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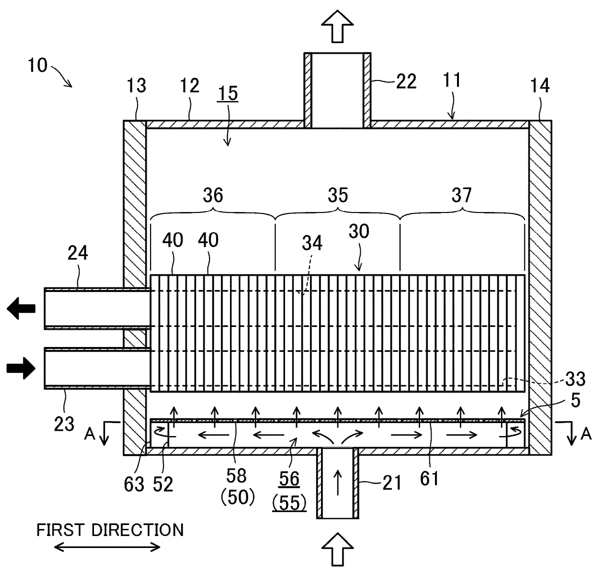
(54) SHELL-AND-PLATE TYPE HEAT EXCHANGER AND REFRIGERATION DEVICE

(57) A partitioning member (5) is arranged between a plate stack (30) and a refrigerant inlet (21). The partitioning member (5) extends along a first direction that is a stacking direction of the plate stack (30). The partitioning member (5) has a plurality of communication holes (50). The plurality of communication holes (50) are open toward the plate stack (30) at positions facing the central heat exchange section (35), the first heat exchange section (36), and the second heat exchange section (37).

FIG.2



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Description

TECHNICAL FIELD

[0001] The present disclosure relates to a shell-and-plate heat exchanger and a refrigeration apparatus.

BACKGROUND ART

[0002] Patent Document 1 discloses an evaporator including a pressure container into which a refrigerant flows, a plurality of heat transfer tube support plates spaced apart from one another along the longitudinal axis of the pressure container, and a group of heat transfer tubes installed to penetrate the plurality of heat transfer tube support plates.

CITATION LIST

PATENT DOCUMENT

[0003] Patent Document 1: Japanese Unexamined Patent Publication No. 2017-072343

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0004] An amount of refrigerant flowing along the longitudinal axis of the pressure container may vary when the refrigerant flows from a refrigerant inlet toward a refrigerant outlet of the pressure container; however, according to Patent Document 1, the refrigerant flows along the longitudinal axis of the pressure container between the plurality of heat transfer tube support plates, thereby reducing the variation in the amount of the refrigerant along the longitudinal axis.

[0005] In contrast, in a shell-and-plate heat exchanger including a plate stack that includes a plurality of heat transfer plates stacked and joined together, a refrigerant flowing between the plurality of heat transfer plates cannot flow in a stacking direction.

[0006] Thus, if the amount of refrigerant flowing in the stacking direction of the plate stack varies, the heat exchange of the refrigerant occurs while such variations are not eliminated, resulting in a deterioration in the heat exchange efficiency of the plate stack as a whole.

[0007] It is an object of the present disclosure to increase the heat exchange efficiency of a plate stack as a whole.

SOLUTION TO THE PROBLEMS

[0008] A first aspect of the present disclosure is directed to a shell-and-plate heat exchanger, including: a shell (11) having an internal space (15); and a plate stack (30) housed in the internal space (15) and including a plurality of heat transfer plates (40) stacked and joined together, the shell-and-plate heat exchanger causing heat exchange between a refrigerant that has flowed into the internal space (15) of the shell (11) and a heating medium that has flowed into a heating medium channel (32) of the plate stack (30), the shell-and-plate heat exchanger further including: a refrigerant inlet (21) provided in a lower portion of the shell (11) and allowing the refrigerant to flow into the internal space (15); and a partitioning member (5) arranged between the plate stack (30) and the refrigerant inlet (21), the partitioning member (5) extending along a first direction that is a stacking direction of the plate stack (30), wherein if the plate stack (30) is assumed to be equally divided into three sections in the first direction, a section in the middle in the first direction is referred to as a central heat exchange section (35), a section closer to one end in the first direction than the central heat exchange section (35) is referred to as a first heat exchange section (36), and a section closer to the other end in the first direction than the central heat exchange section (35) is referred to as a second heat exchange section (37), and the partitioning member (5) has a plurality of communication holes (50) that are open toward the plate stack (30) at positions facing the central heat exchange section (35), the first heat exchange section (36), and the second heat exchange section (37).

[0009] According to the first aspect, the partitioning member (5) reduces variations in the amount of the refrigerant flowing in the first direction, thereby making it possible to increase the heat exchange efficiency of the plate stack (30) as a whole.

[0010] A second aspect of the present disclosure is an embodiment of the first aspect. In the shell-and-plate heat exchanger of the second aspect, the partitioning member (5) includes a first partition plate (61) extending along the first direction, an internal channel (55) through which the refrigerant that has flowed in from the refrigerant inlet (21) flows is formed below the first partition plate (61), the internal channel (55) includes: a first channel (56) extending along the first direction, the first channel (56) guiding the refrigerant that has flowed in from the refrigerant inlet (21) to spaces under the first heat exchange section (36) and the second heat exchange section (37); and a second channel (57) guiding the refrigerant that has turned back at ends of the first channel (56) in the first direction and passed through the first channel (56) to a space under the central heat exchange section (35), and the communication holes (50) include: a first communication hole (58) formed in the first partition plate (61), the first communication hole (58) communicating with the first channel (56) and being open toward the plate stack (30); and a second communication hole (59) formed in the first partition plate (61), the second communication hole (59) communicating with the second channel (57) and being open toward the plate stack (30).

[0011] According to the second aspect, the first channel (56) guides the refrigerant that has flowed in through the refrigerant inlet (21) to the spaces under the first heat exchange section (36) and the second heat exchange section (37), and the refrigerant that has passed through the first channel (56) is guided to the space under the central heat exchange section (35). It is thus possible to reduce variations in the amount of the refrigerant flowing in the first direction.

[0012] A third aspect of the present disclosure is an embodiment of the first aspect. In the shell-and-plate heat exchanger of the third aspect, the partitioning member (5) includes a first partition plate (61) extending along the first direction, and a second partition plate (62) disposed below the first partition plate (61) and extending along the first direction, a downstream end of the refrigerant inlet (21) is connected to the second partition plate (62), an internal channel (55) through which the refrigerant that has flowed in from the refrigerant inlet (21) flows is formed between the first partition plate (61) and the second partition plate (62), the communication holes (50) include a first communication hole (68) formed in the first partition plate (61), the first communication hole (68) communicating with the internal channel (55) and being open toward the plate stack (30), and the second partition plate (62) has a plurality of second communication holes (69) communicating with the internal channel (55) and being open in a direction opposite to the plate stack (30).

[0013] According to the third aspect, the internal channel (55) guides the refrigerant that has flowed in from the refrigerant inlet (21) to the spaces under the first heat exchange section (36) and the second heat exchange section (37) and causes the gas refrigerant to flow out through the first communication holes (68) and the liquid refrigerant to flow out through the second communication holes (69). It is thus possible to reduce variations in the amount of the refrigerant flowing in the first direction.

[0014] A fourth aspect of the present disclosure is an embodiment of the first aspect. In the shell-and-plate heat exchanger of the fourth aspect, the partitioning member (5) includes a first partition plate (61) extending along the first direction, an internal channel (55) through which the refrigerant that has flowed in from the refrigerant inlet (21) flows is formed below the first partition plate (61), the communication holes (50) are formed in the first partition plate (61), the communication holes (50) communicating with the internal channel (55) and being open toward the plate stack (30), and the shell-and-plate heat exchanger further includes a stirring member (82) disposed in the internal channel (55) and configured to stir a liquid refrigerant and a gas refrigerant contained in the refrigerant.

[0015] According to the fourth aspect, the liquid refrigerant and the gas refrigerant contained in the refrigerant that has flowed in from the refrigerant inlet (21) are stirred by the stirring member (82) while flowing in the first direction. It is thus possible to reduce variations in the ratio between the liquid refrigerant and the gas refrigerant in the first direction.

[0016] A fifth aspect of the present disclosure is an embodiment of the first aspect. In the shell-and-plate heat exchanger of the fifth aspect, the partitioning member (5) includes a first partition plate (61) extending along the first direction, and a second partition plate (62) disposed below the first partition plate (61) and extending along the first direction, an upper channel (76) is formed between the first partition plate (61) and the second partition plate (62), a lower channel (77) through which the refrigerant that has flowed in from the refrigerant inlet (21) flows is formed below the second partition plate (62), the communication holes (50) include an upper communication hole (78) formed in the first partition plate (61), the upper communication hole (78) communicating with the upper channel (76) and being open toward the plate stack (30), and the second partition plate (62) has a plurality of lower communication holes (79) communicating with the upper channel (76) and the lower channel (77).

[0017] According to the fifth aspect, the refrigerant that has flowed in from the refrigerant inlet (21) is made to flow through the lower channel (77) in the first direction, and is then guided by the upper channel (76) to the spaces under the first heat exchange section (36) and the second heat exchange section (37). It is thus possible to stir the liquid refrigerant and the gas refrigerant contained in the refrigerant and reduce variations in the amount of the refrigerant flowing in the first direction.

[0018] A sixth aspect of the present disclosure is an embodiment of any one of the first to fifth aspects. In the shell-and-plate heat exchanger of the sixth aspect, a variation between a degree of dryness of the refrigerant made to exchange heat in the central heat exchange section (35) and a degree of dryness of the refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37) is 70% or less, and a variation between a mass flow rate of a liquid refrigerant made to exchange heat in the central heat exchange section (35) and a mass flow rate of the liquid refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37) is 30% or less.

[0019] According to the sixth aspect, appropriately setting the degree of dryness of the refrigerant and the mass flow rate of the liquid refrigerant in the first direction can increase the heat exchange efficiency of the plate stack (30) as a whole.

[0020] A seventh aspect of the present disclosure is an embodiment of the sixth aspect. In the shell-and-plate heat exchanger of the seventh aspect, the variation between the degree of dryness of the refrigerant made to exchange heat in the central heat exchange section (35) and the degree of dryness of the refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37) is 40% or less, and the variation between the mass flow rate of the liquid refrigerant made to exchange heat in the central heat exchange section (35) and the mass flow rate of the liquid refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37) is 20% or less.

[0021] According to the seventh aspect, appropriately setting the degree of dryness of the refrigerant and the mass flow rate of the liquid refrigerant in the first direction can increase the heat exchange efficiency of the plate stack (30) as a whole.

[0022] An eighth aspect of the present disclosure is an embodiment of any one of the first to seventh aspects. In the shell-and-plate heat exchanger of the eighth aspect, the refrigerant inlet (21) is formed in a lower portion of the shell (11) at a central position in the first direction.

[0023] According to the eighth aspect, providing the refrigerant inlet (21) at a central position in the first direction makes it possible to distribute the refrigerant that has flowed into the internal space (15) through the refrigerant inlet (21) uniformly toward both ends in the first direction.

[0024] A ninth aspect of the present disclosure is an embodiment of any one of the first to seventh aspects. In the shell-and-plate heat exchanger of the ninth aspect, the refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted in the first direction from a central position in the first direction.

[0025] According to the ninth aspect, the refrigerant inlet (21) is provided at a position shifted in the first direction from the central position in the first direction. It is thus possible to locate the refrigerant inlet (21) at an arbitrary position.

[0026] A tenth aspect of the present disclosure is an embodiment of any one of the first to ninth aspects. In the shell-and-plate heat exchanger of the tenth aspect, among the plurality of communication holes (50), a diameter d1 of the communication holes (50) at positions closest to the refrigerant inlet (21) and a diameter d2 of the communication holes (50) at positions farthest from the refrigerant inlet (21) are set to satisfy a condition "$d1 < d2$."

[0027] According to the tenth aspect, the diameters of the communication holes (50) are set so that the refrigerant can flow to the communication holes (50) far from the refrigerant inlet (21) easily. It is thus possible to reduce variations in the distribution amount of the refrigerant.

[0028] An eleventh aspect of the present disclosure is an embodiment of any one of the first to fourth aspects. In the shell-and-plate heat exchanger of the eleventh aspect, the partitioning member (5) includes a first partition plate (61) extending along the first direction, the refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted in the first direction from a central position in the first direction, one end of the first partition plate (61) in the first direction is referred to as a first end (91), and the other end is referred to as a second end (92), a distance from the refrigerant inlet (21) to the first end (91) is longer than a distance from the refrigerant inlet (21) to the second end (92), when viewed in a plate thickness direction of the first partition plate (61), a region of the first partition plate (61) closer to the first end (91) than the refrigerant inlet (21) is referred to as a first region, and a region of the first partition plate (61) closer to the second end (92) than the refrigerant inlet (21) is referred to as a second region, and among the plurality of communication holes (50), a diameter d3 of the communication holes (50) formed in the first region and a diameter d4 of the communication holes (50) formed in the second region are set to satisfy a condition "$d3 > d4$."

[0029] According to the eleventh aspect, the diameters of the communication holes (50) in the first region and the second region are set so that the refrigerant can flow to the communication holes (50) of the first partition plate (61) in the first region distant from the refrigerant inlet (21) easily. It is thus possible to reduce variations in the distribution amount of the refrigerant.

[0030] A twelfth aspect of the present disclosure is an embodiment of the fifth aspect. In the shell-and-plate heat exchanger of the twelfth aspect, the refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted in a stacking direction from a central position in the first direction, one end of the second partition plate (62) in the first direction is referred to as a first end (91), and the other end is referred to as a second end (92), a distance from the refrigerant inlet (21) to the first end (91) is longer than a distance from the refrigerant inlet (21) to the second end (92), when viewed in a plate thickness direction of the second partition plate (62), a region of the second partition plate (62) closer to the first end (91) than the refrigerant inlet (21) is referred to as a first region, and a region of the second partition plate (62) closer to the second end (92) than the refrigerant inlet (21) is referred to as a second region, and among the plurality of lower communication holes (79), a diameter d5 of the lower communication holes (79) formed in the first region and a diameter d6 of the lower communication holes (79) formed in the second region are set to satisfy a condition "$d5 > d6$."

[0031] According to the twelfth aspect, the diameters of the lower communication holes (79) in the first region and the second region are set so that the refrigerant can flow to the lower communication holes (79) of the second partition plate (62) in the first region distant from the refrigerant inlet (21) easily. It is thus possible to reduce variations in the distribution amount of the refrigerant.

[0032] A thirteenth aspect of the present disclosure is an embodiment of the second aspect. In the shell-and-plate heat exchanger of the thirteenth aspect, the refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted in the first direction from a central position in the first direction, one end of the first partition plate (61) in the first direction is referred to as a first end (91), and the other end is referred to as a second end (92), a distance from the refrigerant inlet (21) to the first end (91) is longer than a distance from the refrigerant inlet (21) to the second end (92), when viewed in a plate thickness direction of the first partition plate (61), a region of the first channel (56) closer to the first end (91) than the refrigerant inlet (21) is referred to as a first region, and a region of the first channel (56) closer to the second end (92) than the refrigerant inlet (21) is referred to a second region, and a channel width L1 of the first region and a channel width L2 of the second region satisfy a condition "L1 > L2."

[0033] According to the thirteenth aspect, the channel widths of the first channel (56) in the first region and the second region are set so that the refrigerant can flow to the first channel (56) in the first region distant from the refrigerant inlet (21) easily. It is thus possible to reduce variations in the distribution amount of the refrigerant.

[0034] A fourteenth aspect of the present disclosure is directed to a refrigeration apparatus. The refrigeration apparatus includes: the shell-and-plate heat exchanger (10) of any one of the first to thirteenth aspects; and a refrigerant circuit (1a) through which a refrigerant to exchange heat in the shell-and-plate heat exchanger (10) flows.

[0035] According to the fourteenth aspect, it is possible to provide a refrigeration apparatus including the shell-and-plate heat exchanger (10).

BRIEF DESCRIPTION OF THE DRAWINGS

[0036]

FIG. 1 is a refrigerant circuit diagram showing a configuration of a refrigeration apparatus according to a first embodiment.

FIG. 2 is a cross-sectional side view showing a configuration of a shell-and-plate heat exchanger.

FIG. 3 is a cross-sectional front view showing the configuration of the shell-and-plate heat exchanger.

FIG. 4 is a cross-sectional side view showing a configuration of a plate stack.

FIG. 5 is a plan view showing a configuration of a partitioning member.

FIG. 6 is a cross-sectional view taken along line A-A in FIG. 2 and viewed in the direction of arrows.

FIG. 7 is a cross-sectional side view showing a configuration of a shell-and-plate heat exchanger according to a second embodiment.

FIG. 8 is a cross-sectional front view showing the configuration of the shell-and-plate heat exchanger.

FIG. 9 is a cross-sectional view taken along line B1-B1 shown in FIG. 7 and viewed in the direction of arrows.

FIG. 10 is a cross-sectional view taken along line B2-B2 shown in FIG. 7 and viewed in the direction of arrows.

FIG. 11 is a diagram of a partitioning member according to a variation of the second embodiment, and corresponds to FIG. 9.

FIG. 12 is a diagram of the partitioning member according to the variation of the second embodiment, and corresponds to FIG. 10.

FIG. 13 is a cross-sectional side view showing a configuration of a shell-and-plate heat exchanger according to a third embodiment.

FIG. 14 is a cross-sectional front view showing the configuration of the shell-and-plate heat exchanger.

FIG. 15 is a cross-sectional view taken along line C1-C1 shown in FIG. 13 and viewed in the direction of arrows.

FIG. 16 is a cross-sectional view taken along line C2-C2 shown in FIG. 13 and viewed in the direction of arrows.

FIG. 17 is a cross-sectional view taken along line C3-C3 shown in FIG. 13 and viewed in the direction of arrows.

FIG. 18 is a cross-sectional side view showing a configuration of a shell-and-plate heat exchanger according to a fourth embodiment.

FIG. 19 is a cross-sectional front view showing the configuration of the shell-and-plate heat exchanger.

FIG. 20 is a cross-sectional view taken along line D-D shown in FIG. 18 and viewed in the direction of arrows.

FIG. 21 is a plan view showing a configuration of a partitioning member according to a fifth embodiment.

FIG. 22 is a cross-sectional plan view showing the position of a refrigerant inlet.

FIG. 23 is a plan view showing a configuration of a partitioning member according to a sixth embodiment.

FIG. 24 is a cross-sectional plan view showing the position of a refrigerant inlet.

FIG. 25 is a plan view showing a configuration of a partitioning member according to a seventh embodiment.

FIG. 26 is a cross-sectional plan view showing the position of a refrigerant inlet.

FIG. 27 is a plan view showing a configuration of a partitioning member according to an eighth embodiment.

FIG. 28 is a cross-sectional plan view showing the position of a refrigerant inlet.

FIG. 29 is a plan view showing a configuration of a partitioning member according to a ninth embodiment.

DESCRIPTION OF EMBODIMENT

<<First Embodiment>>

[0037] As illustrated in FIG. 1, a shell-and-plate heat exchanger (10) (will be hereinafter "referred to as a heat exchanger") is provided in a refrigeration apparatus (1). The refrigeration apparatus (1) includes a refrigerant circuit (1a) filled with a refrigerant. The refrigerant circuit (1a) includes a compressor (2), a radiator (3), a decompression mechanism (4), and the heat exchanger (10) serving as an evaporator. The decompression mechanism (4) is, for example, an expansion valve. The refrigerant circuit (1a) performs a vapor compression refrigeration cycle.

[0038] The refrigeration apparatus (1) is an air conditioner. The air conditioner may be any of a cooling-only apparatus, a heating-only apparatus, or an air conditioner switchable between cooling and heating. In this case, the air conditioner has a switching mechanism (e.g., a four-way switching valve) configured to switch the direction of circulation of the refrigerant. The refrigeration apparatus (1) may be a water heater, a chiller unit, or a cooling apparatus configured to cool air in an internal space. The cooling apparatus cools the air in an internal space of a refrigerator, a freezer, a container, or the like.

<Heat Exchanger>

[0039] As illustrated in FIGS. 2 and 3, the heat exchanger (10) includes a shell (11) and a plate stack (30). The plate stack (30) is housed in an internal space (15) of the shell (11).

[0040] The refrigerant flows into the internal space (15) of the shell (11). The refrigerant includes a gas refrigerant and a liquid refrigerant. The refrigerant exchanges heat with a heating medium flowing in the plate stack (30). As can be seen, the heat exchanger (10) allows the refrigerant that has flowed into the internal space (15) of the shell (11) to evaporate, and thus, functions as an evaporator. Examples of the heating medium used include water and brine.

<Shell>

[0041] The shell (11) includes a cylindrical body (12), a first closing member (13), and a second closing member (14). The cylindrical body (12) is a circular cylindrical member extending in a horizontal direction and having openings on both axial ends.

[0042] The first closing member (13) is a disk-shaped member. The first closing member (13) closes an opening on one end (the left end in FIG. 2) of the cylindrical body (12). The first closing member (13) is attached to the cylindrical body (12) by welding.

[0043] The second closing member (14) is a disk-shaped member. The second closing member (14) closes an opening on the other end (the right end in FIG. 2) of the cylindrical body (12). The second closing member (14) is attached to the cylindrical body (12) by welding.

[0044] The shell (11) has the internal space (15) defined by the cylindrical body (12), the first closing member (13), and the second closing member (14). The internal space (15) stores therein the liquid refrigerant. The plate stack (30) is housed in the internal space (15).

[0045] The cylindrical body (12) is provided with a refrigerant inlet (21) and a refrigerant outlet (22). The refrigerant inlet (21) is formed at the bottom of the cylindrical body (12). The refrigerant is introduced into the internal space (15) through the refrigerant inlet (21). The refrigerant inlet (21) is formed in a lower portion of the shell (11) at a central position in the stacking direction of the plate stack (30).

[0046] The refrigerant outlet (22) is formed at the top of the cylindrical body (12). The refrigerant evaporated in the internal space (15) is emitted out of the shell (11) through the refrigerant outlet (22). The refrigerant inlet (21) and the refrigerant outlet (22) are connected to the refrigerant circuit (1a).

[0047] The first closing member (13) is provided with a heating medium inlet (23) and a heating medium outlet (24). The heating medium inlet (23) and the heating medium outlet (24) are tubular members.

[0048] The heating medium inlet (23) penetrates the first closing member (13). The heating medium inlet (23) is connected to a heating medium introduction path (33) of the plate stack (30). The heating medium inlet (23) supplies the heating medium to the plate stack (30). The refrigerant that has flowed into the internal space (15) of the shell (11) exchanges heat with the heating medium that has flowed into heating medium channels (32), which will be described later, of the plate stack (30).

[0049] The heating medium outlet (24) penetrates the first closing member (13) above the heating medium inlet (23). The heating medium outlet (24) is connected to a heating medium emission path (34) of the plate stack (30). The heating medium outlet (24) emits the heating medium out of the plate stack (30).

<Plate Stack>

[0050] The plate stack (30) includes a plurality of heat transfer plates (40) stacked and joined together. The plate stack (30) is housed in the internal space (15) of the shell (11) in a posture in which the stacking direction of the heat transfer plates (40) is the lateral direction. In the following description, the stacking direction of the plate stack (30) will be referred to as a "first direction."

[0051] As illustrated in FIG. 4, the heat transfer plates (40) include first plates (40a) and second plates (40b). The first plates (40a) and the second plates (40b) are alternately stacked to form the plate stack (30). In the following description, for each of the first plates (40a) and the second plates (40b), a surface on the left side in FIG. 4 will be referred to as a "front surface," and a surface on the right side in FIG. 5 will be referred to as a "back surface."

<Heating Medium Introduction Path and Heating Medium Emission Path>

[0052] Each of the first plates (40a) has an inlet protrusion (41a) and an outlet protrusion (43a). The inlet protrusion (41a) and the outlet protrusion (43a) are portions of the first plate (40a) bulged toward the front surface.

[0053] The inlet protrusion (41a) is formed in a lower portion of the first plate (40a). A first inlet hole (42a) is formed in a center portion of the inlet protrusion (41a). The first inlet hole (42a) is a circular hole penetrating the first plate (40a) in a thickness direction.

[0054] The outlet protrusion (43a) is formed in an upper portion of the first plate (40a). A first outlet hole (44a) is formed in a center portion of the outlet protrusion (43a).

The first outlet hole (44a) is a circular hole penetrating the first plate (40a) in the thickness direction.

[0055] Each of the second plates (40b) has an inlet recess (41b) and an outlet recess (43b). The inlet recess (41b) and the outlet recess (43b) are portions of the second plate (40b) bulged toward the back surface.

[0056] The inlet recess (41b) is formed in a lower portion of the second plate (40b). A second inlet hole (42b) is formed in a center portion of the inlet recess (41b). The second inlet hole (42b) is a circular hole penetrating the second plate (40b) in the thickness direction. The inlet recess (41b) is positioned to face the inlet protrusion (41a) of the first plate (40a). The second inlet hole (42b) is positioned to face the first inlet hole (42a) of the first plate (40a).

[0057] The outlet recess (43b) is formed in an upper portion of the second plate (40b). A second outlet hole (44b) is formed in a center portion of the outlet recess (43b). The second outlet hole (44b) is a circular hole penetrating the second plate (40b) in the thickness direction. The outlet recess (43b) is positioned to face the outlet protrusion (43a) of the first plate (40a). The second outlet hole (44b) is positioned to face the first outlet hole (44a) of the first plate (40a).

[0058] In the plate stack (30), each first plate (40a) and an adjacent one of the second plates (40b) on the back side of the first plate (40a) are welded together at their peripheral portions along the entire perimeter. These plates may be brazed together.

[0059] In the plate stack (30), the first inlet hole (42a) of each first plate (40a) overlaps the second inlet hole (42b) of an adjacent one of the second plates (40b) on the front side of the first plate (40a). The rims of the overlapping first inlet hole (42a) and second inlet hole (42b) are welded together along the entire perimeter. These rims may be brazed together. The first inlet hole (42a) and the second inlet hole (42b) communicate with the heating medium channels (32), which will be described later, to introduce the heating medium into the heating medium channels (32).

[0060] In the plate stack (30), the first outlet hole (44a) of each first plate (40a) overlaps the second outlet hole (44b) of an adjacent one of the second plates (40b) on the front side of the first plate (40a). The rims of the overlapping first outlet hole (44a) and second outlet hole (44b) are welded together along the entire perimeter. These rims may be brazed together. The first outlet hole (44a) and the second outlet hole (44b) communicate with the heating medium channels (32), which will be described later, to emit the heating medium out of the heating medium channels (32).

[0061] In the plate stack (30), the inlet protrusions (41a) and first inlet holes (42a) of the first plates (40a) and the inlet recesses (41b) and second inlet holes (42b) of the second plates (40b) form the heating medium introduction path (33).

[0062] In the plate stack (30), the outlet protrusions (43a) and first outlet holes (44a) of the first plates (40a) and the outlet recesses (43b) and second outlet holes (44b) of the second plates (40b) form the heating medium emission path (34).

[0063] The heating medium introduction path (33) is a passage extending in the stacking direction of the heat transfer plates (40) in the plate stack (30). The heating medium introduction path (33) is a passage blocked from the internal space (15) of the shell (11), and allows all the heating medium channels (32) to communicate with the heating medium inlet (23).

[0064] The heating medium emission path (34) is a passage extending in the stacking direction of the heat transfer plates (40) in the plate stack (30). The heating medium emission path (34) is a passage blocked from the internal space (15) of the shell (11), and allows all the heating medium channels (32) to communicate with the heating medium outlet (24).

<Refrigerant Channel and Heating Medium Channel>

[0065] The plate stack (30) includes a refrigerant channel (31) and a heating medium channel (32). The refrigerant channel (31) and the heating medium channel (32) are formed with a heat transfer plate (40) interposed therebetween, and include a plurality of refrigerant channels (31) and a plurality of heating medium channels (32). The heat transfer plate (40) separates the refrigerant channel (31) and the heating medium channel (32) from each other. Each of the first plate (40a) and the second plate (40b) includes repetition of long and narrow ridges and grooves.

[0066] Each first plate (40a) includes first front-side protrusions (45a) and first back-side protrusions (47a) alternately arranged. The first front-side protrusions (45a) bulge toward the front side of the first plate (40a). The first back-side protrusions (47a) bulge toward the back side of the first plate (40a).

[0067] Each second plate (40b) includes second front-side protrusions (47b) and second back-side protrusions (45b) alternately arranged. The second front-side protrusions (47b) bulge toward the front side of the second plate (40b). The second back-side protrusions (45b) bulge toward the back side of the second plate (40b).

[0068] Each of the refrigerant channels (31) is a channel sandwiched between the front surface of the first plate (40a) and the back surface of the second plate (40b). The refrigerant channel (31) is a channel that communicates with the internal space (15) of the shell (11) and allows the refrigerant to flow therethrough.

[0069] Specifically, each refrigerant channel (31) includes channels formed between the front surfaces of the first back-side protrusions (47a) and the back surfaces of the second front-side protrusions (47b), and spaces formed between the first front-side protrusions (45a) and the second back-side protrusions (45b).

[0070] Each of the heating medium channels (32) is a channel sandwiched between the back surface of the first plate (40a) and the front surface of the second plate

(40b). The heating medium channel (32) is a channel blocked from the internal space (15) of the shell (11) and allows the heating medium to flow therethrough.

[0071] Specifically, each heating medium channel (32) includes channels formed between the back surfaces of the first front-side protrusions (45a) and the front surfaces of the second back-side protrusions (45b), and spaces formed between the first back-side protrusions (47a) and the second front-side protrusions (47b).

<Flows of Heating Medium and Refrigerant>

[0072] Flows of the heating medium and the refrigerant in the heat exchanger (10) will be described. The flow of the heating medium is shown by the arrows in FIG. 4.

[0073] As illustrated in FIG. 4, the heating medium flows from the heating medium inlet (23) into the heating medium introduction path (33). The heating medium flowing through the heating medium introduction path (33) flows from the first inlet holes (42a) and the second inlet holes (42b) toward the first outlet holes (44a) and the second outlet holes (44b) through the heating medium channels (32).

[0074] Specifically, the heating medium flowing through the heating medium introduction path (33) enters the heating medium channel (32). The heating medium flows along the heating medium channel (32), passes through the space formed between the first back-side protrusion (47a) and the second front-side protrusion (47b), and enters an adjacent heating medium channel (32) above the heating medium channel (32). In this manner, the heating medium flows upward while flowing from one end to the other of the heat transfer plate (40).

[0075] Next, the flow of the refrigerant will be described below. The refrigerant that has passed through the decompression mechanism (4) in the refrigerant circuit (1a) flows toward the heat exchanger (10). The liquid refrigerant flows into the internal space (15) of the shell (11) through the refrigerant inlet (21). The liquid refrigerant stored in the internal space (15) reaches close to the upper end of the plate stack (30). The plate stack (30) is immersed in the liquid refrigerant. The refrigerant stored in the internal space (15) has a relatively low pressure. The low-pressure refrigerant exchanges heat with the heating medium flowing through the heating medium channels (32).

[0076] Specifically, the refrigerant channel (31) and the heating medium channel (32) are adjacent to each other with the heat transfer plate (40) interposed therebetween. Thus, the liquid refrigerant absorbs heat from the heating medium flowing through the heating medium channel (32) and evaporates. The evaporated refrigerant moves from the refrigerant channel (31) further upward from the plate stack (30). The evaporated refrigerant flows out through the refrigerant outlet (22) into the refrigerant circuit.

<Partitioning Member>

[0077] The shell-and-plate heat exchanger (10) of this embodiment includes the plate stack (30) that includes the plurality of heat transfer plates (40) stacked and joined together. Thus, the refrigerant flowing between the plurality of heat transfer plates (40) cannot flow in the stacking direction.

[0078] Thus, if the amount of refrigerant flowing in the stacking direction of the plate stack (30) varies, the heat exchange of the refrigerant occurs while such variations are not eliminated, resulting in a deterioration in the heat exchange efficiency of the plate stack (30) as a whole.

[0079] To address this, in this embodiment, the heat exchange efficiency of the plate stack (30) as a whole can be increased.

[0080] As illustrated in FIG. 2, if the plate stack (30) is assumed to be equally divided into three sections in the stacking direction, a section in the middle in the stacking direction is referred to as a "central heat exchange section (35)"; a section closer to one end (the left end in FIG. 2) in the stacking direction than the central heat exchange section (35) is referred to as a "first heat exchange section (36)"; and a section closer to the other end (the right end in FIG. 2) in the stacking direction than the central heat exchange section (35) is referred to as a "second heat exchange section (37)."

[0081] As illustrated also in FIG. 3, the heat exchanger (10) includes a partitioning member (5). The partitioning member (5) reduces a variation between the ratio between the liquid refrigerant and the gas refrigerant contained in the refrigerant made to exchange heat in the central heat exchange section (35) and the ratio between the liquid refrigerant and the gas refrigerant contained in the refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37).

[0082] Specifically, the partitioning member (5) is disposed below the plate stack (30). The partitioning member (5) includes a first partition plate (61), a pair of guide plates (52), and first sidewall portions (63).

[0083] The first partition plate (61) serves as a partition between the plate stack (30) and the refrigerant inlet (21). The first partition plate (61) extends along the stacking direction of the plate stack (30) between the first closing member (13) and the second closing member (14) in the internal space (15) of the shell (11).

[0084] The stacking direction of the plate stack (30) is hereinafter referred to as a "first direction" (the lateral direction in FIG. 2), and the width direction of the first partition plate (61) orthogonal to the first direction is hereinafter referred to as a "second direction" (the lateral direction in FIG. 3).

[0085] The first sidewall portions (63) are edge portions of the first partition plate (61) in the second direction which are bent to incline downward. Both ends of the first sidewall portions (63) in the second direction are in contact with the inner peripheral surface of the cylindrical body (12) of the shell (11).

[0086] Thus, the partitioning member (5) forms an internal channel (55). The internal channel (55) extends along the stacking direction of the plate stack (30). The refrigerant that has flowed into the internal channel (55) from the refrigerant inlet (21) flows through the internal channel (55). The internal channel (55) is formed in a space surrounded by the first partition plate (61), the first sidewall portions (63), the cylindrical body (12), the first closing member (13), and the second closing member (14).

[0087] The pair of guide plates (52) are provided on a lower portion of the first partition plate (61). The pair of guide plates (52) are spaced apart from each other in the second direction and extend along the stacking direction of the plate stack (30). Both ends of each of the pair of guide plates (52) in the first direction are located inward of both ends of the first partition plate (61) in the first direction (see FIG. 5). Thus, a gap is formed between the left end portion of the guide plate (52) and the first closing member (13), and between the right end portion of the guide plate (52) and the second closing member (14).

[0088] The pair of guide plates (52) are inclined such that the closer to the downside, the closer to the outside of the first partition plate (61) in the second direction to be away from each other. The pair of guide plates (52) each have a lower end in contact with the inner peripheral surface of the cylindrical body (12) of the shell (11).

[0089] Thus, the internal channel (55) includes a first channel (56) and second channels (57). The first channel (56) is a space formed between the pair of guide plates (52). The first channel (56) guides the refrigerant that has flowed therein from the refrigerant inlet (21) to spaces under the first heat exchange section (36) and the second heat exchange section (37).

[0090] The second channels (57) are spaces each formed between the guide plate (52) and the associated first sidewall portion (63), which is a bent portion of the first partition plate (61) on each end in the second direction. The second channels (57) guide the refrigerant that has turned back at ends of the first channel (56) in the first direction and passed through the first channel (56) to a space under the central heat exchange section (35).

[0091] As illustrated also in FIGS. 5 and 6, the partitioning member (5) has first communication holes (58) and second communication holes (59). The first communication holes (58) and the second communication holes (59) are formed in the first partition plate (61).

[0092] The first communication holes (58) communicate with the first channel (56) and are open toward the plate stack (30). The plurality of first communication holes (58) are spaced apart from one another in the first direction and in the second direction in the first partition plate (61). The first communication holes (58) discharge the gas refrigerant contained in the refrigerant flowing through the first channel (56).

[0093] The second communication holes (59) communicate with the second channels (57) and are open toward the plate stack (30). The plurality of second communication holes (59) are spaced apart from one another in the first direction in the first partition plate (61). The second communication holes (59) discharge the liquid refrigerant contained in the refrigerant flowing through the second channels (57).

[0094] As described, the refrigerant that has flowed into the internal space (15) of the shell (11) through the refrigerant inlet (21) passes through the first channel (56) in the partitioning member (5) and flows along the first direction. It is thus possible to distribute the refrigerant among the central heat exchange section (35), the first heat exchange section (36), and the second heat exchange section (37) in the plate stack (30).

[0095] Here, it is preferable that the variation between the degree of dryness of the refrigerant made to exchange heat in the central heat exchange section (35) and the degree of dryness of the refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37) is 70% or less, particularly 40% or less.

[0096] Furthermore, it is preferable that the variation between the mass flow rate of the liquid refrigerant made to exchange heat in the central heat exchange section (35) and the mass flow rate of the liquid refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37) is 30% or less, particularly 20% or less.

-Advantages of First Embodiment-

[0097] According to a feature of this embodiment, the partitioning member (5) reduces variations in the amount of the refrigerant flowing in the stacking direction of the plate stack (30), thereby making it possible to increase the heat exchange efficiency of the plate stack (30) as a whole.

[0098] According to a feature of this embodiment, the first channel (56) guides the refrigerant that has flowed in through the refrigerant inlet (21) to the spaces under the first heat exchange section (36) and the second heat exchange section (37), and the refrigerant that has passed through the first channel (56) is guided to the space under the central heat exchange section (35). It is thus possible to reduce variations in the amount of the refrigerant flowing in the stacking direction of the plate stack (30).

[0099] According to a feature of this embodiment, appropriately setting the degree of dryness of the refrigerant and the mass flow rate of the liquid refrigerant in the stacking direction of the plate stack (30) can increase the heat exchange efficiency of the plate stack (30) as a whole.

[0100] According to a feature of this embodiment, providing the refrigerant inlet (21) at a central position in the first direction makes it possible to distribute the refrigerant that has flowed into the internal space (15) through the refrigerant inlet (21) uniformly toward both ends in the first direction.

[0101] According to a feature of this embodiment, a refrigeration apparatus includes: the shell-and-plate heat exchanger (10); and the refrigerant circuit (1a) through which the refrigerant to exchange heat in the shell-and-plate heat exchanger (10) flows. It is thus possible to provide a refrigeration apparatus including the shell-and-plate heat exchanger (10).

<<Second Embodiment>>

[0102] In the following description, the same reference characters designate the same components as those of the first embodiment, and the description is focused only on the difference.

[0103] As illustrated in FIG. 7, a heat exchanger (10) includes a partitioning member (5). The partitioning member (5) reduces a variation between the ratio between the liquid refrigerant and the gas refrigerant contained in the refrigerant made to exchange heat in the central heat exchange section (35) and the ratio between the liquid refrigerant and the gas refrigerant contained in the refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37).

[0104] The partitioning member (5) is disposed below the plate stack (30). The partitioning member (5) includes a first partition plate (61), a second partition plate (62), and a first sidewall portion (63).

[0105] As illustrated also in FIG. 8, the first partition plate (61) extends along the first direction. The second partition plate (62) is disposed below the first partition plate (61) and extends along the first direction. The first sidewall portion (63) extends along peripheral portions of the first partition plate (61) and the second partition plate (62), and couples the first partition plate (61) and the second partition plate (62) together.

[0106] Accordingly, the partitioning member (5) is a box-shaped member with an internal channel (55). The partitioning member (5) extends along the first direction between the first closing member (13) and the second closing member (14) in the internal space (15) of the shell (11).

[0107] A downstream end of the refrigerant inlet (21) is connected to the second partition plate (62). The refrigerant inlet (21) is disposed below the central heat exchange section (35) of the plate stack (30).

[0108] The refrigerant that has flowed into the internal channel (55) from the refrigerant inlet (21) flows through the internal channel (55). The internal channel (55) guides the refrigerant that has flowed into a space under the central heat exchange section (35) from the refrigerant inlet (21) to a space under each of the first heat exchange section (36) and the second heat exchange section (37).

[0109] The partitioning member (5) has first communication holes (68) and second communication holes (69). The first communication holes (68) are formed in the first partition plate (61). The second communication holes (69) are formed in the second partition plate (62).

[0110] The first communication holes (68) communicate with the internal channel (55) and are open toward the plate stack (30). The plurality of first communication holes (68) are spaced apart from one another in the first direction and in the second direction in the first partition plate (61) (see FIG. 9). The first communication holes (68) discharge the gas refrigerant contained in the refrigerant flowing through the internal channel (55).

[0111] In the example illustrated in FIG. 9, the pitch of the first communication holes (68) arranged in the first direction is changed as appropriate. Specifically, the pitch (P1) between the first communication holes (68) adjacent to each other near the refrigerant inlet (21) is set to be greater than the pitch (P2) between the first communication holes (68) adjacent to each other at end portions in the first direction.

[0112] Such a configuration makes it easier for the refrigerant to be discharged from end portions of the internal channel (55) in the first direction. It is thus possible to reduce the likelihood that most of the gas refrigerant that has flowed into the internal channel (55) from the refrigerant inlet (21) is discharged toward the central heat exchange section (35), and it becomes easier to distribute the refrigerant to the first heat exchange section (36) and the second heat exchange section (37) as well.

[0113] The second communication holes (69) communicate with the internal channel (55) and are open in a direction opposite to the plate stack (30). The plurality of second communication holes (69) are spaced apart from one another in the first direction and in the second direction in the second partition plate (62) (see FIG. 10). The second communication holes (69) discharge the liquid refrigerant contained in the refrigerant flowing through the internal channel (55).

[0114] In the example illustrated in FIG. 10, the pitch of the second communication holes (69) arranged in the first direction is changed as appropriate. Specifically, the pitch (P1) between the second communication holes (69) adjacent to each other near the refrigerant inlet (21) is set to be greater than the pitch (P2) between the second communication holes (69) adjacent to each other at end portions in the first direction.

[0115] Such a configuration makes it easier for the refrigerant to be discharged from end portions of the internal channel (55) in the first direction. It is thus possible to reduce the likelihood that most of the liquid refrigerant that has flowed into the internal channel (55) from the refrigerant inlet (21) is discharged toward the central heat exchange section (35), and it becomes easier to distribute the refrigerant to the first heat exchange section (36) and the second heat exchange section (37) as well.

[0116] The refrigerant heading toward the partitioning member (5) from the refrigerant inlet (21) passes through the internal channel (55) in the partitioning member (5) and flows along the first direction. It is thus possible to distribute the refrigerant among the central heat exchange section (35), the first heat exchange section (36), and the second heat exchange section (37) in the plate stack (30).

-Advantages of Second Embodiment-

[0117] According to a feature of this embodiment, the internal channel (55) guides the refrigerant that has flowed in from the refrigerant inlet (21) to the spaces under the first heat exchange section (36) and the second heat exchange section (37) and causes the gas refrigerant to flow out through the first communication holes (68) and the liquid refrigerant to flow out through the second communication holes (69). It is thus possible to reduce variations in the amount of the refrigerant flowing in the stacking direction of the plate stack (30).

<<Variation of Second Embodiment>>

[0118] In the example illustrated in FIG. 11, the first communication holes (68) are arranged at equal pitches in the first direction. Specifically, the pitch (P1) between the first communication holes (68) adjacent to each other near the refrigerant inlet (21) is set to be equal to the pitch (P2) between the first communication holes (68) adjacent to each other at end portions in the first direction.

[0119] In contrast, the diameters of the first communication holes (68) arranged in the first direction are changed as appropriate. Specifically, the first communication holes (68) at the end portions in the first direction each have a diameter d2 that is greater than the diameter d1 of the first communication hole (68) near the refrigerant inlet (21).

[0120] That is, among the plurality of communication holes (50), the diameter d1 of the communication holes (50) at positions closest to the refrigerant inlet (21) and the diameter d2 of the communication holes (50) at positions farthest from the refrigerant inlet (21) are set to satisfy the condition "d1 < d2."

[0121] Such a configuration makes it easier for the refrigerant to be discharged from end portions of the internal channel (55) in the first direction. It is thus possible to reduce the likelihood that most of the gas refrigerant that has flowed into the internal channel (55) from the refrigerant inlet (21) is discharged toward the central heat exchange section (35), and it becomes easier to distribute the refrigerant to the first heat exchange section (36) and the second heat exchange section (37) as well.

[0122] In the example illustrated in FIG. 10, the second communication holes (69) are arranged at equal pitches in the first direction. Specifically, the pitch (P1) between the second communication holes (69) adjacent to each other near the refrigerant inlet (21) is set to be equal to the pitch (P2) between the second communication holes (69) adjacent to each other at end portions in the first direction.

[0123] In contrast, the diameters of the second communication holes (69) arranged in the first direction are changed as appropriate. Specifically, the second communication holes (69) at the end portions in the first direction each have a diameter d2 that is greater than the diameter d1 of the second communication holes (69) near the refrigerant inlet (21).

[0124] Such a configuration makes it easier for the refrigerant to be discharged from end portions of the internal channel (55) in the first direction. It is thus possible to reduce the likelihood that most of the liquid refrigerant that has flowed into the internal channel (55) from the refrigerant inlet (21) is discharged toward the central heat exchange section (35), and it becomes easier to distribute the refrigerant to the first heat exchange section (36) and the second heat exchange section (37) as well.

<<Third Embodiment>>

[0125] As illustrated in FIG. 13, a heat exchanger (10) includes a partitioning member (5). The partitioning member (5) reduces a variation between the ratio between the liquid refrigerant and the gas refrigerant contained in the refrigerant made to exchange heat in the central heat exchange section (35) and the ratio between the liquid refrigerant and the gas refrigerant contained in the refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37).

[0126] The partitioning member (5) is disposed below the plate stack (30). The partitioning member (5) has an internal channel (55) through which the refrigerant that has flowed in from the refrigerant inlet (21) flows. The partitioning member (5) includes a first partition plate (61), a second partition plate (62), a first sidewall portion (63), and a second sidewall portion (64). The internal channel (55) includes an upper channel (76) and a lower channel (77).

[0127] As illustrated also in FIG. 14, the first partition plate (61) extends along the first direction. The second partition plate (62) is disposed below the first partition plate (61) and extends along the first direction. The first sidewall portion (63) extends along peripheral portions of the first partition plate (61) and the second partition plate (62), and couples the first partition plate (61) and the second partition plate (62) together. The second sidewall portion (64) extends downward from the peripheral portions of the second partition plate (62). A lower end portion of the second sidewall portion (64) is in contact with the inner peripheral surface of the cylindrical body (12) of the shell (11).

[0128] Thus, the upper channel (76) is formed by the first partition plate (61), the second partition plate (62), and the first sidewall portion (63). The lower channel (77) is formed by the second partition plate (62), the second sidewall portion (64), and the cylindrical body (12).

[0129] The refrigerant inlet (21) communicates with the lower channel (77). The refrigerant that has flowed into the lower channel (77) from the refrigerant inlet (21) flows through the lower channel (77). The refrigerant inlet (21) is formed in a lower portion of the shell (11) at a central position in the stacking direction of the plate stack (30).

[0130] The partitioning member (5) has upper communication holes (78) and lower communication holes (79). The upper communication holes (78) are formed in the first partition plate (61). The lower communication holes (79) are formed in the second partition plate (62).

[0131] The upper communication holes (78) communicate with the upper channel (76) and are open toward the plate stack (30). The plurality of upper communication holes (78) are spaced apart from one another in the first direction and in the second direction in the first partition plate (61) (see FIG. 15). The upper communication holes (78) discharge the refrigerant flowing through the upper channel (76).

[0132] The lower communication holes (79) allow the lower channel (77) and the upper channel (76) to communicate with each other. The plurality of lower communication holes (79) are spaced apart from one another in the first direction and in the second direction in the second partition plate (62) (see FIG. 16). The number of lower communication holes (79) is less than the number of the upper communication holes (78). The lower communication holes (79) are open at positions away from the refrigerant inlet (21). The lower communication holes (79) discharge the refrigerant flowing through the lower channel (77) to the upper channel (76).

[0133] As illustrated also in FIG. 17, the refrigerant that has flowed into the lower channel (77) from the refrigerant inlet (21) flows through the lower channel (77). The lower channel (77) guides the refrigerant that has flowed into a space under the central heat exchange section (35) from the refrigerant inlet (21) to a space under each of the first heat exchange section (36) and the second heat exchange section (37).

[0134] The refrigerant that has flowed into the lower channel (77) flows toward the upper channel (76) from the lower communication holes (79). The upper channel (76) guides the refrigerant that has flowed into spaces under the first heat exchange section (36) and the second heat exchange section (37) from the lower communication holes (79) to spaces under the central heat exchange section (35), the first heat exchange section (36), and the second heat exchange section (37). The refrigerant flowing through the upper channel (76) is discharged from the upper communication holes (78) toward the plate stack (30).

-Advantages of Third Embodiment-

[0135] According to a feature of this embodiment, the refrigerant that has flowed in from the refrigerant inlet (21) is made to flow through the lower channel (77) in the stacking direction of the plate stack (30), and is then guided by the upper channel (76) to the spaces under the first heat exchange section (36) and the second heat exchange section (37). It is thus possible to stir the liquid refrigerant and the gas refrigerant contained in the refrigerant and reduce variations in the amount of the refrigerant flowing in the stacking direction of the plate stack (30).

<<Fourth Embodiment>>

[0136] As illustrated in FIG. 18, a heat exchanger (10) includes a partitioning member (5). The partitioning member (5) reduces a variation between the ratio between the liquid refrigerant and the gas refrigerant contained in the refrigerant made to exchange heat in the central heat exchange section (35) and the ratio between the liquid refrigerant and the gas refrigerant contained in the refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37).

[0137] Specifically, the partitioning member (5) is disposed below the plate stack (30). The partitioning member (5) includes a first partition plate (61), a stirring member (82), and first sidewall portions (63).

[0138] The first partition plate (61) serves as a partition between the plate stack (30) and the refrigerant inlet (21). The first partition plate (61) extends along the first direction between the first closing member (13) and the second closing member (14) in the internal space (15) of the shell (11).

[0139] The first sidewall portions (63) are edge portions of the first partition plate (61) in the second direction which are bent to incline downward. Both ends of the first sidewall portions (63) in the second direction are in contact with the inner peripheral surface of the cylindrical body (12) of the shell (11).

[0140] Thus, the partitioning member (5) has an internal channel (55). The internal channel (55) extends along the stacking direction of the plate stack (30). The refrigerant that has flowed into the internal channel (55) from the refrigerant inlet (21) flows through the internal channel (55). The internal channel (55) is formed in a space surrounded by the first partition plate (61), the first sidewall portions (63), the cylindrical body (12), the first closing member (13), and the second closing member (14).

[0141] The stirring member (82) is disposed in the internal channel (55). The stirring member (82) is made of a porous material, such as a mesh material. The gas refrigerant and the liquid refrigerant contained in the refrigerant flowing through the internal channel (55) are stirred while passing through the stirring member (82).

[0142] As illustrated also in FIG. 20, the partitioning member (5) has communication holes (50). The communication holes (50) are formed in the first partition plate (61). The communication holes (50) communicate with the internal channel (55) and are open toward the plate stack (30). The plurality of communication holes (50) are spaced apart from one another in the first direction and in the second direction in the first partition plate (61). The communication holes (50) discharge the refrigerant flowing through the internal channel (55).

-Advantages of Fourth Embodiment-

[0143] According to a feature of this embodiment, the liquid refrigerant and the gas refrigerant contained in the refrigerant that has flowed in from the refrigerant inlet (21) are stirred by the stirring member (82) while flowing in the stacking direction of the plate stack (30). It is thus possible to reduce variations in the ratio between the liquid refrigerant and the gas refrigerant in the stacking direction of the plate stack (30).

<<Fifth Embodiment>>

[0144] In the following description, the same reference characters designate the same components as those of the first embodiment, and the description is focused only on the difference.

[0145] As illustrated in FIGS. 21 and 22, a partitioning member (5) includes a first partition plate (61), a pair of guide plates (52), and first sidewall portions (63). The partitioning member (5) has an internal channel (55). The internal channel (55) extends along the first direction. The internal channel (55) includes a first channel (56) and second channels (57).

[0146] The partitioning member (5) has a plurality of communication holes (50). The communication holes (50) include first communication holes (58) and second communication holes (59). The first communication holes (58) and the second communication holes (59) are formed in the first partition plate (61).

[0147] The first communication holes (58) communicate with the first channel (56). The plurality of first communication holes (58) are spaced apart from one another in the first direction and in the second direction in the first partition plate (61). The second communication holes (59) communicate with the second channels (57). The plurality of second communication holes (59) are spaced apart from one another in the first direction in the first partition plate (61).

[0148] The refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted in the first direction from a central position in the first direction. One end of the first partition plate (61) in the first direction is referred to as a "first end (91)," and the other end is referred to as a "second end (92)." The distance from the refrigerant inlet (21) to the first end (91) is longer than the distance from the refrigerant inlet (21) to the second end (92).

[0149] Here, when viewed in the plate thickness direction of the first partition plate (61), a region of the first partition plate (61) closer to the first end (91) than the refrigerant inlet (21) is referred to as a "first region," and a region of the first partition plate (61) closer to the second end (92) than the refrigerant inlet (21) is referred to as a "second region." The first region and the second region are a left region and a right region, respectively, separated from each other by the centerline passing through the center of the refrigerant inlet (21).

[0150] Among the plurality of communication holes (50), the diameter d3 of the communication holes (50) formed in the first region and the diameter d4 of the communication holes (50) formed in the second region are set to satisfy the condition "d3 > d4."

-Advantages of Fifth Embodiment-

[0151] According to a feature of this embodiment, the diameters of the communication holes (50) are set so that the refrigerant can flow to the communication holes (50) far from the refrigerant inlet (21) easily. It is thus possible to reduce variations in the distribution amount of the refrigerant.

<<Sixth Embodiment>>

[0152] In the following description, the same reference characters designate the same components as those of the first embodiment, and the description is focused only on the difference.

[0153] As illustrated in FIGS. 23 and 24, a partitioning member (5) includes a first partition plate (61), a pair of guide plates (52), and first sidewall portions (63). The partitioning member (5) has an internal channel (55). The internal channel (55) extends along the first direction. The internal channel (55) includes a first channel (56) and second channels (57).

[0154] The partitioning member (5) has a plurality of communication holes (50). The communication holes (50) include first communication holes (58) and second communication holes (59). The first communication holes (58) and the second communication holes (59) are formed in the first partition plate (61).

[0155] The first communication holes (58) communicate with the first channel (56). The plurality of first communication holes (58) are spaced apart from one another in the first direction and in the second direction in the first partition plate (61). The second communication holes (59) communicate with the second channels (57). The plurality of second communication holes (59) are spaced apart from one another in the first direction in the first partition plate (61).

[0156] The refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted in the first direction from a central position in the first direction. One end of the first partition plate (61) in the first direction is referred to as a "first end (91)," and the other end is referred to as a "second end (92)." The distance from the refrigerant inlet (21) to the first end (91) is longer than the distance from the refrigerant inlet (21) to the second end (92).

[0157] Here, when viewed in the plate thickness direction of the first partition plate (61), a region of the first partition plate (61) closer to the first end (91) than the refrigerant inlet (21) is referred to as a "first region," and a region of the first partition plate (61) closer to the second end (92) than the refrigerant inlet (21) is referred to as a "second region."

[0158] The channel width L1 of the first channel (56) in the first region and the channel width L2 of the first channel (56) in the second region are set to satisfy the condition "L1 > L2."

[0159] Specifically, the channel width of the first channel (56) in the first region is constant. The channel width of the first channel (56) in the second region is narrowest at the end portion near the second end (92). The channel width of the first channel (56) gradually becomes narrower from the first region toward the second region. In other words, in the first channel (56), the refrigerant flows more easily in the first region where the channel width is wider, than in the second region where the channel width is narrower.

-Advantages of Sixth Embodiment-

[0160] According to a feature of this embodiment, the channel widths of the first channel (56) in the first region and the second region are set so that the refrigerant can flow to the first channel (56) in the first region distant from the refrigerant inlet (21) easily. It is thus possible to reduce variations in the distribution amount of the refrigerant.

<<Seventh Embodiment>>

[0161] In the following description, the same reference characters designate the same components as those of the second embodiment, and the description is focused only on the difference.

[0162] As illustrated in FIGS. 25 and 26, a partitioning member (5) includes a first partition plate (61), a second partition plate (62), and a first sidewall portion (63). The partitioning member (5) has an internal channel (55). The internal channel (55) extends along the first direction.

[0163] A downstream end of the refrigerant inlet (21) is connected to the second partition plate (62). The refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted in the first direction from a central position in the first direction.

[0164] The partitioning member (5) has a plurality of communication holes (50). The communication holes (50) include first communication holes (68) and second communication holes (69). The first communication holes (68) are spaced apart from one another in the first direction and in the second direction in the first partition plate (61). The plurality of second communication holes (69) are spaced apart from one another in the first direction and in the second direction in the second partition plate (62).

[0165] One end of the first partition plate (61) in the first direction is referred to as a "first end (91)," and the other end is referred to as a "second end (92)." The distance from the refrigerant inlet (21) to the first end (91) is longer than the distance from the refrigerant inlet (21) to the second end (92).

[0166] Here, when viewed in the plate thickness direction of the first partition plate (61), a region of the first partition plate (61) closer to the first end (91) than the refrigerant inlet (21) is referred to as a "first region," and a region of the first partition plate (61) closer to the second end (92) than the refrigerant inlet (21) is referred to as a "second region."

[0167] Among the communication holes (50) formed in the first partition plate (61), the diameter d3 of the first communication holes (68) formed in the first region and the diameter d4 of the first communication holes (68) formed in the second region are set to satisfy the condition "d3 > d4."

[0168] Further, among the communication holes (50) formed in the second partition plate (62), the diameter d5 of the second communication holes (69) formed in the first region and the diameter d6 of the second communication holes (69) formed in the second region are set to satisfy the condition "d5 > d6."

-Advantages of Seventh Embodiment-

[0169] According to a feature of this embodiment, the diameters of the communication holes (50) in the first region and the second region are set so that the refrigerant can flow to the communication holes (50) of the first partition plate (61) and the second partition plate (62) in the first region distant from the refrigerant inlet (21) easily. It is thus possible to reduce variations in the distribution amount of the refrigerant.

<<Eighth Embodiment>>

[0170] In the following description, the same reference characters designate the same components as those of the third embodiment, and the description is focused only on the difference.

[0171] As illustrated in FIGS. 27 and 28, a partitioning member (5) includes a first partition plate (61), a second partition plate (62), a first sidewall portion (63), and a second sidewall portion (64). The partitioning member (5) has an internal channel (55). The internal channel (55) extends along the first direction. The internal channel (55) includes an upper channel (76) and a lower channel (77).

[0172] The refrigerant inlet (21) communicates with the lower channel (77). The refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted from a central position in the first direction.

[0173] The partitioning member (5) has a plurality of communication holes (50). The communication holes (50) include upper communication holes (78) and lower communication holes (79). The plurality of upper communication holes (78) are spaced apart from one another in the first direction and in the second direction in the first partition plate (61). The upper communication holes (78) communicate with the upper channel (76). The plurality of lower communication holes (79) are spaced apart from one another in the first direction and in the second direction in the second partition plate (62). The lower communication holes (79) communicate with the upper channel (76) and the lower channel (77).

[0174] One end of the second partition plate (62) in the first direction is referred to as a "first end (91)," and the other end is referred to as a "second end (92)." The distance from the refrigerant inlet (21) to the first end (91) is longer than the distance from the refrigerant inlet (21) to the second end (92).

[0175] Here, when viewed in the plate thickness direction of the second partition plate (62), a region of the second partition plate (62) closer to the first end (91) than the refrigerant inlet (21) is referred to as a "first region," and a region of the second partition plate (62) closer to the second end (92) than the refrigerant inlet (21) is referred to as a "second region."

[0176] Among the plurality of lower communication holes (79), the diameter d5 of the lower communication holes (79) formed in the first region and the diameter d6 of the lower communication holes (79) formed in the second region are set to satisfy the condition "d5 > d6."

-Advantages of Eighth Embodiment-

[0177] According to a feature of this embodiment, the diameters of the lower communication holes (79) in the first region and the second region are set so that the refrigerant can flow to the lower communication holes (79) of the second partition plate (62) in the first region distant from the refrigerant inlet (21) easily. It is thus possible to reduce variations in the distribution amount of the refrigerant.

<<Ninth Embodiment>>

[0178] In the following description, the same reference characters designate the same components as those of the fourth embodiment, and the description is focused only on the difference.

[0179] As illustrated in FIG. 29, a partitioning member (5) includes a first partition plate (61), a stirring member (82), and first sidewall portions (63). The partitioning member (5) has an internal channel (55). The internal channel (55) extends along the first direction.

[0180] The refrigerant inlet (21) communicates with the internal channel (55). The refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted from a central position in the first direction.

[0181] The partitioning member (5) has a plurality of communication holes (50). The plurality of communication holes (50) are spaced apart from one another in the first direction and in the second direction in the first partition plate (61). The communication holes (50) communicate with the internal channel (55).

[0182] One end of the first partition plate (61) in the first direction is referred to as a "first end (91)," and the other end is referred to as a "second end (92)." The distance from the refrigerant inlet (21) to the first end (91) is longer than the distance from the refrigerant inlet (21) to the second end (92).

[0183] Here, when viewed in the plate thickness direction of the first partition plate (61), a region of the first partition plate (61) closer to the first end (91) than the refrigerant inlet (21) is referred to as a "first region," and a region of the first partition plate (61) closer to the second end (92) than the refrigerant inlet (21) is referred to as a "second region."

[0184] Among the plurality of communication holes (50), the diameter d3 of the communication holes (50) formed in the first region and the diameter d4 of the communication holes (50) formed in the second region are set to satisfy the condition "d3 > d4."

-Advantages of Ninth Embodiment-

[0185] According to a feature of this embodiment, the diameters of the communication holes (50) in the first region and the second region are set so that the refrigerant can flow to the communication holes (50) of the first partition plate (61) in the first region distant from the refrigerant inlet (21) easily. It is thus possible to reduce variations in the distribution amount of the refrigerant.

<<Other Embodiments>>

[0186] While the embodiments and variations have been described above, it will be understood that various changes in form and details can be made without departing from the spirit and scope of the claims. The elements according to embodiments, the variations thereof, and the other embodiments may be combined and replaced with each other. In addition, the expressions of "first," "second," "third," ... , in the specification and claims are used to distinguish the terms to which these expressions are given, and do not limit the number and order of the terms.

INDUSTRIAL APPLICABILITY

[0187] As can be seen from the foregoing description, the present disclosure is useful for a shell-and-plate heat exchanger and a refrigeration apparatus.

DESCRIPTION OF REFERENCE CHARACTERS

[0188]

1	Refrigeration Apparatus
1a	Refrigerant Circuit
5	Partitioning Member
10	Shell-and-Plate Heat Exchanger
11	Shell
15	Internal Space
21	Refrigerant Inlet
30	Plate Stack

32 Heating Medium Channel
35 Central Heat Exchange Section
36 First Heat Exchange Section
37 Second Heat Exchange Section
40 Heat Transfer Plate
50 Communication Hole
55 Internal Channel
56 First Channel
57 Second Channel
58 First Communication Hole
59 Second Communication Hole
68 First Communication Hole
69 Second Communication Hole
76 Upper Channel
77 Lower Channel
78 Upper Communication Hole
79 Lower Communication Hole
82 Stirring Member
91 First End
92 Second End

Claims

1. A shell-and-plate heat exchanger, comprising: a shell (11) having an internal space (15); and a plate stack (30) housed in the internal space (15) and including a plurality of heat transfer plates (40) stacked and joined together, the shell-and-plate heat exchanger causing heat exchange between a refrigerant that has flowed into the internal space (15) of the shell (11) and a heating medium that has flowed into a heating medium channel (32) of the plate stack (30),

the shell-and-plate heat exchanger further comprising: a refrigerant inlet (21) provided in a lower portion of the shell (11) and allowing the refrigerant to flow into the internal space (15); and
a partitioning member (5) arranged between the plate stack (30) and the refrigerant inlet (21), the partitioning member (5) extending along a first direction that is a stacking direction of the plate stack (30), wherein
if the plate stack (30) is assumed to be equally divided into three sections in the first direction, a section in the middle in the first direction is referred to as a central heat exchange section (35), a section closer to one end in the first direction than the central heat exchange section (35) is referred to as a first heat exchange section (36), and a section closer to the other end in the first direction than the central heat exchange section (35) is referred to as a second heat exchange section (37), and
the partitioning member (5) has a plurality of communication holes (50) that are open toward the plate stack (30) at positions facing the central heat exchange section (35), the first heat exchange section (36), and the second heat exchange section (37).

2. The shell-and-plate heat exchanger of claim 1, wherein

the partitioning member (5) includes a first partition plate (61) extending along the first direction,
an internal channel (55) through which the refrigerant that has flowed in from the refrigerant inlet (21) flows is formed below the first partition plate (61),
the internal channel (55) includes:

a first channel (56) extending along the first direction, the first channel (56) guiding the refrigerant that has flowed in from the refrigerant inlet (21) to spaces under the first heat exchange section (36) and the second heat exchange section (37); and
a second channel (57) guiding the refrigerant that has turned back at ends of the first channel (56) in the first direction and passed through the first channel (56) to a space under the central heat exchange section (35), and
the communication holes (50) include:

a first communication hole (58) formed in the first partition plate (61), the first communication hole (58) communicating with the first channel (56) and being open toward the plate stack (30); and
a second communication hole (59) formed in the first partition plate (61), the second communication hole (59) communicating with the second channel (57) and being open toward the plate stack (30).

3. The shell-and-plate heat exchanger of claim 1, wherein

the partitioning member (5) includes a first partition plate (61) extending along the first direction, and a second partition plate (62) disposed below the first partition plate (61) and extending along the first direction,
a downstream end of the refrigerant inlet (21) is connected to the second partition plate (62),
an internal channel (55) through which the refrigerant that has flowed in from the refrigerant inlet (21) flows is formed between the first partition plate (61) and the second partition plate (62),
the communication holes (50) include a first communication hole (68) formed in the first par-

tition plate (61), the first communication hole (68) communicating with the internal channel (55) and being open toward the plate stack (30), and

the second partition plate (62) has a plurality of second communication holes (69) communicating with the internal channel (55) and being open in a direction opposite to the plate stack (30).

4. The shell-and-plate heat exchanger of claim 1, wherein

the partitioning member (5) includes a first partition plate (61) extending along the first direction,

an internal channel (55) through which the refrigerant that has flowed in from the refrigerant inlet (21) flows is formed below the first partition plate (61),

the communication holes (50) are formed in the first partition plate (61), the communication holes (50) communicating with the internal channel (55) and being open toward the plate stack (30), and

the shell-and-plate heat exchanger further includes a stirring member (82) disposed in the internal channel (55) and configured to stir a liquid refrigerant and a gas refrigerant contained in the refrigerant.

5. The shell-and-plate heat exchanger of claim 1, wherein

the partitioning member (5) includes a first partition plate (61) extending along the first direction, and a second partition plate (62) disposed below the first partition plate (61) and extending along the first direction,

an upper channel (76) is formed between the first partition plate (61) and the second partition plate (62),

a lower channel (77) through which the refrigerant that has flowed in from the refrigerant inlet (21) flows is formed below the second partition plate (62),

the communication holes (50) include an upper communication hole (78) formed in the first partition plate (61), the upper communication hole (78) communicating with the upper channel (76) and being open toward the plate stack (30), and the second partition plate (62) has a plurality of lower communication holes (79) communicating with the upper channel (76) and the lower channel (77).

6. The shell-and-plate heat exchanger of any one of claims 1 to 5, wherein

a variation between a degree of dryness of the refrigerant made to exchange heat in the central heat exchange section (35) and a degree of dryness of the refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37) is 70% or less, and

a variation between a mass flow rate of a liquid refrigerant made to exchange heat in the central heat exchange section (35) and a mass flow rate of the liquid refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37) is 30% or less.

7. The shell-and-plate heat exchanger of claim 6, wherein

the variation between the degree of dryness of the refrigerant made to exchange heat in the central heat exchange section (35) and the degree of dryness of the refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37) is 40% or less, and

the variation between the mass flow rate of the liquid refrigerant made to exchange heat in the central heat exchange section (35) and the mass flow rate of the liquid refrigerant made to exchange heat in each of the first heat exchange section (36) and the second heat exchange section (37) is 20% or less.

8. The shell-and-plate heat exchanger of any one of claims 1 to 7, wherein the refrigerant inlet (21) is formed in a lower portion of the shell (11) at a central position in the first direction.

9. The shell-and-plate heat exchanger of any one of claims 1 to 7, wherein the refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted in the first direction from a central position in the first direction.

10. The shell-and-plate heat exchanger of any one of claims 1 to 9, wherein among the plurality of communication holes (50), a diameter d1 of the communication holes (50) at positions closest to the refrigerant inlet (21) and a diameter d2 of the communication holes (50) at positions farthest from the refrigerant inlet (21) are set to satisfy a condition "d1 < d2."

11. The shell-and-plate heat exchanger of any one of claims 1 to 4, wherein

the partitioning member (5) includes a first partition plate (61) extending along the first direction,

the refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted in the first direction from a central position in the first direction,

one end of the first partition plate (61) in the first direction is referred to as a first end (91), and the other end is referred to as a second end (92),

a distance from the refrigerant inlet (21) to the first end (91) is longer than a distance from the refrigerant inlet (21) to the second end (92),

when viewed in a plate thickness direction of the first partition plate (61), a region of the first partition plate (61) closer to the first end (91) than the refrigerant inlet (21) is referred to as a first region, and a region of the first partition plate (61) closer to the second end (92) than the refrigerant inlet (21) is referred to as a second region, and

among the plurality of communication holes (50), a diameter d3 of the communication holes (50) formed in the first region and a diameter d4 of the communication holes (50) formed in the second region are set to satisfy a condition "d3 > d4."

12. The shell-and-plate heat exchanger of claim 5, wherein

the refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted in a stacking direction from a central position in the first direction,

one end of the second partition plate (62) in the first direction is referred to as a first end (91), and the other end is referred to as a second end (92),

a distance from the refrigerant inlet (21) to the first end (91) is longer than a distance from the refrigerant inlet (21) to the second end (92),

when viewed in a plate thickness direction of the second partition plate (62), a region of the second partition plate (62) closer to the first end (91) than the refrigerant inlet (21) is referred to as a first region, and a region of the second partition plate (62) closer to the second end (92) than the refrigerant inlet (21) is referred to as a second region, and

among the plurality of lower communication holes (79), a diameter d5 of the lower communication holes (79) formed in the first region and a diameter d6 of the lower communication holes (79) formed in the second region are set to satisfy a condition "d5 > d6."

13. The shell-and-plate heat exchanger of claim 2, wherein

the refrigerant inlet (21) is formed in a lower portion of the shell (11) at a position shifted in the first direction from a central position in the first direction,

one end of the first partition plate (61) in the first direction is referred to as a first end (91), and the other end is referred to as a second end (92),

a distance from the refrigerant inlet (21) to the first end (91) is longer than a distance from the refrigerant inlet (21) to the second end (92),

when viewed in a plate thickness direction of the first partition plate (61), a region of the first channel (56) closer to the first end (91) than the refrigerant inlet (21) is referred to as a first region, and a region of the first channel (56) closer to the second end (92) than the refrigerant inlet (21) is referred to a second region, and

a channel width L1 of the first region and a channel width L2 of the second region satisfy a condition "L1 > L2."

14. A refrigeration apparatus, comprising:

the shell-and-plate heat exchanger (10) of any one of claims 1 to 13; and

a refrigerant circuit (1a) through which a refrigerant to exchange heat in the shell-and-plate heat exchanger (10) flows.

FIG.1

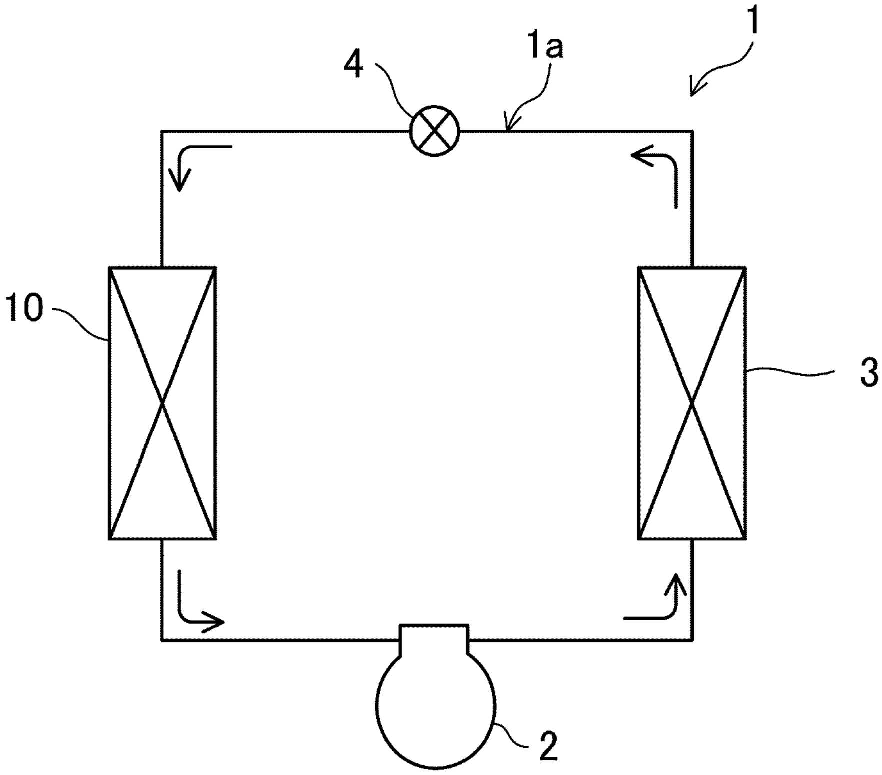


FIG.2

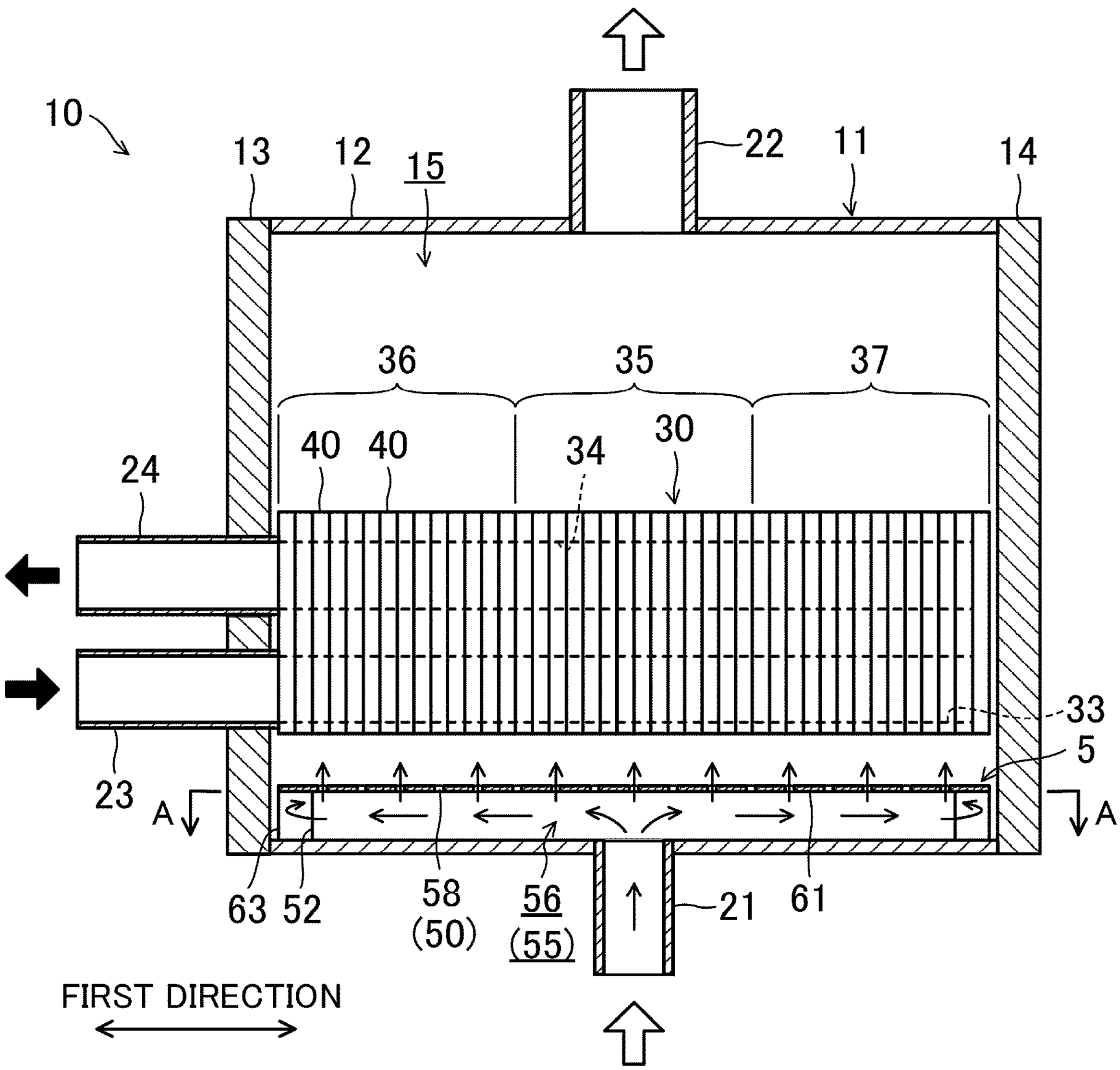

10
13
12
15
22
11
14
36
35
37
40
40
34
30
24
33
5
23
A
A
63
52
58
(50)
56
(55)
21
61
FIRST DIRECTION

FIG.3

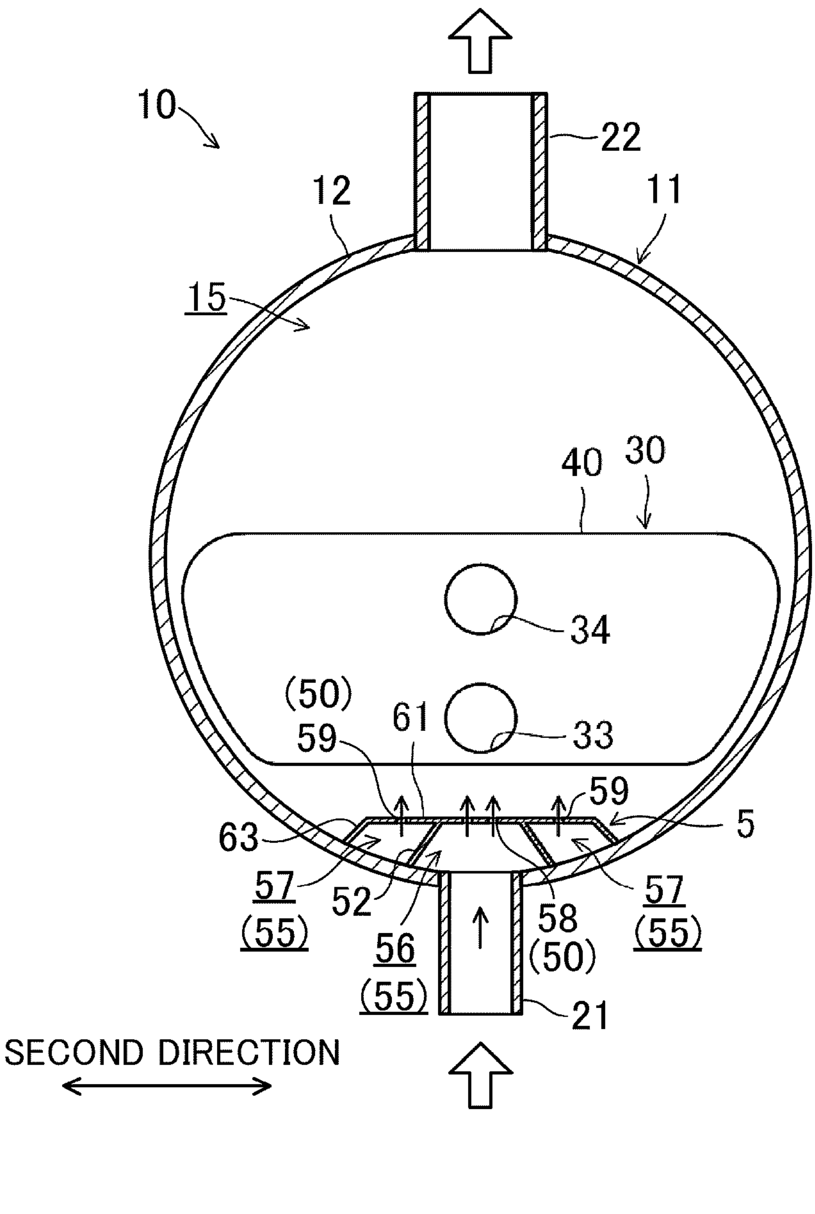

10
22
12
11
15
40
30
34
(50)
59
61
33
59
5
63
57
(55)
52
56
(55)
58
(50)
57
(55)
21
SECOND DIRECTION

FIG.4

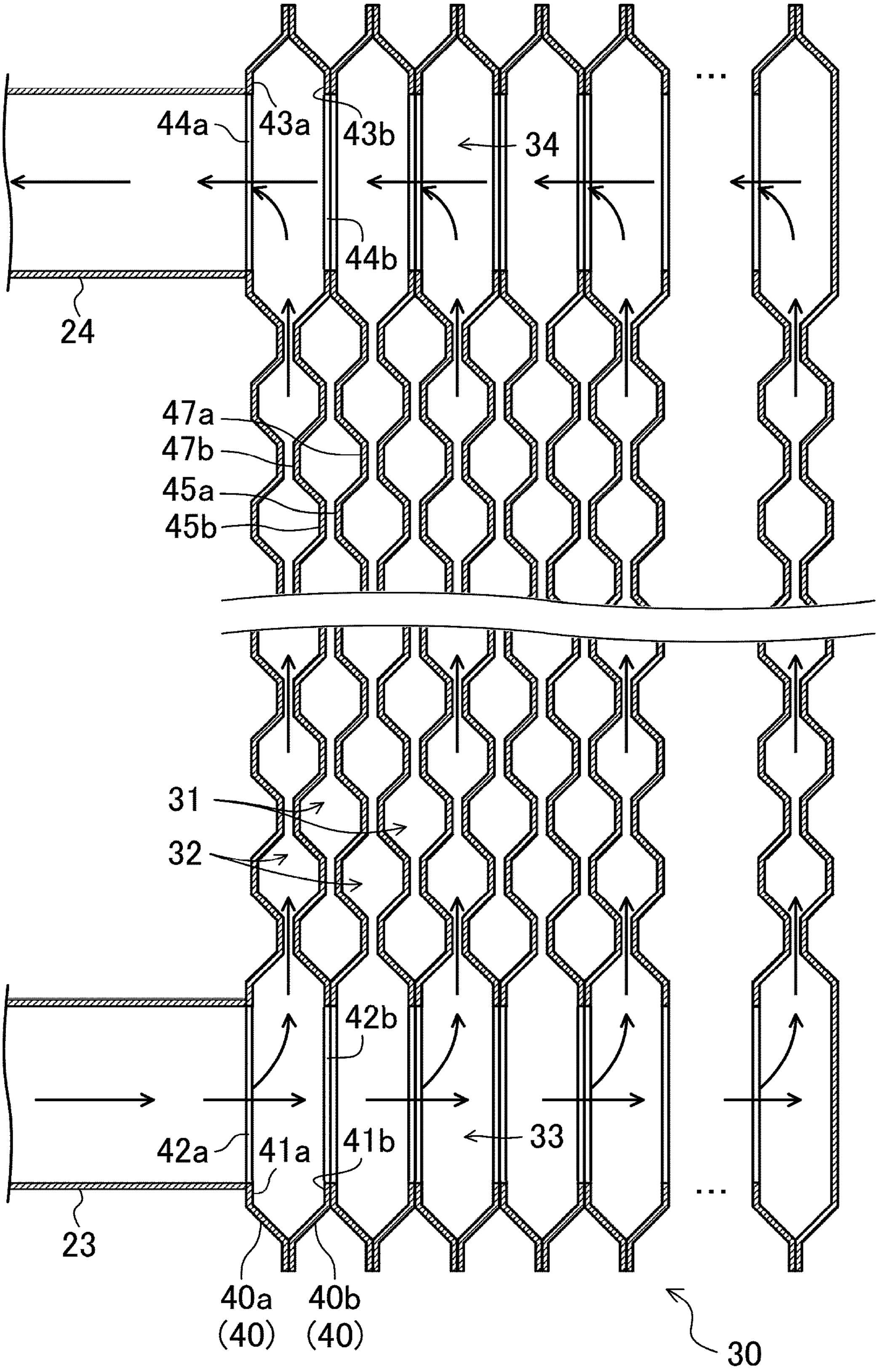

43a
43b
44a
34
44b
24
47a
47b
45a
45b
31
32
42b
42a
41a
41b
33
23
40a
(40)
40b
(40)
30

FIG.5

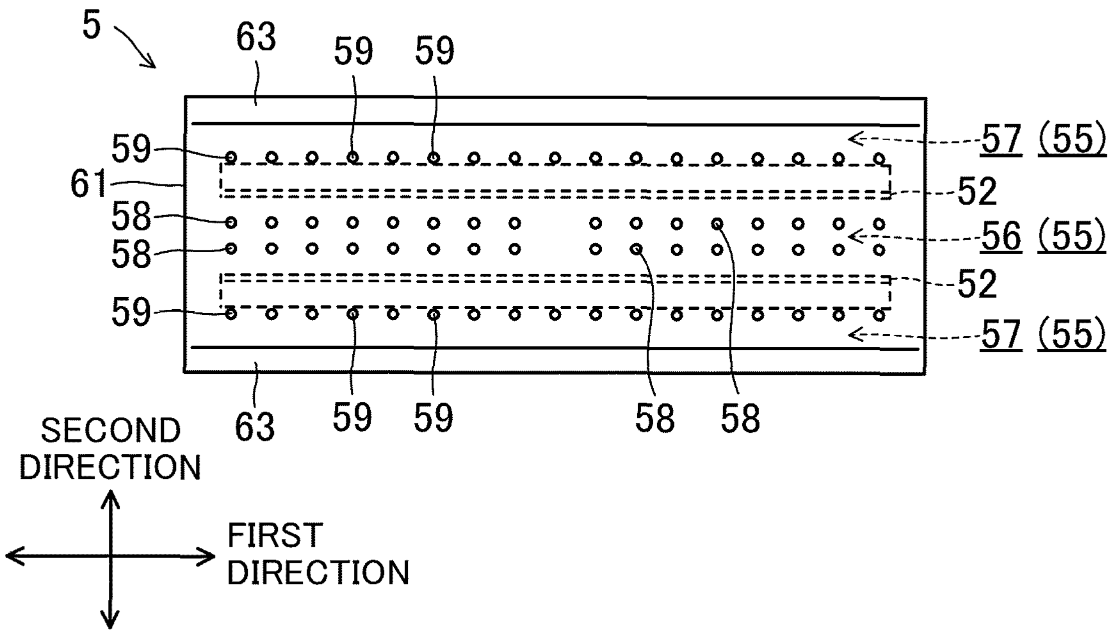

5
63
59
59
59
61
58
58
59
57 (55)
52
56 (55)
52
57 (55)
63
59
59
58
58
SECOND DIRECTION
FIRST DIRECTION

FIG.6

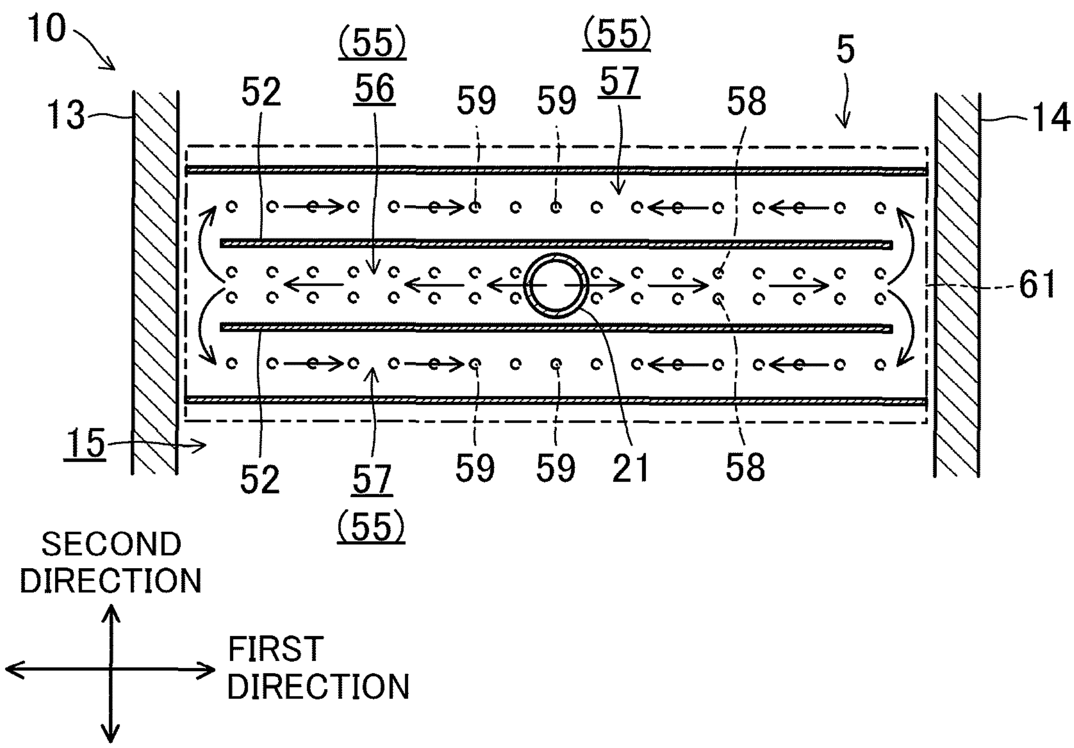

10
13
52
(55)
56
59
59
(55)
57
58
5
14
61
15
52
57
(55)
59
59
21
58
SECOND DIRECTION
FIRST DIRECTION

FIG.7

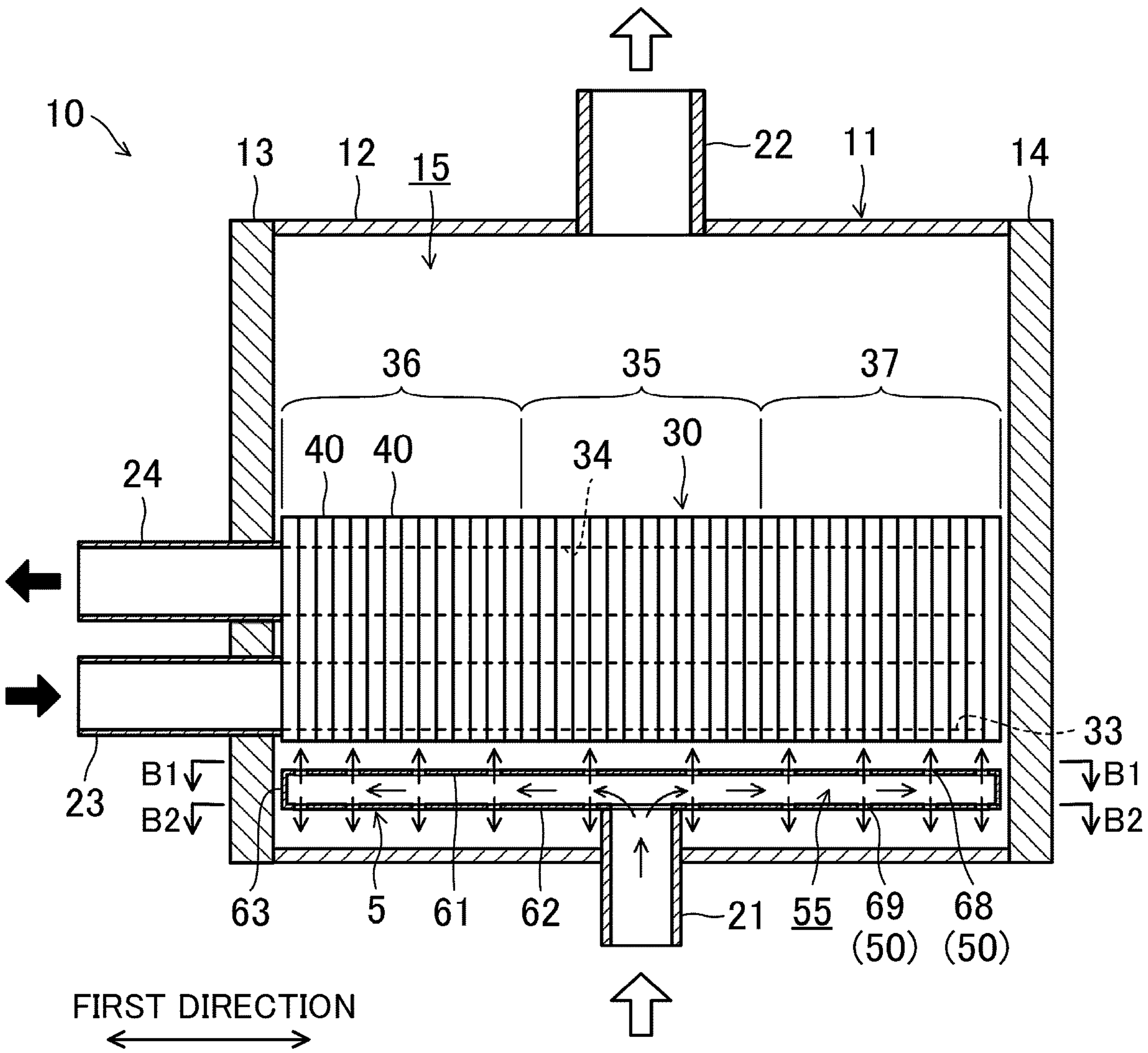

10
13
12
15
22
11
14
36
35
37
40
40
34
30
24
33
B1
B2
B1
B2
23
63
5
61
62
21
55
69
(50)
68
(50)
FIRST DIRECTION

FIG.8

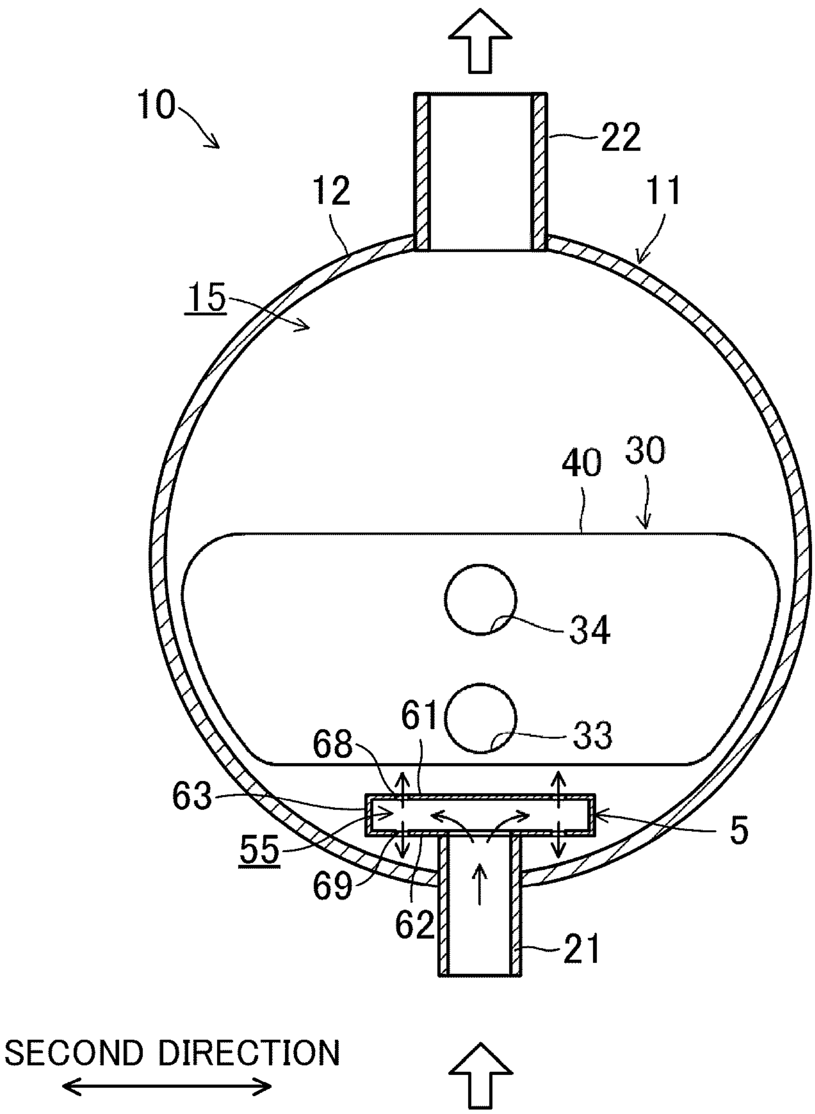


FIG.9

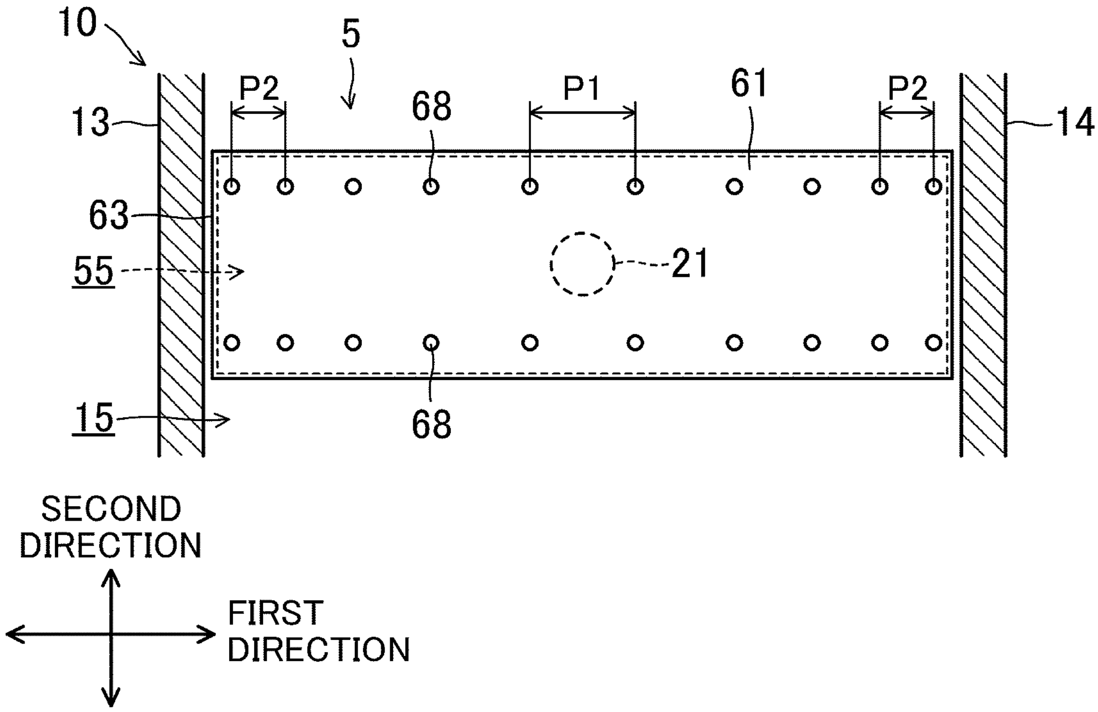

10
5
P2
68
P1
61
P2
13
14
63
55
21
68
15
SECOND DIRECTION
FIRST DIRECTION

FIG.10

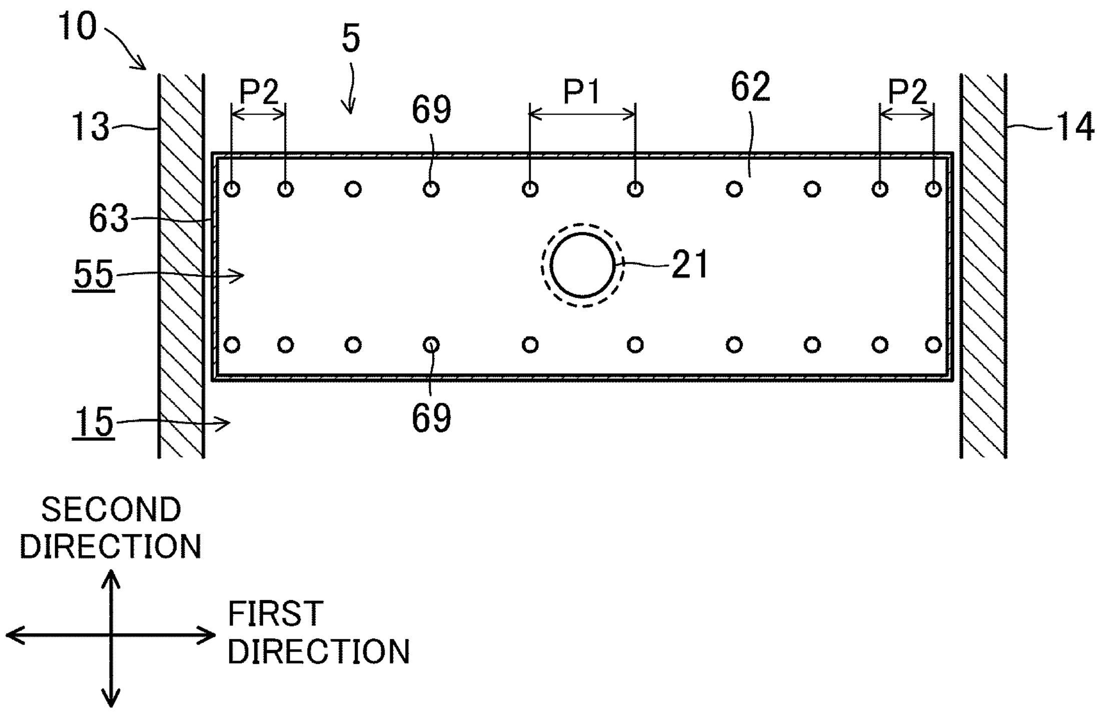
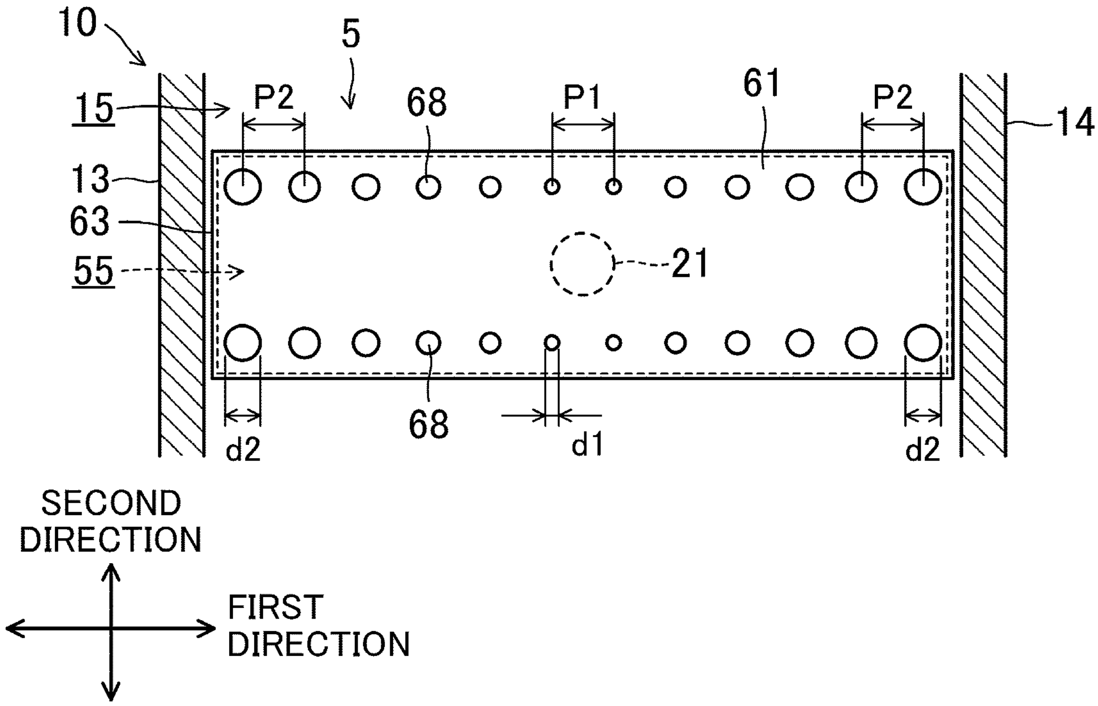
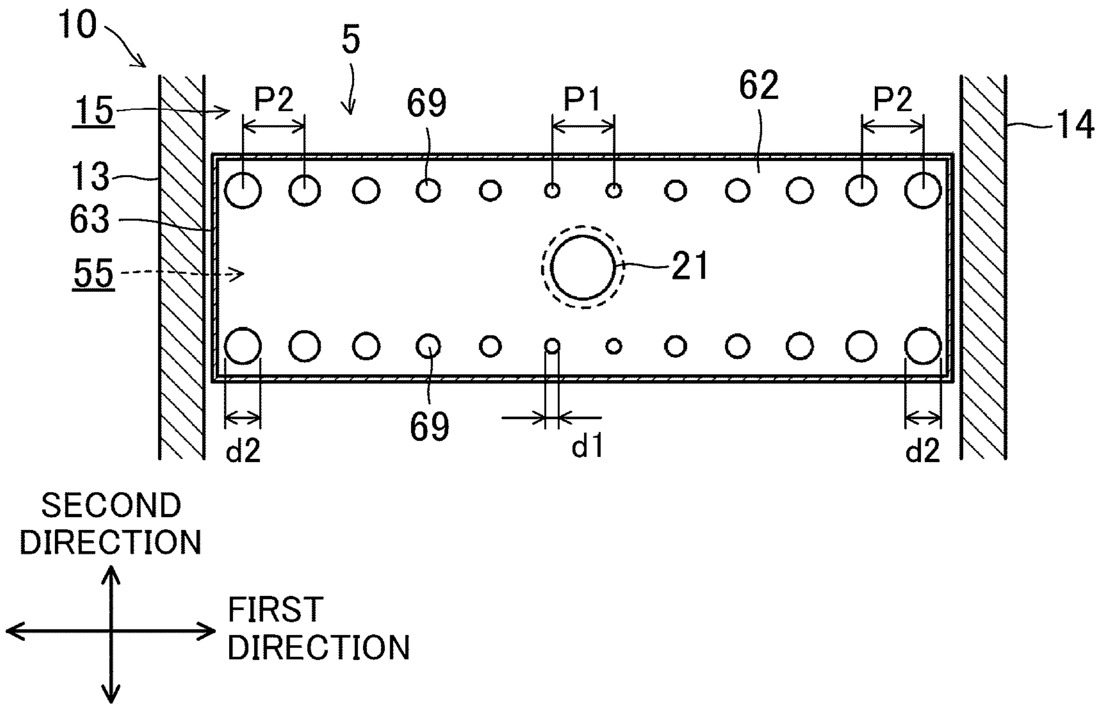

10
5
P2
69
P1
62
P2
13
14
63
55
21
69
15
SECOND DIRECTION
FIRST DIRECTION

FIG.11



10
5
15
P2
68
P1
61
P2
14
13
63
55
21
68
d2
d1
d2
SECOND DIRECTION
FIRST DIRECTION

FIG.12



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15
P2
69
P1
62
P2
14
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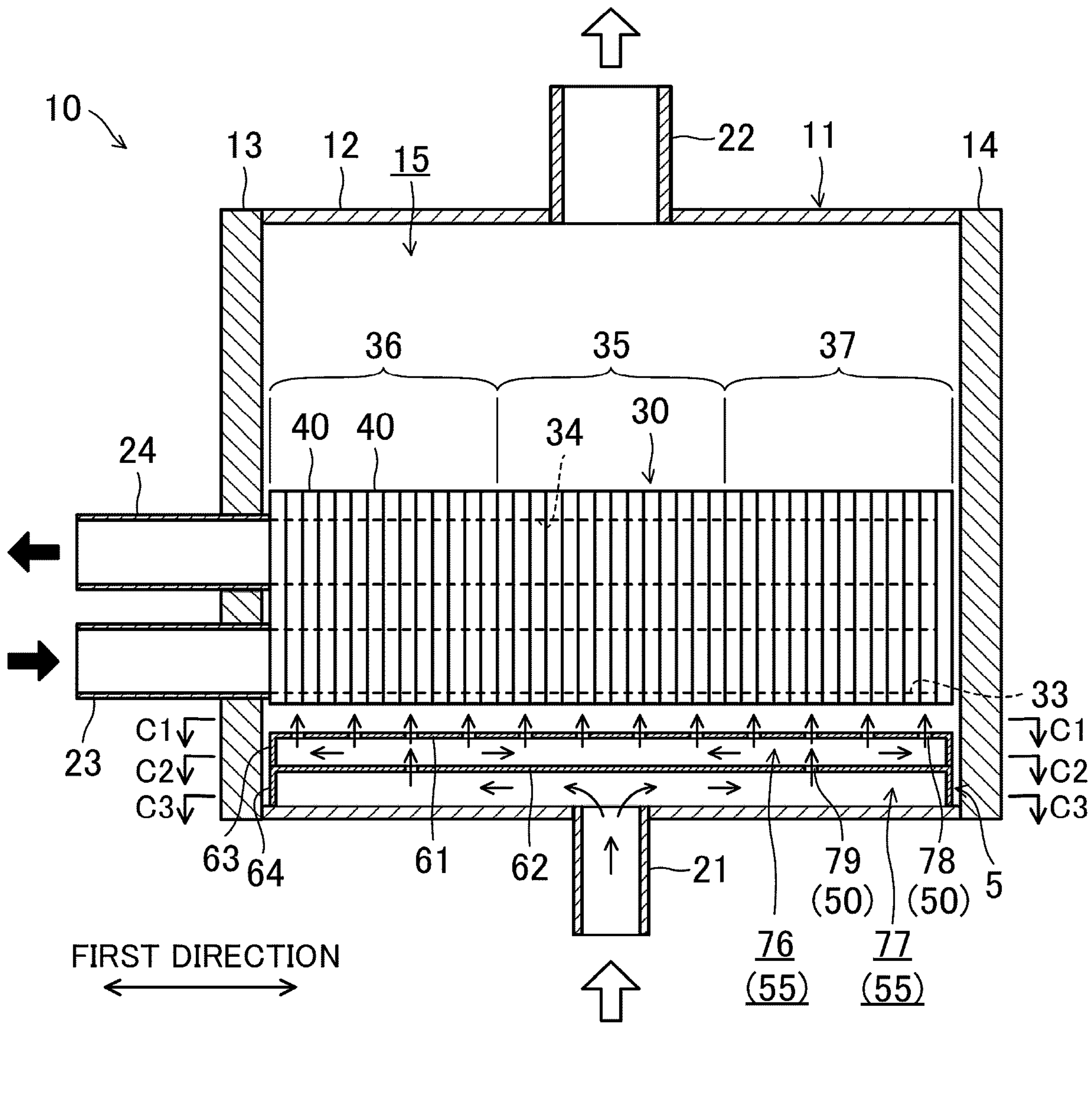
63
55
21
69
d2
d1
d2
SECOND DIRECTION
FIRST DIRECTION

FIG.13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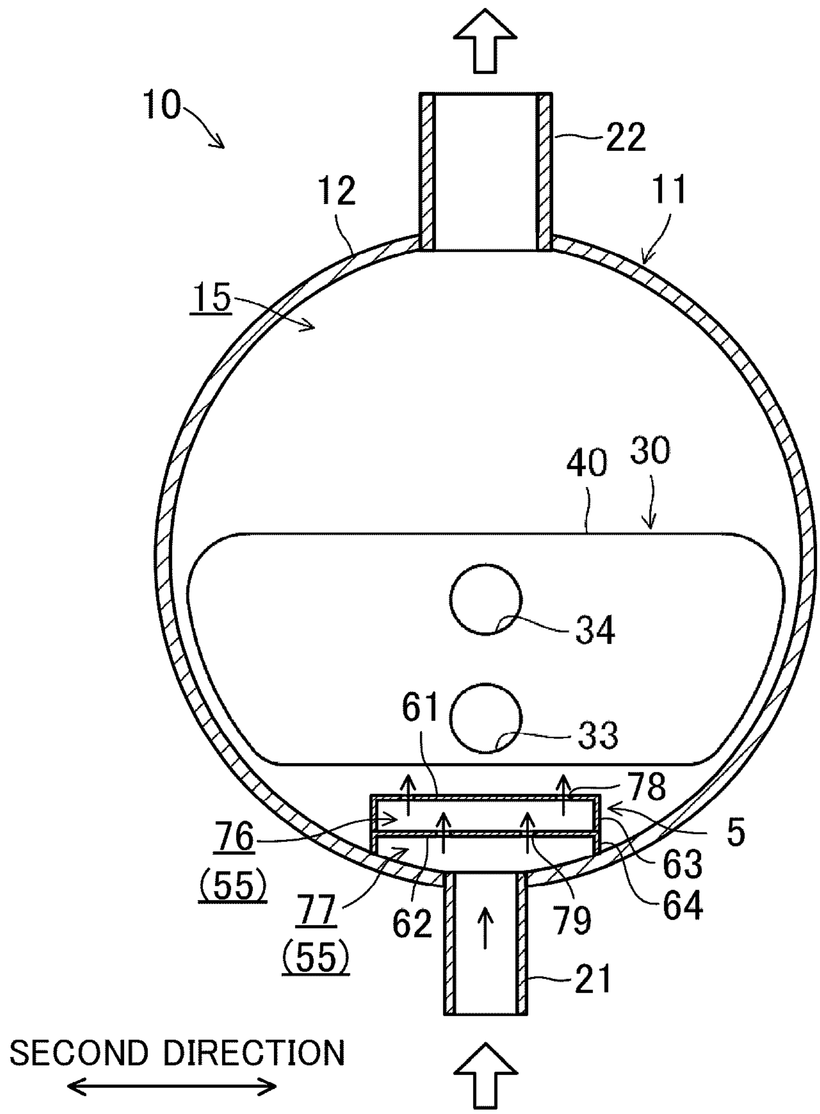
C1
C2
C3
C1
C2
C3
63
64
61
62
21
79
(50)
78
(50)
5
76
(55)
77
(55)
FIRST DIRECTION

FIG.14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(55)
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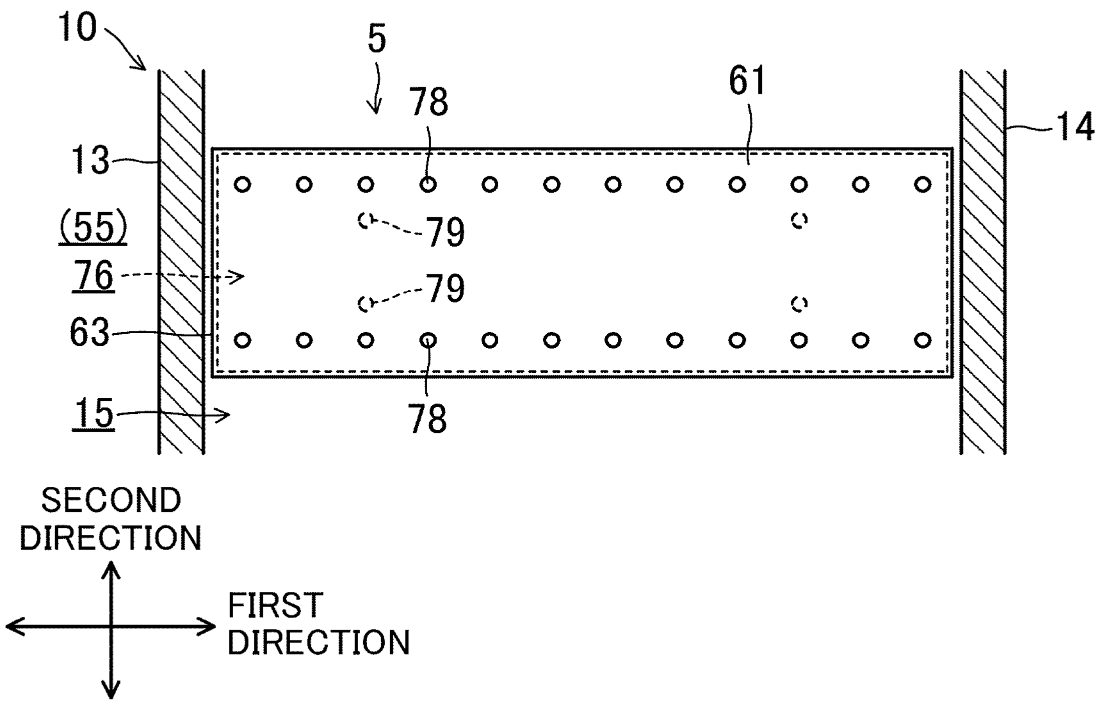
63
64
77
(55)
62
79
21
SECOND DIRECTION

FIG.15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(55)
76
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79
63
78
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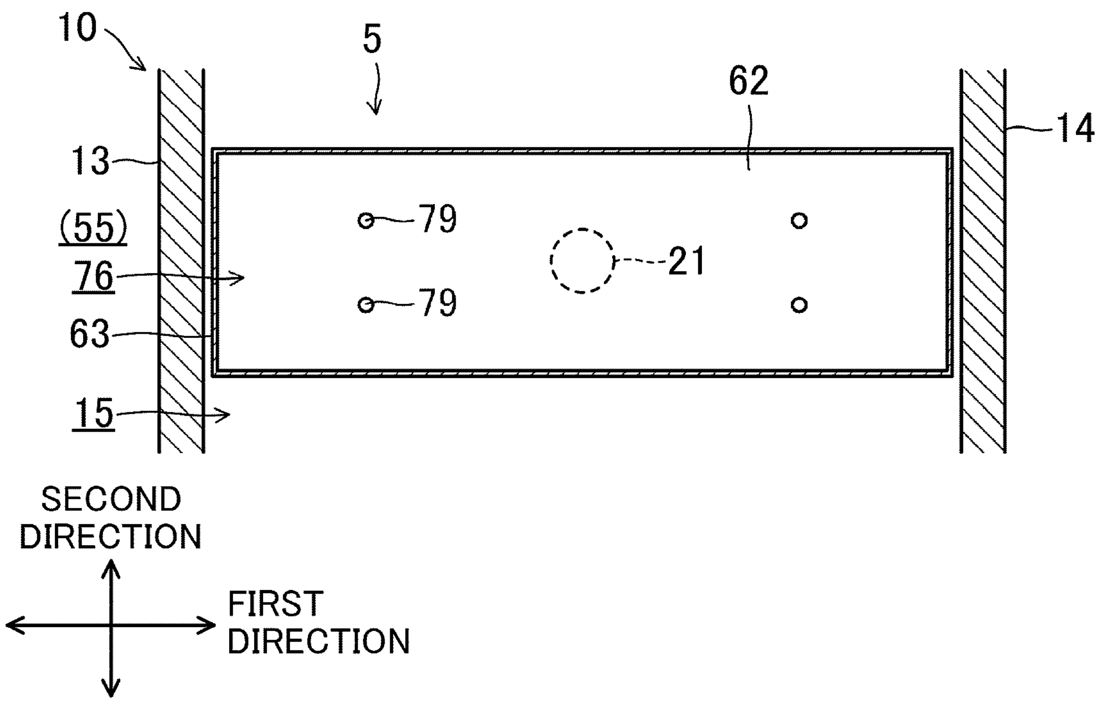
SECOND DIRECTION
FIRST DIRECTION

FIG.16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(55)
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76
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79
63
15
SECOND DIRECTION
FIRST DIRECTION

FIG.17

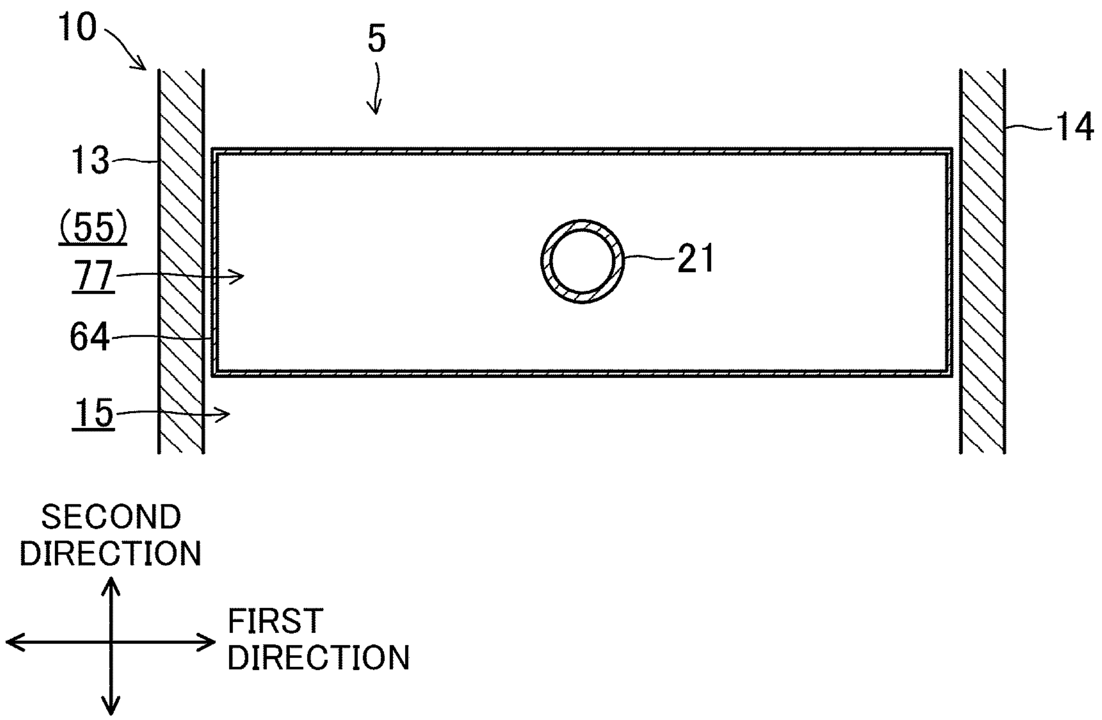
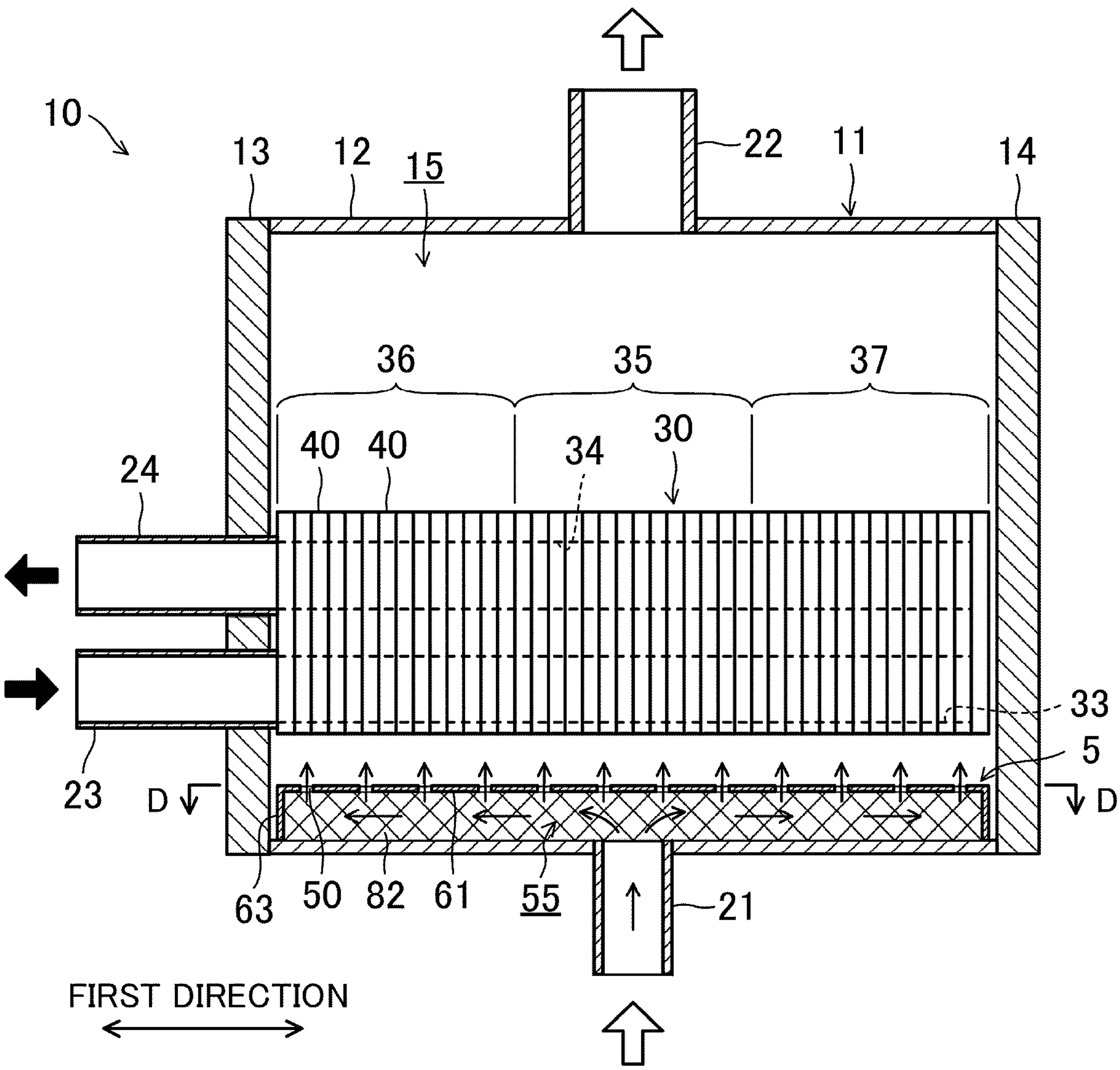


FIG.18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D
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63
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82
61
55
21
FIRST DIRECTION

FIG.19

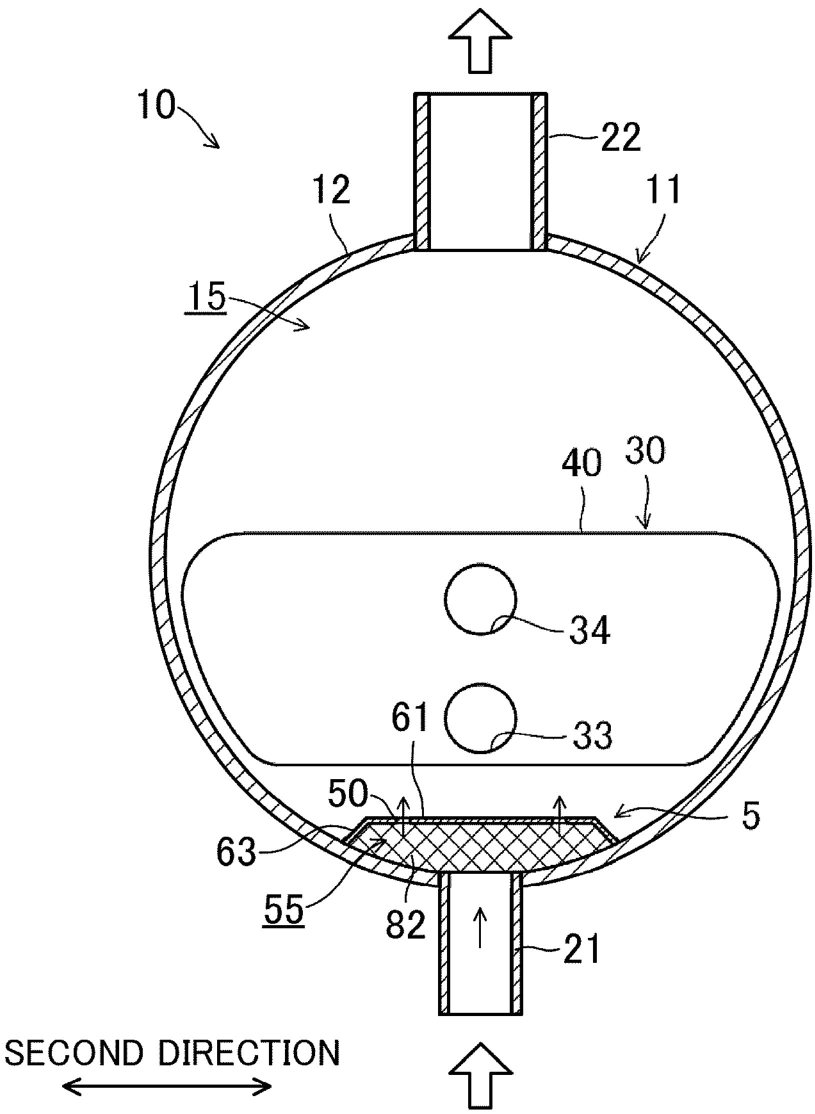
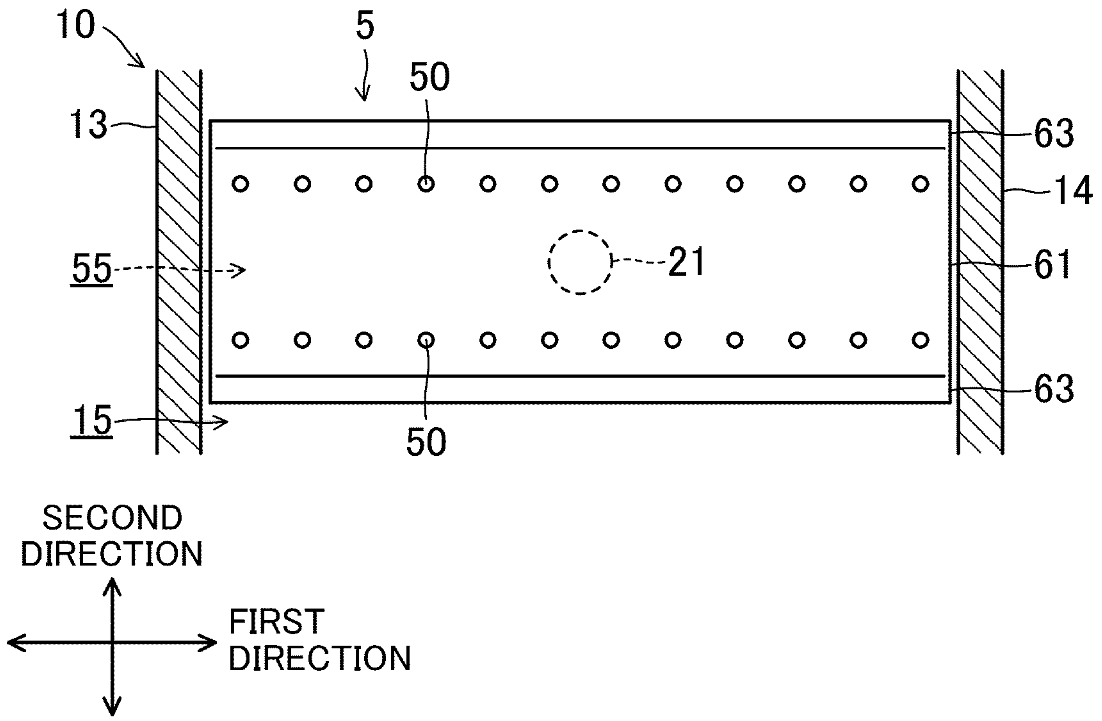


FIG.20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SECOND DIRECTION
FIRST DIRECTION

FIG.21

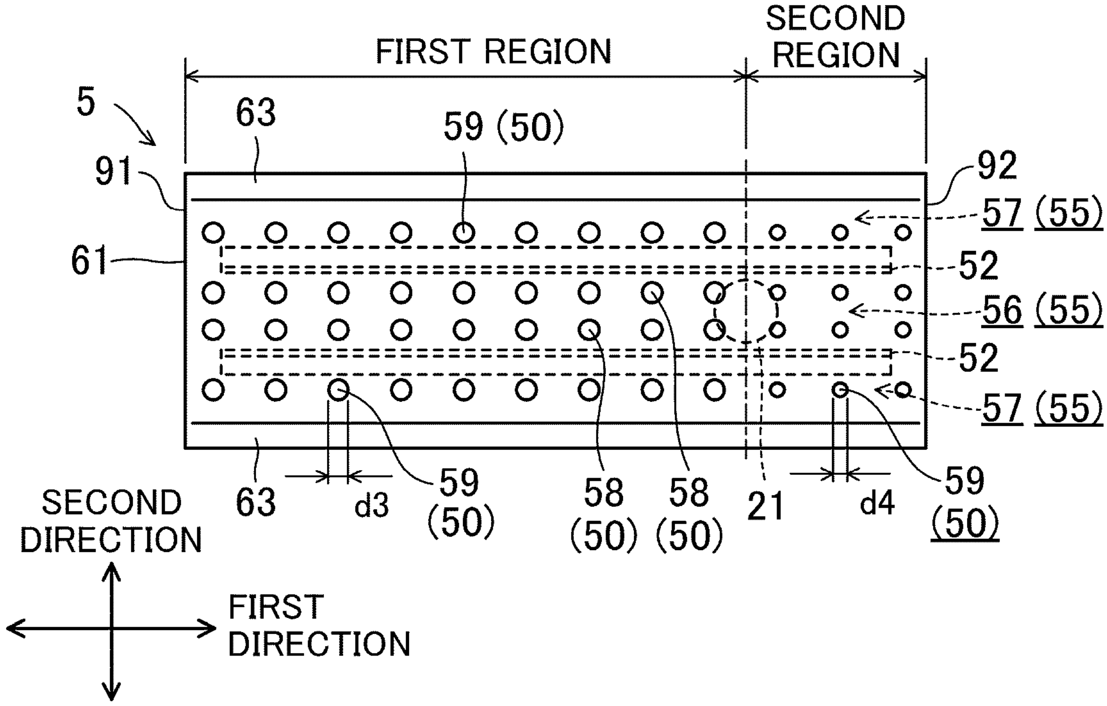
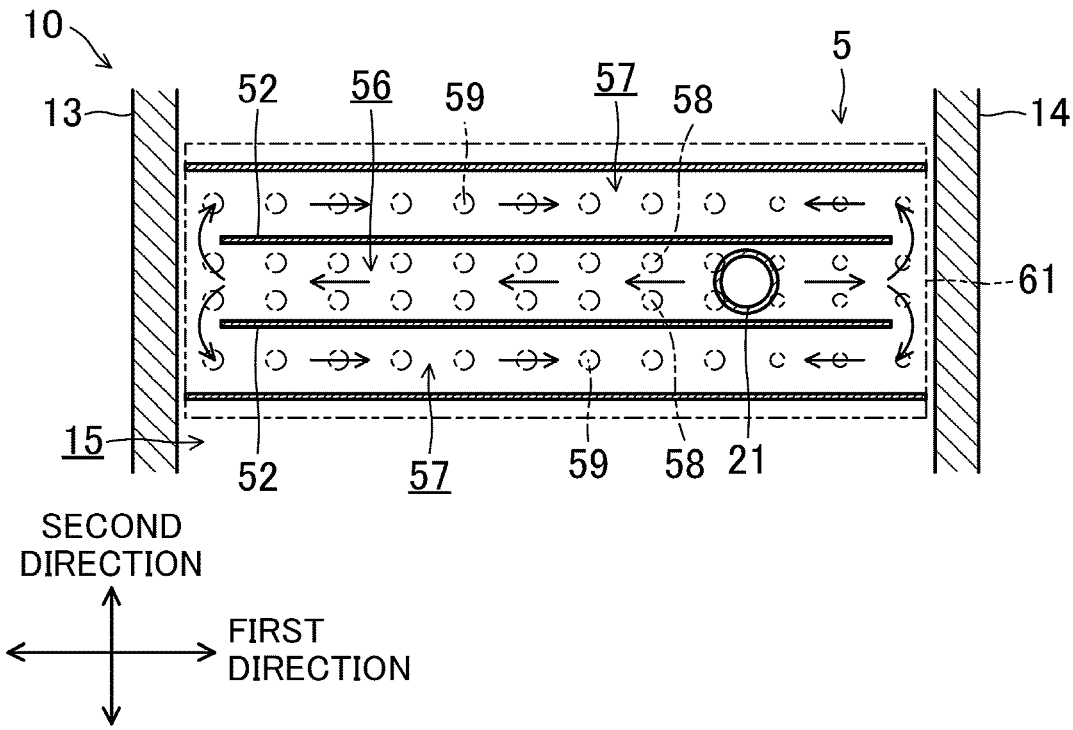

FIRST REGION
SECOND REGION
5
63
59 (50)
91
92
57 (55)
61
52
56 (55)
52
57 (55)
63
d3
59 (50)
58 (50)
58 (50)
21
d4
59 (50)
SECOND DIRECTION
FIRST DIRECTION

FIG.22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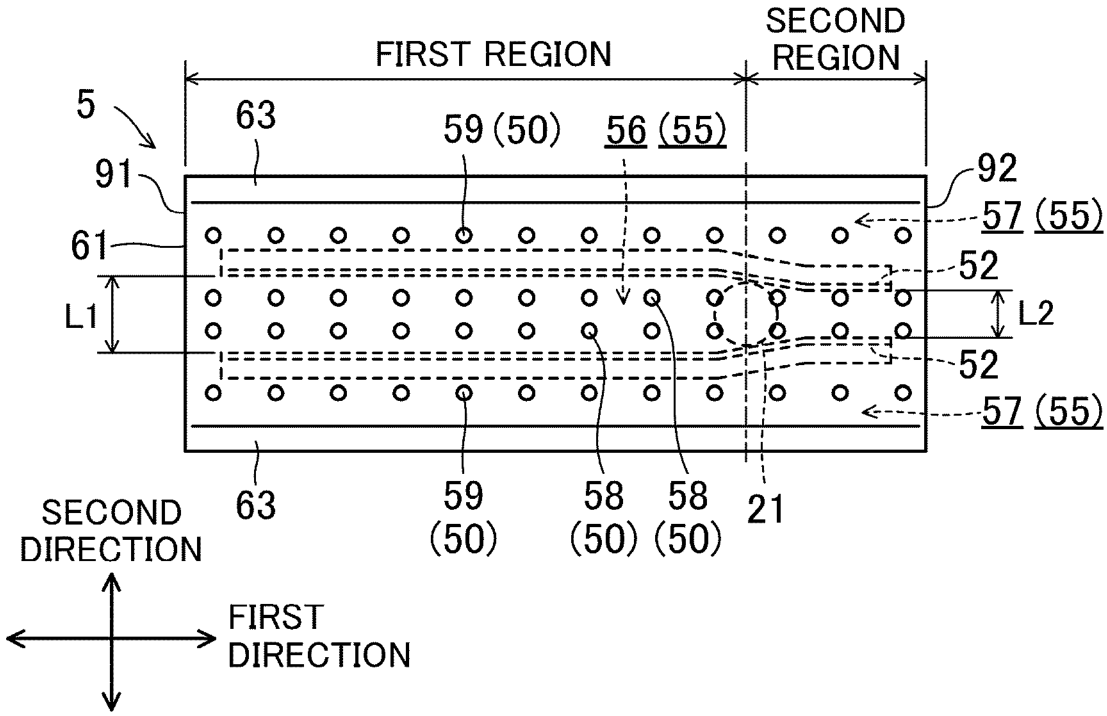
21
SECOND DIRECTION
FIRST DIRECTION

FIG.23


FIRST REGION
SECOND REGION
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63
59 (50)
56 (55)
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92
57 (55)
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52
L1
L2
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57 (55)
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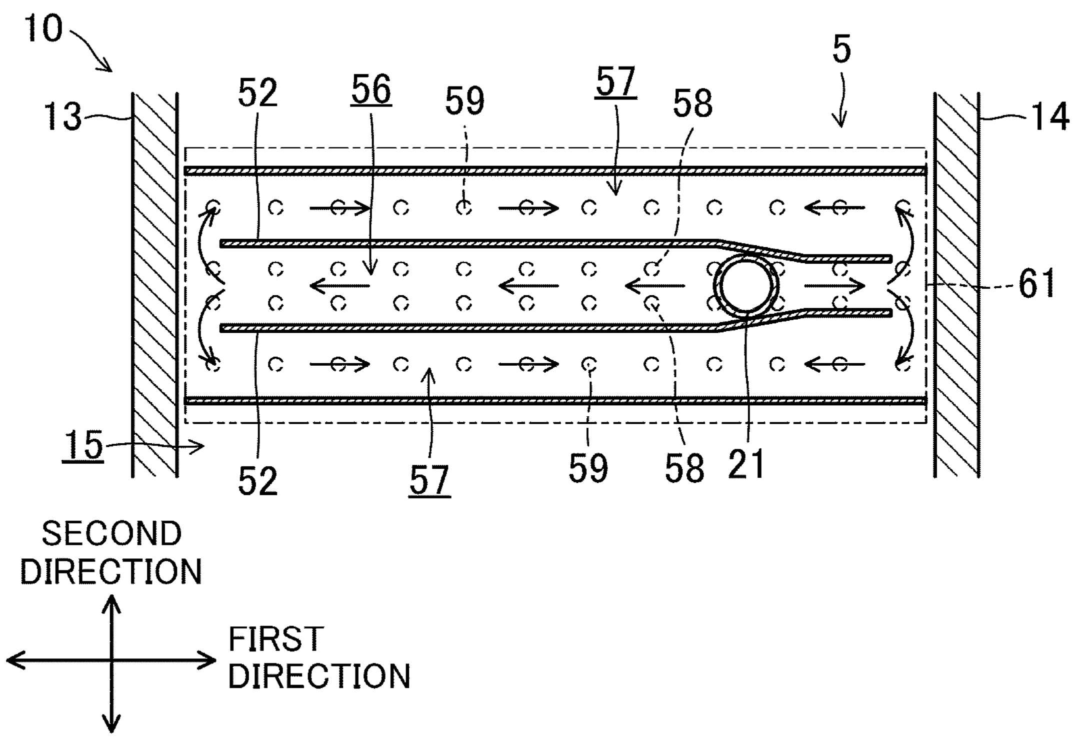
59 (50)
58 (50)
58 (50)
21
SECOND DIRECTION
FIRST DIRECTION

FIG.24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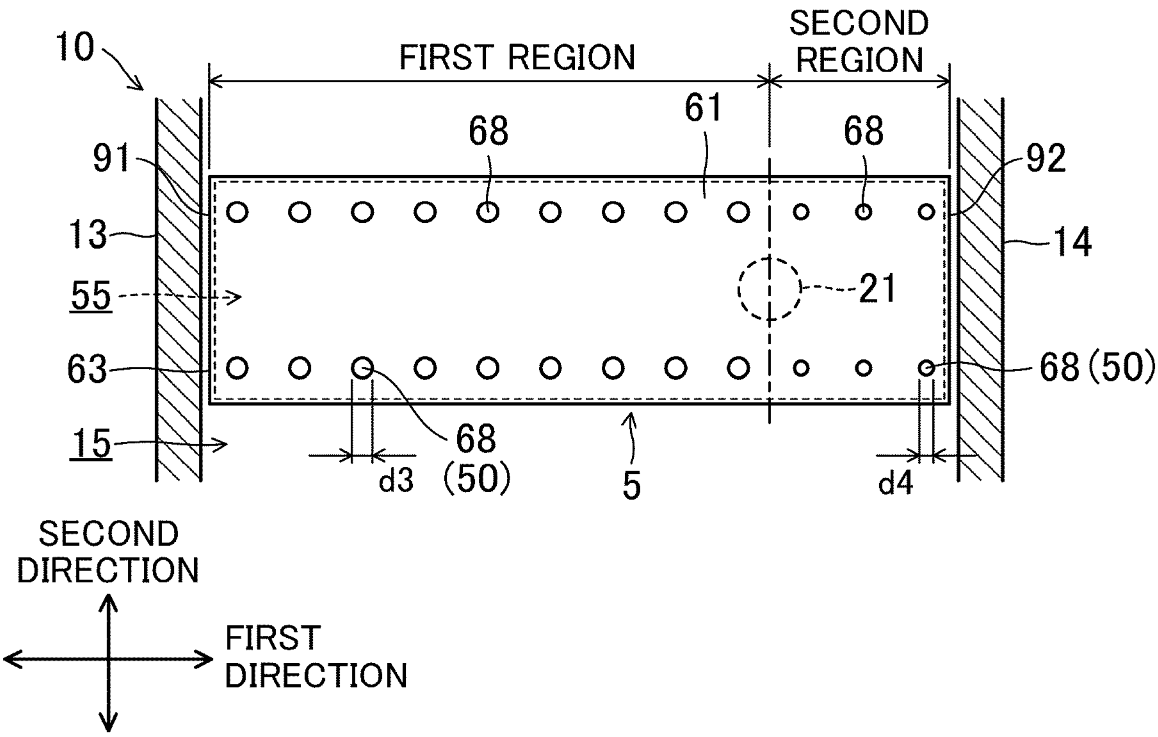
SECOND DIRECTION
FIRST DIRECTION

FIG.25


10
FIRST REGION
SECOND REGION
61
68
68
91
92
13
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21
63
68 (50)
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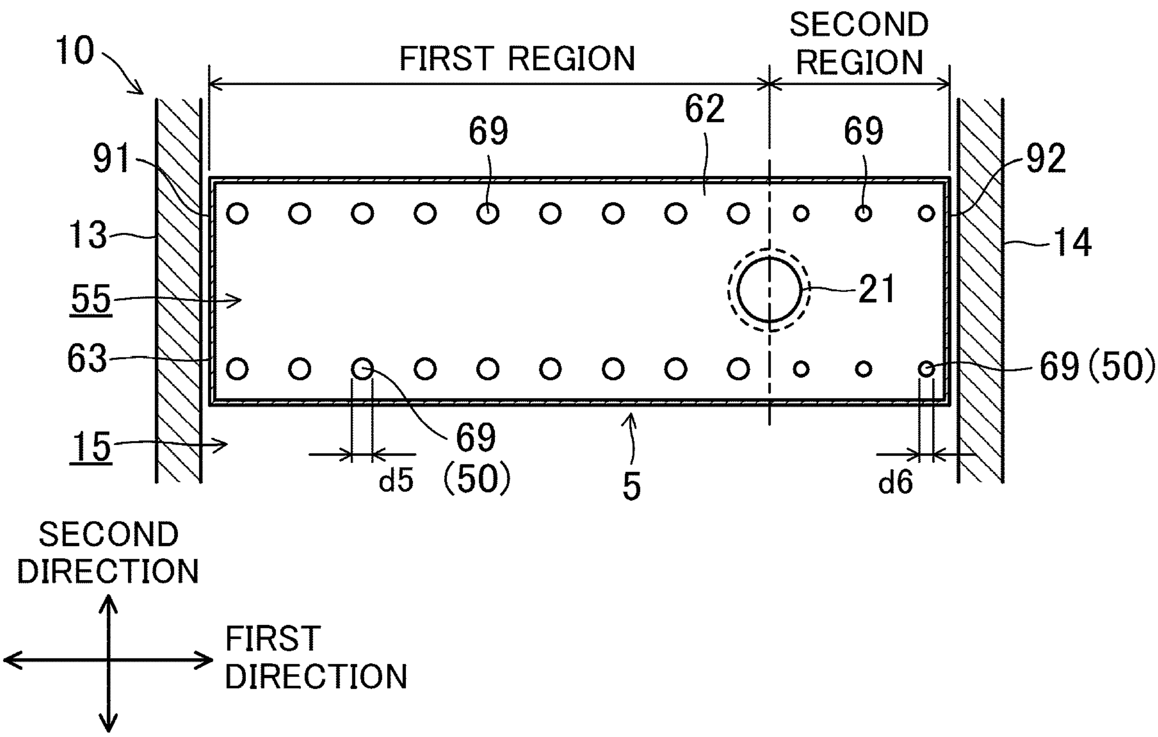
68
(50)
d3
5
d4
SECOND DIRECTION
FIRST DIRECTION

FIG.26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FIRST REGION
SECOND REGION
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69
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92
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69 (50)
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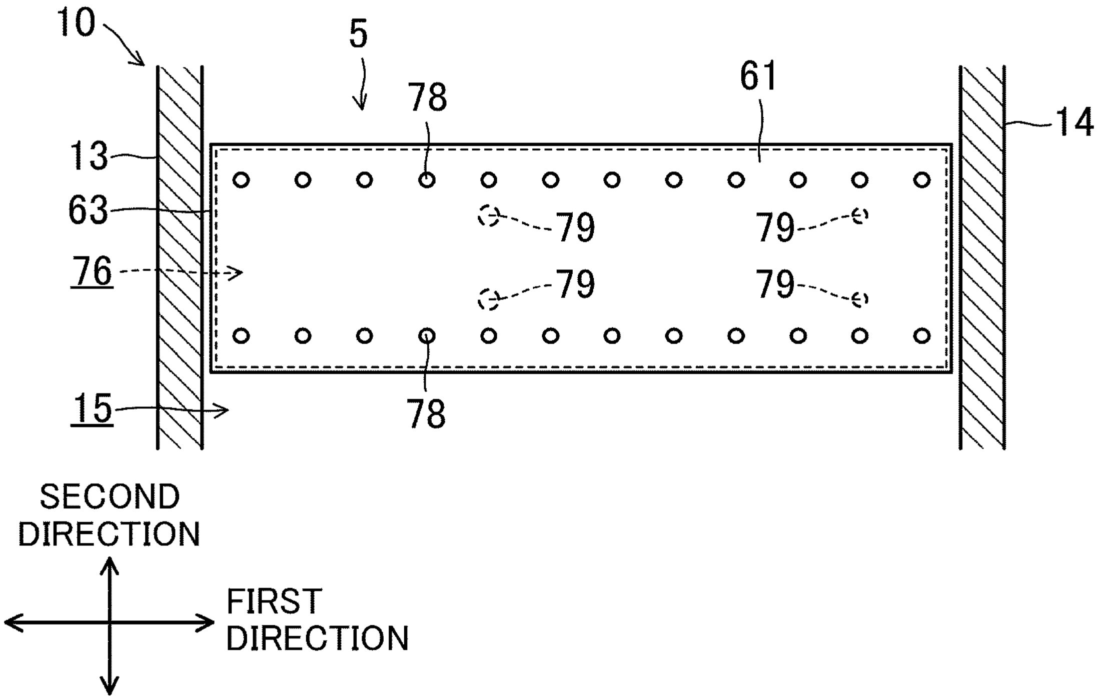
69
(50)
d5
5
d6
SECOND DIRECTION
FIRST DIRECTION

FIG.27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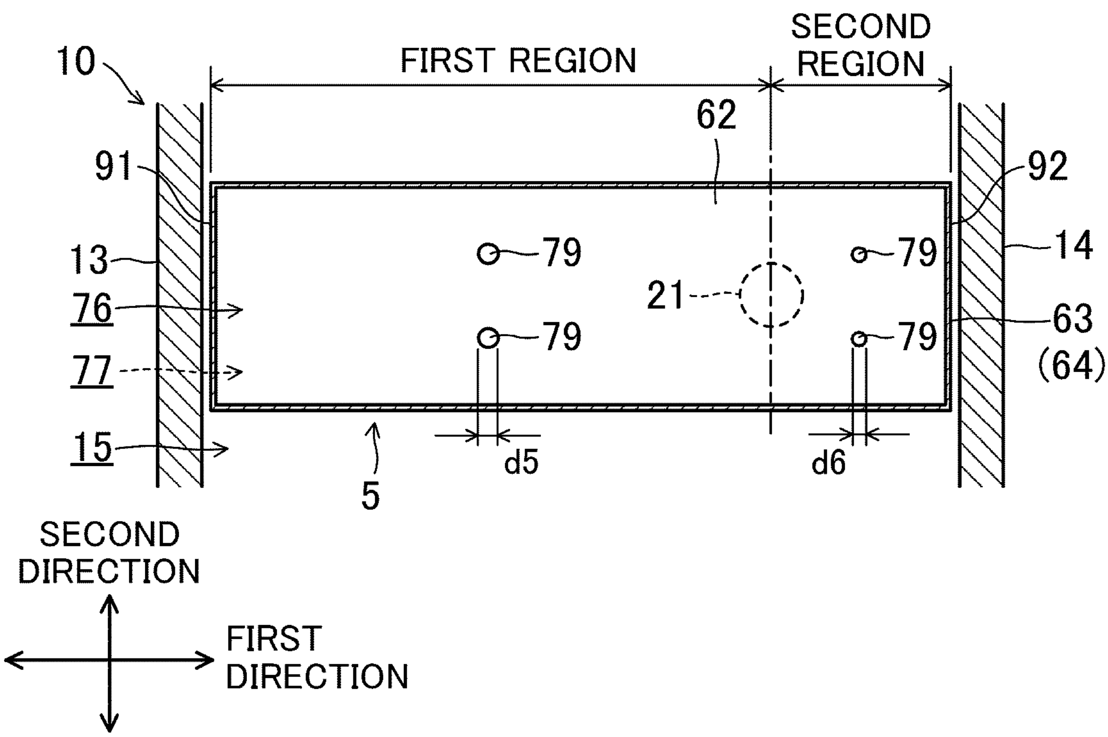
SECOND DIRECTION
FIRST DIRECTION

FIG.28


FIRST REGION
SECOND REGION
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(64)
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d5
d6
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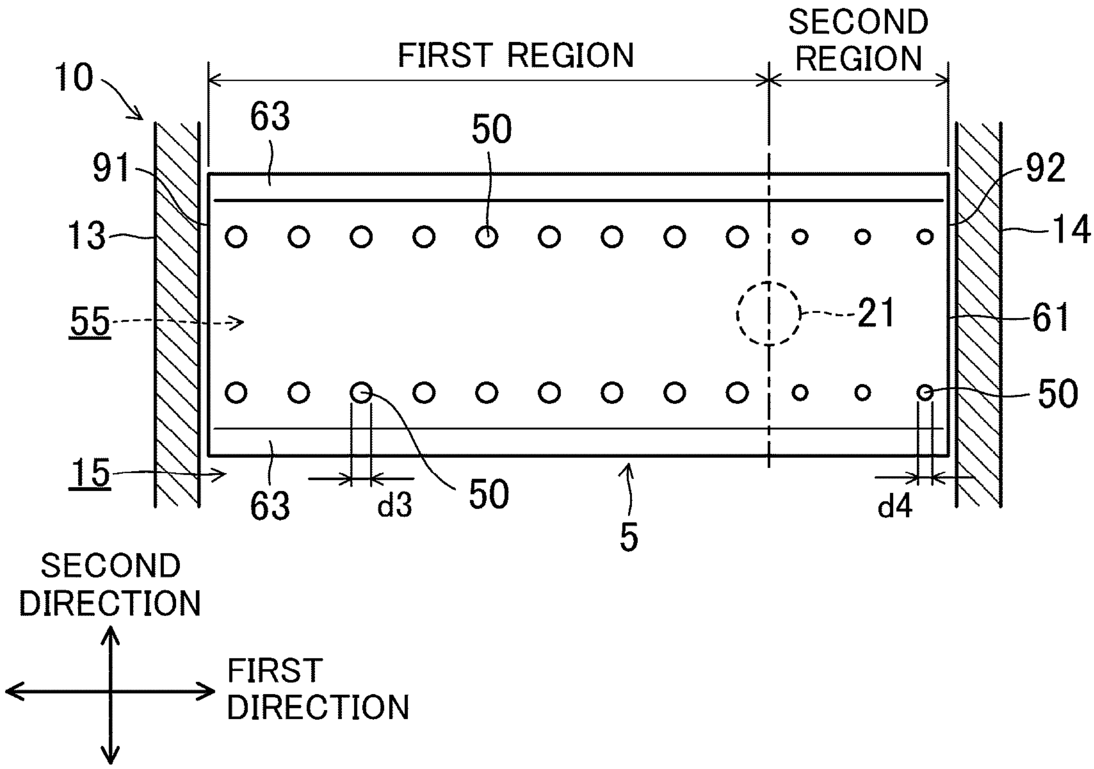
SECOND DIRECTION
FIRST DIRECTION

FIG.29


FIRST REGION
SECOND REGION
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d4
SECOND DIRECTION
FIRST DIRECTION

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2024/011788

A. CLASSIFICATION OF SUBJECT MATTER

F28D 9/00(2006.01)i; ***F25B 39/02***(2006.01)i; ***F28F 9/22***(2006.01)i
FI: F28D9/00; F25B39/02 N; F28F9/22

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; F25B39/02; F28F9/22

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2024
Registered utility model specifications of Japan 1996-2024
Published registered utility model applications of Japan 1994-2024

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	WO 2021/145363 A1 (DAIKIN INDUSTRIES, LTD.) 22 July 2021 (2021-07-22) paragraphs [0022]-[0031], [0077]-[0081], fig. 1-3, 8, 9	1, 8, 14
A		2-7, 9-13
Y	WO 2021/145365 A1 (DAIKIN INDUSTRIES, LTD.) 22 July 2021 (2021-07-22) paragraphs [0019]-[0051], fig. 1-5	1, 5-10, 14
A		2-4, 11-13
Y	JP 2002-081699 A (ISHIKAWAJIMA HARIMA HEAVY IND. CO., LTD.) 22 March 2002 (2002-03-22) paragraphs [0027]-[0052], fig. 1-4	1, 5-10, 14
Y	CN 205156444 U (GREE ELECTRIC APPLIANCES INC ZHUHAI) 13 April 2016 (2016-04-13) paragraphs [0071]-[0086], [0098]-[0104], fig. 5-9, 12	1, 5-10, 14

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 May 2024	**11 June 2024**

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

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2024/011788

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2002-349999 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 04 December 2002 (2002-12-04) paragraphs [0015]-[0028], fig. 1-5	1, 5-10, 14

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/011788

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2021/145363 A1	22 July 2021	US 2022/0341674 A1 paragraphs [0015]-[0026], [0087]-[0091], fig. 1-3, 8, 9 JP 2021-110515 A EP 4071432 A1 CN 114930106 A	
WO 2021/145365 A1	22 July 2021	US 2022/0333872 A1 paragraphs [0016]-[0056], fig. 1-5 JP 2021-110516 A EP 4067801 A1 CN 114787573 A	
JP 2002-081699 A	22 March 2002	(Family: none)	
CN 205156444 U	13 April 2016	(Family: none)	
JP 2002-349999 A	04 December 2002	(Family: none)	

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Patent documents cited in the description

- JP 2017072343 A **[0003]**