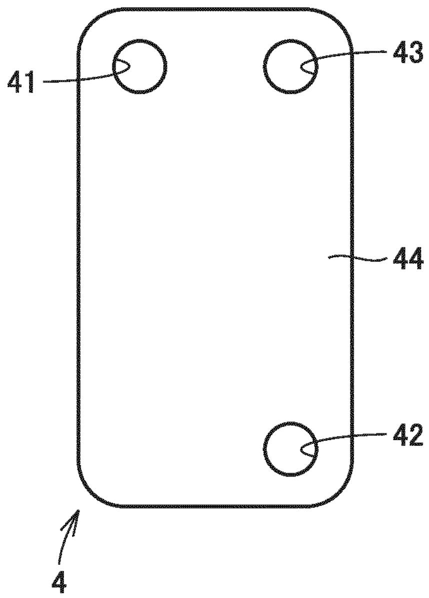


FIG.12

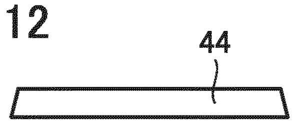


FIG.13

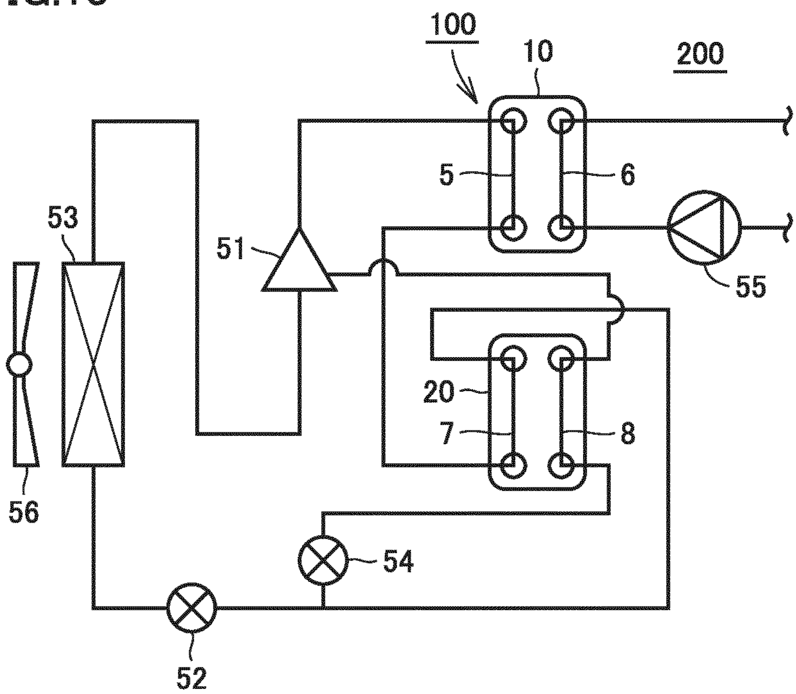
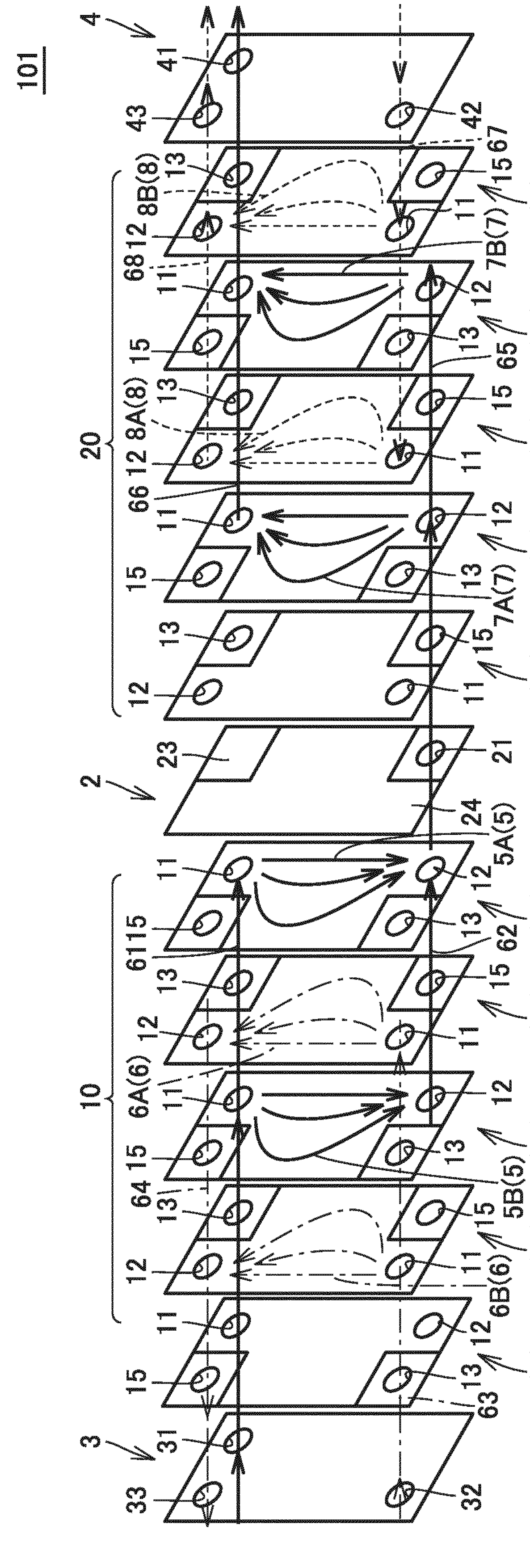


FIG.14


101
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8B(8)
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7A(7)
6A(6)
6B(6)
5A(5)
5B(5)
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1(1g)
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1(1c)
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FIG.15

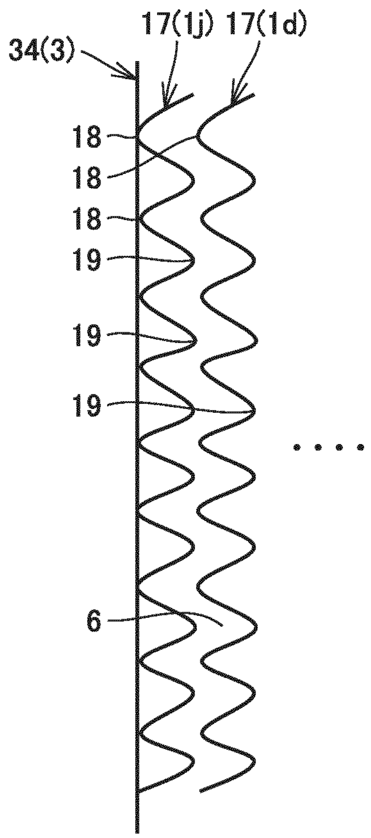


FIG.16

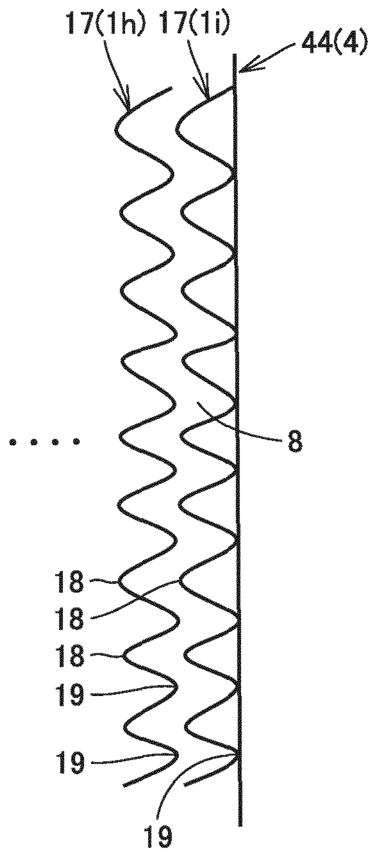


FIG.17

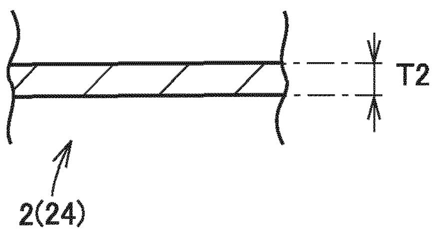


FIG.18

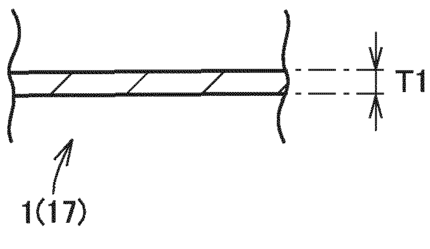


FIG.19

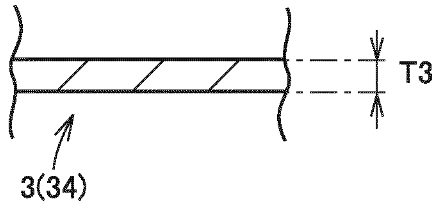


FIG.20

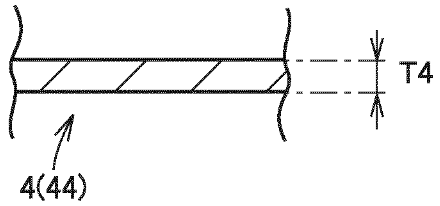


FIG.21

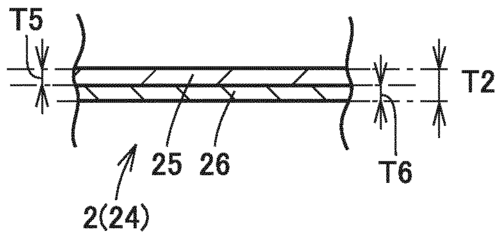


FIG.22

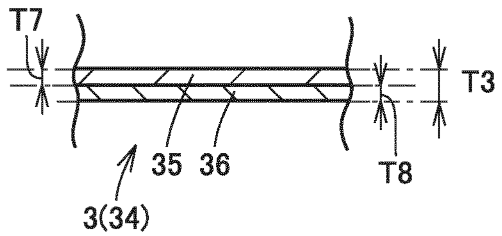
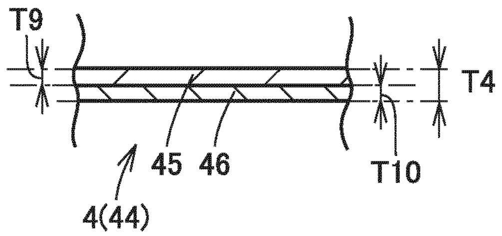


FIG.23



INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2016/076641

A. CLASSIFICATION OF SUBJECT MATTER
F28D9/00(2006.01)i, *F25B1/00*(2006.01)i, *F25B39/04*(2006.01)i, *F28F3/08*(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)
F28D9/00, F25B1/00, F25B39/04, F28F3/08

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	1996-2016
Kokai Jitsuyo Shinan Koho	1971-2016	Toroku Jitsuyo Shinan Koho	1994-2016

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	WO 2004/042312 A1 (VALEO THERMIQUE MOTEUR), 21 May 2004 (21.05.2004), fig. 3 to 5 & FR 2846736 A1 & AU 2003288347 A	1 2-7
X Y	JP 2000-171177 A (Osaka Gas Co., Ltd.), 23 June 2000 (23.06.2000), paragraphs [0044], [0050], [0053]; fig. 2 & WO 2000/034729 A1 & EP 1054225 A1 paragraphs [0028], [0034], [0037]; fig. 2 & CN 1290338 A	1 2-7
Y	JP 6-3081 A (Mitsubishi Electric Corp.), 11 January 1994 (11.01.1994), paragraphs [0011] to [0013]; fig. 1 to 2 (Family: none)	2-7

☒ 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
18 November 2016 (18.11.16)

Date of mailing of the international search report
29 November 2016 (29.11.16)

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

Authorized officer

Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/076641

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2016/117069 A1 (Mitsubishi Electric Corp.), 28 July 2016 (28.07.2016), paragraphs [0009] to [0018], [0026] to [0029]; fig. 1 to 4 & EP 3088830 A1 paragraphs [0009] to [0020], [0031] to [0034]; fig. 1 to 4	3-7
Y	JP 2000-18735 A (Kobe Steel, Ltd.), 18 January 2000 (18.01.2000), paragraphs [0009] to [0014]; fig. 1 to 3 (Family: none)	5-7
A	EP 2952832 A1 (VAILLANT GMBH), 09 December 2015 (09.12.2015), entire text; all drawings (Family: none)	1-7
A	JP 2005-106385 A (Hisaka Works, Ltd.), 21 April 2005 (21.04.2005), entire text; all drawings (Family: none)	1-7

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REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2005106385 A **[0002] [0004]**