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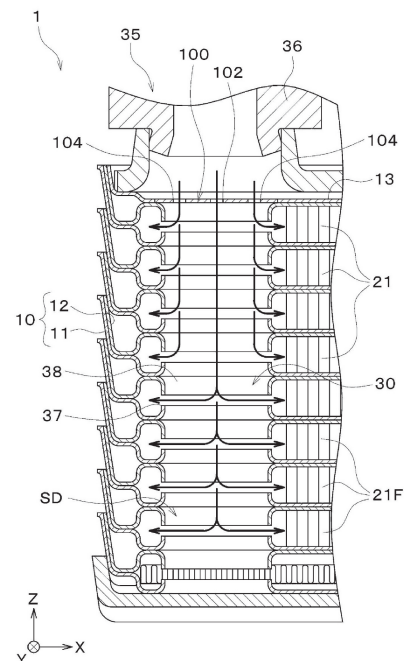
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(54) **HEAT EXCHANGER**

(57) A heat exchanger includes a plurality of fluid passages (21) and a tank (30, 70, 80). The fluid passages are stacked in layers in a stacking direction that is predetermined. The plurality of fluid passages are configured to conduct a fluid that has a gas phase and a liquid phase. The tank has: a distribution space (SD) that is configured to distribute the fluid to the fluid passages; and a flow inlet (35) that is configured to introduce the fluid into the distribution space. A fluid distributor (100), which is configured to control flow of the fluid to the fluid passages, is disposed at a location adjacent to the flow inlet of the distribution space of the tank. The fluid distributor has a primary through-hole (102) and a secondary through-hole (104). The primary through-hole is disposed in a center portion (101) of the fluid distributor, and the center portion is formed in a predetermined range centered on a center point (C) in a cross-section of the distribution space. The secondary through-hole is disposed in a peripheral portion (103) of the fluid distributor (100), wherein the peripheral portion is formed in a range between an inner wall surface of the distribution space (SD) and the center portion (101).

FIG. 7



Description

CROSS REFERENCE TO RELATED APPLICATION

- 5 **[0001]** This application is based on and incorporates herein by reference Japanese Patent Application No. 2023-142197 filed on September 1, 2023.

TECHNICAL FIELD

- 10 **[0002]** The present disclosure relates to a heat exchanger that includes a tank into which a fluid having a gas phase and a liquid phase flows, and a plurality of fluid passages stacked in layers.

BACKGROUND ART

- 15 **[0003]** Previously, a heat exchanger has a tank for distributing/collecting a refrigerant and a plurality of refrigerant passages through which the refrigerant flows from the tank. The refrigerant passages are stacked in layers in a predetermined direction in which the tank extends. In such a heat exchanger, to improve heat exchange performance, the temperature distribution in the stacked refrigerant passages is important, and to achieve this, it is desirable to uniformly distribute the fluid to each fluid passage when distributing the fluid from the tank to the fluid passages.
- 20 **[0004]** However, in practice, when the fluid flows inside the tank toward the stacked fluid passages, the distribution of the fluid may become uneven due to influences such as inertial forces acting on the fluid.
- [0005]** As a technology addressing this issue, the technology described in Patent Document 1 is known. In the heat exchanger described in Patent Document 1, a configuration is adopted in which a swirl vane is disposed at a flow inlet port of the tank in order to uniformly distribute the refrigerant to each refrigerant passage. In Patent Document 1, when the fluid
- 25 flows into the interior of the tank, a swirl component is imparted to the flow of the fluid by the swirl vane, thereby dispersing the two-phase fluid and bringing the distribution of the fluid to each fluid passage closer to a uniform state.

CITATION LIST

- 30 PATENT LITERATURE

[0006] PATENT LITERATURE 1: JP 2021-25764A

SUMMARY OF INVENTION

- 35 **[0007]** Here, in the heat exchanger, there are cases where the total number of stacked fluid passages increases or the manner of fluid inflow into the tank is changed. Depending on the manner of these changes, it is conceivable that the technology of Patent Document 1 cannot achieve the uniform distribution of the fluid to each fluid passage.
- [0008]** For example, when the total number of stacked fluid passages increases, the tank elongates along the stacking direction. Therefore, even if the swirl component is imparted by the swirl vane disposed at the flow inlet port of the tank, it is conceivable that the flow of the fluid entering from the flow inlet port will not reach the fluid passages disposed on a downstream side in the tank.
- [0009]** Furthermore, when the manner of connecting the fluid supply passage to the flow inlet port of the tank is changed such that the fluid supply passage is laterally connected to the tank, the inertia acting on the fluid flowing in from the flow inlet port differs before and after the change in the path of the supply passage. Even in the case where the flow of the fluid becomes unevenly increased toward the flow inlet port side due to the inertial force acting on the fluid, the refrigerant will still flow in the unevenly increased state toward the flow inlet port side due to that inertia. Therefore, even if the swirl component is imparted to the flow of the fluid by the swirl vane, it is conceivable that the distribution of the fluid to each fluid passage will become uneven.
- 45 **[0010]** In view of the above points, it is an objective of the present disclosure to provide a heat exchanger that improves the uniformity in distributing a two-phase fluid flowing into a tank to a plurality of stacked fluid passages.
- [0011]** A heat exchanger according to one aspect of the present disclosure includes a plurality of fluid passages and a tank. The fluid passages are stacked in layers in a stacking direction that is predetermined. The plurality of fluid passages are configured to conduct a fluid that has a gas phase and a liquid phase. The tank extends in the stacking direction of the plurality of fluid passages and is connected to the plurality of fluid passages. The tank has: a distribution space that is configured to distribute the fluid to the plurality of fluid passages; and a flow inlet that is configured to introduce the fluid into the distribution space. A fluid distributor, which is configured to control flow of the fluid to the plurality of fluid passages, is disposed at a location adjacent to the flow inlet of the distribution space of the tank.
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[0012] The fluid distributor has a primary through-hole and a secondary through-hole. The primary through-hole is configured to guide the fluid to one or more of the plurality of fluid passages, which are connected to a downstream portion of the distribution space located on a downstream side in a flow direction of the fluid flowing in the distribution space. The secondary through-hole is configured to guide the fluid to another one or more of the plurality of fluid passages, which are connected to an upstream portion of the distribution space located on an upstream side in the flow direction of the fluid flowing in the distribution space. The primary through-hole is disposed in a center portion of the fluid distributor. The center portion is formed in a predetermined range centered on a center point in a cross-section of the distribution space. The secondary through-hole is disposed in a peripheral portion of the fluid distributor. The peripheral portion is formed in a range between an inner wall surface of the distribution space and the center portion.

[0013] Therefore, according to the heat exchanger of the present disclosure, the fluid that has flowed into the distribution space of the tank can be distributed, via the fluid distributor, to the plurality of fluid passages stacked in the stacking direction. The primary through-hole is formed in the center portion of the fluid distributor, and by the fluid passing through the primary through-hole, the fluid can be guided to the fluid passages connected to the downstream-side portion in the flow direction of the fluid flowing through the distribution space. Furthermore, the secondary through-hole is formed in the peripheral portion of the fluid distributor, and by the fluid passing through the secondary through-hole, the fluid can be guided to the fluid passages connected to the upstream-side portion in the flow direction within the distribution space. That is, the heat exchanger can improve the uniformity of fluid distribution to the fluid passages connected to the distribution space by allowing the fluid to flow out into the distribution space via the primary through-hole and the secondary through-hole of the fluid distributor.

BRIEF DESCRIPTION OF DRAWINGS

[0014] The present disclosure, together with additional objectives, features and advantages thereof, will be best understood from the following description in view of the accompanying drawings.

FIG. 1 is a front view of a heat exchanger according to a first embodiment.

FIG. 2 is a plan view of the heat exchanger according to the first embodiment.

FIG. 3 is an explanatory view illustrating a refrigerant distribution structure in the heat exchanger.

FIG. 4 is a cross-sectional view showing a refrigerant inflow tank of the heat exchanger according to the first embodiment.

FIG. 5 is a plan view showing a structure of a fluid distributor according to the first embodiment.

FIG. 6 is a graph showing refrigerant distribution characteristics achieved by the fluid distributor according to the first embodiment.

FIG. 7 is an explanatory view illustrating a distribution pattern of the refrigerant achieved by the fluid distributor of the first embodiment.

FIG. 8 is a plan view showing a structure of a fluid distributor of a heat exchanger according to a second embodiment.

FIG. 9 is a cross-sectional view showing a fluid distributor of a heat exchanger according to a third embodiment.

FIG. 10 is a cross-sectional view showing a fluid distributor of a heat exchanger according to a fourth embodiment.

FIG. 11 is an explanatory view illustrating an arrangement of a fluid distributor in a heat exchanger according to a fifth embodiment.

FIG. 12 is a cross-sectional view showing a fluid distributor of a heat exchanger according to a sixth embodiment.

FIG. 13 is a cross-sectional view showing a fluid distributor of a heat exchanger according to a seventh embodiment.

FIG. 14 is a plan view showing a fluid distributor of a heat exchanger according to an eighth embodiment.

DESCRIPTION OF EMBODIMENTS

[0015] Hereinafter, embodiments of the present disclosure will be described with reference to the drawings. In each of the following embodiments, the same reference signs may be assigned to portions that are the same as or equivalent to those described in the preceding embodiment(s), and the description thereof may be omitted. Further, when only a portion of any one of the components is described in the embodiment, the description of the rest of the components described in the preceding embodiment may be applied to the rest of the components. In addition to the combinations of portions that are specifically shown to be combinable in the respective embodiments, it is also possible to partially combine the embodiments even if they are not specifically shown, provided that the combinations are not impeded.

(First Embodiment)

[0016] The first embodiment of the present disclosure will be described with reference to FIGS. 1 to 7. In order to facilitate understanding of the description, the same components are indicated by the same reference signs as much as possible in

each drawing, and redundant descriptions are omitted.

[0017] In the first embodiment, a heat exchanger according to the present disclosure is applied to an evaporator (so-called chiller) that evaporates a refrigerant by performing heat exchange between the refrigerant, which circulates in a refrigeration cycle of an air conditioning device mounted on a vehicle, and a coolant.

[0018] As shown in FIGS. 1 to 4, the heat exchanger 1 according to the first embodiment is formed by stacking a plurality of plate members 10 in layers in an axial direction of a Z-axis (hereinafter referred to as a Z-axis direction), and the heat exchanger 1 includes a heat exchange core 20, a refrigerant inflow tank 30, a refrigerant discharge tank 40, a coolant inflow tank 50 and a coolant discharge tank 60. Hereinafter, the Z-axis direction will be also referred to as a stacking direction Z.

[0019] The heat exchange core 20 is formed by a part of the plate members 10 stacked in layers in the Z-axis direction and has a plurality of refrigerant passages 21 and a plurality of coolant passages (not shown).

[0020] The refrigerant passage 21, through which the refrigerant flows, and the coolant passage, through which the coolant flows, are provided inside each of the plate members 10. In the heat exchange core 20, the refrigerant passages 21 and the coolant passages are alternately arranged along the Z-axis direction. In the heat exchanger 1, a two-phase refrigerant, which has a gas phase and a liquid phase, flows through the refrigerant passage 21, so that the refrigerant passages 21 serve as an example of a plurality of fluid passages.

[0021] As shown in FIG. 2, the heat exchange core 20 of the heat exchanger 1 has a substantially rectangular shape in a cross-section taken perpendicular to the stacking direction Z. In the following description, a longitudinal direction and a transverse direction of the heat exchange core 20 will be referred to as an X-axis direction and a Y-axis direction, respectively.

[0022] The refrigerant inflow tank 30 and the refrigerant discharge tank 40 are provided at two corners, which are diagonally opposite to each other, among four corners of the plate members 10. Additionally, the coolant inflow tank 50 and the coolant discharge tank 60 are provided at the remaining two corners, which are diagonally opposite to each other, among the four corners of the plate members 10.

[0023] The refrigerant inflow tank 30 is a reservoir into which the refrigerant in the two-phase state having the gas phase and the liquid phase and circulating in the refrigeration cycle flows. As shown in FIG. 4, the refrigerant inflow tank 30 has a cylindrical internal space that extends in the Z-axis direction. The refrigerant, which has flowed into the refrigerant inflow tank 30, is distributed into the refrigerant passages 21 which are stacked in layers in the Z-axis direction in the heat exchange core 20. Accordingly, the internal space of the refrigerant inflow tank 30 is formed by a distribution space SD for distributing the refrigerant to the plurality of refrigerant passages 21, and thereby the refrigerant inflow tank 30 serves as an example of a tank.

[0024] The refrigerant discharge tank 40 is a reservoir into which the refrigerant flowed through the refrigerant passages 21 of the heat exchange core 20 flows. Similarly to the refrigerant inflow tank 30, the refrigerant discharge tank 40 has a cylindrical internal space that extends in the Z-axis direction. Accordingly, the internal space of the refrigerant discharge tank 40 is formed by a collection space SA that is configured to collect the refrigerant which has flowed through the corresponding ones of the refrigerant passages 21. After the refrigerant flows into and is collected in the interior of the refrigerant discharge tank 40, the refrigerant is discharged to the outside of the heat exchanger 1. The discharged refrigerant circulates through the refrigeration cycle.

[0025] The coolant inflow tank 50 is a reservoir into which the coolant circulating in the coolant circuit flows. Similarly to the refrigerant inflow tank 30, the coolant inflow tank 50 has a cylindrical internal space that extends in the Z-axis direction. The coolant passages, which are stacked in layers in the Z-axis direction in the heat exchange core 20, are connected to the internal space of the coolant inflow tank 50. The coolant, which has flowed into the coolant inflow tank 50, is distributed to the coolant passages.

[0026] The coolant discharge tank 60 is a reservoir into which the coolant flowed through the coolant passages of the heat exchange core 20 flows. Similarly to the refrigerant inflow tank 30, the coolant discharge tank 60 has a cylindrical internal space that extends in the Z-axis direction. After the coolant flows into and is collected in the interior of the coolant discharge tank 60 through the coolant passages, the coolant is discharged to the outside of the heat exchanger 1. The discharged coolant circulates through the coolant circuit.

[0027] As described above, in the heat exchanger 1 of the first embodiment, heat exchange is performed in the heat exchange core 20 between the refrigerant, which flows through the refrigerant passages 21, and the coolant, which flows through the coolant passages. As a result, in the heat exchanger 1, the refrigerant is evaporated by the heat possessed by the coolant, and the coolant can be cooled by heat absorption by the refrigerant.

[0028] As shown in FIG. 3, the heat exchange core 20 includes the plate members 10, a plurality of refrigerant fins 21F and a plurality of coolant fins (not shown). These members are made of a metal material such as aluminum alloy.

[0029] In the first embodiment, a plurality of outer plates 11, a plurality of inner plates 12 and a top plate 13 are included in the plate members 10. Each of the outer plates 11 is a plate member that has a substantially rectangular shape in a cross-section taken perpendicular to the stacking direction Z. A raised rim 11B, which projects in a positive Z-axis direction (a positive side in the Z-axis direction), is formed on an outer periphery of the outer plate 11. The outer plates 11 are stacked such that the raised rims 11B face the positive Z-axis direction.

[0030] The outer plate 11 has a burring portion 11A formed by a burring process. The burring portion 11A forms a circular opening that is centered on a central axis of the refrigerant inflow tank 30, and the burring portion 11A is formed such that an opening edge of the opening projects in a tubular shape in the positive Z-axis direction. Accordingly, the burring portion 11A serves as an example of an opening. In the outer plate 11, a protrusion 11C, which protrudes in a negative Z-axis direction

(a negative side in the Z-axis direction), is formed at a portion that corresponds to a base end of the burring portion 11A. **[0031]** Each of the inner plates 12 is a plate member that has a substantially rectangular shape in a cross-section taken perpendicular to the stacking direction Z, similar to that of the outer plate 11. The inner plate 12 is disposed inside the raised rim 11B of an adjacent one of the outer plates 11 and between corresponding adjacent two of the outer plates 11 and is joined to the corresponding adjacent two of the outer plates 11 by brazing.

[0032] The inner plate 12 partitions a space, which is formed between the corresponding adjacent two of the outer plates 11, into the corresponding refrigerant passage 21 and the corresponding coolant passage that are not in communication with each other. More specifically, a gap, which is formed between the inner plate 12 and the outer plate 11 adjacent to the inner plate 12 in the negative Z-axis direction, forms the refrigerant passage 21. Furthermore, a gap, which is formed between the inner plate 12 and the outer plate 11 adjacent to the inner plate 12 in the positive Z-axis direction, forms the coolant passage.

[0033] The refrigerant fin 21F is disposed in each refrigerant passage 21. Similarly, the coolant fin is disposed in each coolant flow passage. For example, an offset fin can be used as the refrigerant fin 21F and the coolant fin. The refrigerant fin 21F increases a heat transfer surface area for the refrigerant flowing through the refrigerant passage 21. The coolant fin increases a heat transfer surface area for the coolant flowing through the coolant passage.

[0034] The inner plate 12 has a burring portion 12A formed by a burring process in a portion of the inner plate 12, which corresponds to the burring portion 11A of the outer plate 11. The burring portion 12A forms a circular opening that is centered on the central axis of the refrigerant inflow tank 30, and the burring portion 12A is formed such that an opening edge of the opening projects in a tubular shape in the negative Z-axis direction. Accordingly, the burring portion 12A serves as an example of an opening, similar to that of the burring portion 11A. In the inner plate 12, a protrusion 12C, which protrudes in the positive Z-axis direction, is formed at a base end of the burring portion 12A.

[0035] The protrusion 12C of the inner plate 12 is joined by brazing to the protrusion 11C of the outer plate 11 adjacent in the positive Z-axis direction. As a result, the burring portion 11A of the outer plate 11 and the burring portion 12A of the adjacent inner plate 12 are arranged side by side in the Z-axis direction. In other words, the refrigerant inflow tank 30, which has the cylindrical internal space, is formed by the burring portions 11A of the outer plates 11 and the burring portions 12A of the inner plates 12.

[0036] A flow inlet 35 is disposed on an axial side of the burring portions 11A and the burring portions 12A in the positive Z-axis direction. The flow inlet 35 of the first embodiment includes a flow inlet port for allowing the refrigerant having the gas phase and the liquid phase to flow into the internal space of the refrigerant inflow tank 30 from the refrigeration cycle, and the flow inlet 35 has a connector member 36. The connector member 36 is a connecting portion for connecting a refrigerant inflow pipe, which is connected to the refrigeration cycle and supplies the refrigerant having the gas phase and the liquid phase, to the flow inlet port. Therefore, the flow inlet 35 is located at a most upstream portion of the internal space of the refrigerant inflow tank 30 in the flow direction of the refrigerant.

[0037] The tubular portions of the burring portions 11A in the outer plates 11 and the tubular portions of the burring portions 12A in the inner plates 12 form a peripheral wall 38 of the refrigerant inflow tank 30.

[0038] Furthermore, by joining the protrusion 11C of each outer plate 11 and the protrusion 12C of the adjacent inner plate 12 together, the coolant passages and the refrigerant inflow tank 30 are partitioned. Therefore, the refrigerant, which flows through the refrigerant inflow tank 30, does not flow into the coolant passages.

[0039] As shown in FIGS. 3 and 4, a distal end of the tubular portion of the burring portion 11A in each outer plate 11 and a distal end of the tubular portion of the burring portion 12A in the adjacent inner plate 12 are spaced apart by a predetermined distance. In other words, the refrigerant passage 21, which is formed between the outer plate 11 and the inner plate 12, is in communication with the other refrigerant passage 21, which is formed between the corresponding outer plate 11 and the corresponding inner plate 12, via the gap between the distal end of the tubular portion in the burring portion 11A and the distal end of the tubular portion in the burring portion 12A.

[0040] The gap, which is formed between the distal end of the tubular portion in each burring portion 11A and the distal end of the tubular portion in the adjacent burring portion 12A, forms a communication portion 37 in the refrigerant inflow tank 30. Each of the communication portions 37 is a portion that distributes the refrigerant, which has flowed into the refrigerant inflow tank 30, to the refrigerant passage 21 and allows it to flow therein.

[0041] Each communication portion 37 of the refrigerant inflow tank 30 is formed in a manner shown in FIGS. 3 and 4, and the tubular portions of the burring portions 11A and the tubular portions of the burring portions 12A form the peripheral wall 38 of the refrigerant inflow tank 30. For this reason, each communication portion 37 of the refrigerant inflow tank 30 is in communication with the corresponding refrigerant passage 21 over the entire circumferential extent of the refrigerant inflow tank 30.

[0042] Therefore, in the refrigerant inflow tank 30 of the heat exchanger 1 according to the first embodiment, the

refrigerant, which has flowed into the interior of the refrigerant inflow tank 30, can be allowed to flow out to each refrigerant passage 21 via the corresponding communication portion 37 formed over the entire circumferential extent of the refrigerant inflow tank 30 in the circumferential direction.

[0043] Here, consider a case in which the communication portion 37 is formed only in a part of the circumference in the circumferential direction in the refrigerant inflow tank 30 having the cylindrical internal space. At the circumferential location where the communication portion 37 is formed, the flow of the refrigerant, which flows inside the refrigerant inflow tank 30, flows out to the refrigerant passage 21 via the communication portion 37. On the other hand, at the other circumferential location where the communication portion 37 is not formed, the flow of the refrigerant passes through the circumferential location circumferentially spaced away from the communication portion 37 and is more likely to flow toward the downstream side in the internal space of the refrigerant inflow tank 30.

[0044] If the refrigerant flow inside the refrigerant inflow tank 30 becomes uneven due to the presence or absence of the communication portion 37 in the circumferential direction, it is anticipated that a circulating flow of the refrigerant will occur in the internal space of the refrigerant inflow tank 30, impairing controllability with respect to the distribution of the refrigerant to the refrigerant passages 21.

[0045] In this respect, when the configuration is adopted in which the communication portion 37 is formed over the entire circumferential extent of the refrigerant inflow tank 30 as in the refrigerant inflow tank 30 of the heat exchanger 1, the refrigerant flow inside the refrigerant inflow tank 30 does not become uneven. Thereby, the heat exchanger 1 can suppress the occurrence of a circulating flow of the refrigerant in the internal space of the refrigerant inflow tank 30 and ensure controllability with respect to the distribution of the refrigerant to the refrigerant passages 21.

[0046] Furthermore, among the plate members 10 of the heat exchange core 20, the top plate 13 is disposed at a position of the plate member 10 that is most on the positive Z-axis direction side. As shown in FIG. 4, the top plate 13 has a fluid distributor 100 at a position which is on the Z-axis of the refrigerant inflow tank 30 (that is, the burring portions 11A, 12A).

[0047] The fluid distributor 100 is disposed at a location adjacent to the flow inlet 35 of the distribution space SD of the refrigerant inflow tank 30. The fluid distributor 100 is formed to uniformly distribute the refrigerant, which has flowed into the distribution space SD, to the refrigerant passages 21 connected to the distribution space SD. As described above, since the fluid distributor 100 is formed in the top plate 13, the number of components can be reduced compared to a case where the fluid distributor 100 is formed as a separate member.

[0048] The fluid distributor 100 is formed in a circular shape that corresponds to a cross-section of the distribution space SD of the refrigerant inflow tank 30 perpendicular to the Z-axis and is centered on a center point C that coincides with the central axis of the distribution space SD. Therefore, an outer diameter dimension of the fluid distributor 100 corresponds to a tank diameter D, which is a diameter of the distribution space SD of the refrigerant inflow tank 30 (that is, a diameter of the opening of each burring portion 11A, 12A).

[0049] As shown in FIGS. 4 and 5, the fluid distributor 100 has a single primary through-hole 102 and a plurality of secondary through-holes 104. The primary through-hole 102 is disposed in a center portion 101 of the fluid distributor 100 and guides the refrigerant toward the refrigerant passages 21 (hereinafter also referred to as downstream-side refrigerant passages 21), which are connected to a downstream portion of the distribution space SD located on the downstream side in the flow direction of the refrigerant flowing in the distribution space SD that extends in the Z-axis direction. The secondary through-holes 104 are disposed in a peripheral portion 103 of the fluid distributor 100 and guide the refrigerant toward the refrigerant passages 21 (hereinafter also referred to as upstream-side refrigerant passages 21), which are connected to an upstream portion of the distribution space SD located on the upstream side in the flow direction of the refrigerant flowing in the distribution space SD, among the refrigerant passages 21 stacked in the stacking direction Z.

[0050] Here, the center portion 101 of the fluid distributor 100 is a portion defined around the center point C located on the central axis of the distribution space SD. The center portion 101 of the fluid distributor 100 of the first embodiment is a circular region having a diameter equal to one third of the tank diameter D (i.e., the outer diameter of the fluid distributor 100) and centered on the center point C.

[0051] Furthermore, the peripheral portion 103 of the fluid distributor 100 is disposed so as to surround the center portion 101 and is a region between an inner wall surface of the distribution space SD (i.e., an outer edge of the fluid distributor 100) and the center portion 101 in the fluid distributor 100. The peripheral portion 103 of the first embodiment is, as shown in FIG. 5, an annular region formed, within the circular fluid distributor 100, between an outer edge of the center portion 101 and the outer edge of the fluid distributor 100 itself.

[0052] Furthermore, in FIG. 5, the outer edge of the center portion 101 in the fluid distributor 100 is indicated as a reference line L. The reference line L can also be referred to as the boundary line between the center portion 101 and the peripheral portion 103 in the fluid distributor 100.

[0053] As shown in FIG. 5, the primary through-hole 102 is opened in a circular shape centered on the center point C in the center portion 101 of the fluid distributor 100. The primary through-hole 102 constricts the flow of the refrigerant that has flowed into the flow inlet 35 of the distribution space SD in the refrigerant inflow tank 30, thereby increasing a flow velocity toward the downstream side in the flow direction in the distribution space SD.

[0054] Here, as described above, since the fluid distributor 100 is formed as a part of the top plate 13, the primary

through-hole 102 is formed by forming a punched hole in the top plate 13 formed in a thin-plate shape. By forming the primary through-hole 102 as the punched hole, a length of the passage serving as a flow constriction can be shortened to an extent that corresponds to a thickness of the top plate 13, thereby reducing pressure loss caused by the fluid distributor 100.

[0055] An opening cross-sectional area of the primary through-hole 102 of the first embodiment is determined such that an index value γ derived from Equation (1) described later satisfies a predetermined numerical condition. Furthermore, the opening cross-sectional area of the primary through-hole 102 is referred to as a primary through-hole cross-sectional area A_a .

[0056] On the other hand, the secondary through-holes 104 are evenly arranged in the peripheral portion 103 of the fluid distributor 100 at predetermined intervals in the circumferential direction of the fluid distributor 100. As shown in FIG. 5, six secondary through-holes 104 are formed in the peripheral portion 103 of the fluid distributor 100 according to the first embodiment. Each of the secondary through-holes 104 constricts the flow of the refrigerant that has flowed into the flow inlet 35 of the distribution space SD in the refrigerant inflow tank 30, thereby guiding the refrigerant to the upstream-side refrigerant passages 21 on the upstream side in the flow direction in the distribution space SD.

[0057] Each secondary through-hole 104 is formed, similarly to the primary through-hole 102, by forming a punched hole in the top plate 13 formed in the thin-plate shape. By forming the secondary through-hole 104 as the punched hole, a length of the passage serving as a flow constriction can be shortened to an extent that corresponds to the thickness of the top plate 13, thereby reducing pressure loss caused by the fluid distributor 100.

[0058] Each secondary through-hole 104 is disposed in the peripheral portion 103 of the fluid distributor 100 such that a distance from the central axis of the distribution space SD (i.e., the center point C) to the secondary through-hole 104 is a predetermined distance. At this time, a secondary through-hole position d is defined by using a center position of each secondary through-hole 104 in the fluid distributor 100 and the center point C.

[0059] Furthermore, in the first embodiment, the opening cross-sectional area of the primary through-hole 102, the opening cross-sectional area of each secondary through-hole 104, and the arrangement of each secondary through-hole 104 in the fluid distributor 100 are determined such that the index value γ obtained by Equation (1) described later satisfies a predetermined numerical condition.

[0060] As described above, in the first embodiment, in order to evenly distribute the refrigerant having the gas phase and the liquid phase to the refrigerant passages 21 connected to the distribution space SD, the details of the primary through-hole 102 and the secondary through-holes 104 are determined using the index value γ calculated by Equation (1) shown below. The larger the index value γ , the stronger the effect of the fluid distributor 100 in feeding the refrigerant toward the downstream side in the flow direction within the distribution space SD.

$$\gamma = 0.91 \times \left(\frac{A_a}{A_b} \right)^{0.5} + 0.05 \times \left[\frac{A_t}{(A_a + A_b)} \right]^{1.5} + 0.26 \times (D - d)^{1.5} \dots \text{Equation (1)}$$

[0061] In Equation (1), A_a is an opening cross-sectional area of the primary through-hole 102, A_b is a total opening cross-sectional area of the secondary through-holes 104, D is a diameter of the distribution space SD of the tank, and d is a position of the respective secondary through-holes 104 in the cross-section of the distribution space SD of the tank.

[0062] In the first term of Equation (1), the opening cross-sectional area of the primary through-hole 102 divided by the total opening cross-sectional area of the secondary through-holes 104 is used. Furthermore, the secondary through-hole cross-sectional area A_b is determined by summing the opening cross-sectional areas of the secondary through-holes 104. At this time, with respect to the flow rate of the refrigerant passing through the fluid distributor 100, the first term of Equation (1) indicates that the larger the value of the first term, the greater the flow rate of the refrigerant passing through the center portion 101 than the flow rate of the refrigerant passing through the peripheral portion 103.

[0063] Furthermore, in the second term of Equation (1), $A_a + A_b$ is used. $A_a + A_b$ represents a total opening cross-sectional area in the fluid distributor 100. Furthermore, A_t represents a cross-sectional area of the distribution space SD in the refrigerant inflow tank 30 and corresponds to a surface area of the fluid distributor 100 itself. In the first embodiment, the diameter of the refrigerant inflow tank 30 is the tank diameter D , and the cross-sectional shape of the distribution space SD is circular, so the tank cross-sectional area A_t can be derived using the tank diameter D . The second term of Equation (1) indicates that the larger the numerical value of the second term, the greater the flow velocity of the refrigerant passing through the primary through-hole 102 and the secondary through-holes 104.

[0064] Furthermore, in the third term of Equation (1), $(D - d)$ is used. As described above, D indicates the diameter of the distribution space SD of the tank, and d indicates the position of the respective secondary through-holes 104 in the cross-section of the distribution space of the tank. Therefore, the third term of Equation (1) indicates that the larger the numerical value of the third term, the closer the secondary through-holes 104 are arranged to the center portion 101 in the fluid distributor 100.

[0065] As described above, when the index value γ is experimentally calculated based on Equation (1) described above,

it can be seen that there are characteristics shown in FIG. 6. A performance ratio in FIG. 6 indicates a degree of unevenness in the distribution of the fluid when the fluid is distributed to the refrigerant passages 21 stacked in layers. FIG. 6 indicates that the closer the distribution is to being uniform across the refrigerant passages 21, the closer the value is to 1, and the maximum value of the performance ratio is 1.

[0066] As shown in FIG. 6, the refrigerant distribution characteristics using the index value γ for the fluid distributor 100 according to the first embodiment indicate that when the index value γ is within a certain range, the refrigerant can be uniformly distributed to the refrigerant passages 21 stacked in the distribution space SD.

[0067] Specifically, when the numerical value of the index value γ is smaller than 0.4, the performance ratio of the fluid distributor 100 shows a value smaller than 0.8. When the fluid distributor 100 with the index value γ of smaller than 0.4 is used, the flow of the refrigerant caused by the fluid distributor 100 is directed more toward the upstream side in the flow direction in the distribution space SD. It is considered that the distribution of the refrigerant to the refrigerant passages 21 of the heat exchange core 20 becomes uneven, deteriorating the temperature distribution in the heat exchange core 20, and thus reducing the heat exchange performance of the heat exchanger 1.

[0068] Furthermore, even when the numerical value of the index value γ is larger than 1.1, the performance ratio of the fluid distributor 100 shows a value smaller than 0.8. When the fluid distributor 100 with the index value γ larger than 1.1 is used, the flow of the refrigerant caused by the fluid distributor 100 is directed more toward the downstream side in the flow direction in the distribution space SD. In this case as well, it is considered that the distribution of the refrigerant to the refrigerant passages 21 of the heat exchange core 20 becomes uneven, deteriorating the temperature distribution in the heat exchange core 20, and thus reducing the heat exchange performance of the heat exchanger 1.

[0069] As shown in FIG. 6, when the index value γ is equal to or larger than 0.4 and equal to or smaller than 1.1, the performance ratio of the fluid distributor 100 shows a value in a range of 0.8 to 1.0. When the fluid distributor 100 with the index value γ in the range of 0.4 to 1.1 is used, the flow of the refrigerant caused by the fluid distributor 100 is uniformly directed from the upstream side to the downstream side in the flow direction in the distribution space SD. Thereby, the refrigerant can be uniformly distributed to all the refrigerant passages 21 connected to the distribution space SD, and the temperature distribution in the heat exchange core 20 also becomes uniform, thereby suppressing a decrease in the heat exchange performance of the heat exchanger 1.

[0070] As described above, in the heat exchanger 1 of the first embodiment, the single primary through-hole 102 is formed in the center portion 101 of the fluid distributor 100, and the six secondary through-holes 104 are evenly arranged in the circumferential direction in the peripheral portion 103 of the fluid distributor 100. The primary through-hole 102 constricts the flow of the refrigerant in the central portion of the distribution space SD, thereby increasing the flow velocity toward the downstream side in the flow direction in the distribution space SD.

[0071] Therefore, according to the heat exchanger 1 of the first embodiment, as shown in FIG. 7, the two-phase refrigerant can be made to flow even to the downstream side in the flow direction in the distribution space SD via the primary through-hole 102 of the fluid distributor 100. Thereby, the two-phase refrigerant can be distributed to the downstream-side refrigerant passages 21 that, among the refrigerant passages 21 stacked in the distribution space SD, are connected to the downstream side in the flow direction in the distribution space SD.

[0072] Furthermore, each of the secondary through-holes 104 constricts the flow of the refrigerant on the radially outer side of the distribution space SD (that is, on the inner wall surface side of the refrigerant inflow tank 30) and guides it to the upstream-side refrigerant passages 21 on the upstream side in the flow direction in the distribution space SD. Thereby, the two-phase refrigerant can be distributed to the upstream-side refrigerant passages 21 that, among the refrigerant passages 21 stacked in the distribution space SD, are connected to the upstream side in the flow direction in the distribution space SD.

[0073] That is, according to the heat exchanger 1 of the first embodiment, by utilizing the primary through-hole 102 and the secondary through-holes 104 of the fluid distributor 100, the refrigerant can be uniformly distributed to the refrigerant passages 21 stacked in the distribution space SD. As a result, the heat exchanger 1 can achieve uniform temperature distribution in the heat exchange core 20, thereby suppressing a decrease in the heat exchange performance of the heat exchanger 1.

[0074] Furthermore, the peripheral wall 38 of the refrigerant inflow tank 30 of the first embodiment is formed, as shown in FIGS. 3 and 4, by the tubular portions of the burring portions 11A and the tubular portions of the burring portions 12A. Furthermore, each communication portion 37 is formed by the gap between the distal end of the tubular portion of the corresponding burring portion 11A and the distal end of the tubular portion in the corresponding burring portion 12A.

[0075] For this reason, each communication portion 37 of the refrigerant inflow tank 30 is in communication with the corresponding refrigerant passage 21 over the entire circumferential extent of the refrigerant inflow tank 30. Therefore, when the two-phase refrigerant flows from the refrigerant inflow tank 30 into each refrigerant passage 21, it flows radially over the entire circumferential extent of the distribution space SD and enters the refrigerant passage 21. Thereby, according to the heat exchanger 1, the two-phase refrigerant can be made to flow into each refrigerant passage 21 without the flow of the two-phase refrigerant becoming uneven inside the distribution space SD, and the influence of the flow of the two-phase refrigerant in the distribution space SD on the uniform distribution can be suppressed.

[0076] Furthermore, in the fluid distributor 100 of the heat exchanger 1 of the first embodiment, the opening cross-sectional area of the primary through-hole 102, the opening cross-sectional area of each secondary through-hole 104, and the arrangement of each secondary through-hole 104 in the fluid distributor 100 are determined such that the index value γ satisfies the predetermined numerical condition. The index value γ indicates the distribution characteristics of the refrigerant with respect to the refrigerant passages 21 stacked in the distribution space SD, and when the index value γ is in the range of 0.4 to 1.1, it indicates the state in which the refrigerant is uniformly distributed to the refrigerant passages 21.

[0077] In other words, in the heat exchanger 1 of the first embodiment, by determining the details of the primary through-hole 102 and the secondary through-holes 104 such that the index value γ calculated by Equation (1) falls within the range of 0.4 to 1.1, the refrigerant can be uniformly distributed to the refrigerant passages 21 in the distribution space SD.

[0078] As shown in FIGS. 4 and 7, in the heat exchanger 1 of the first embodiment, the fluid distributor 100 is disposed at the flow inlet 35 of the refrigerant inflow tank 30 formed by the distribution space SD. Therefore, the heat exchanger 1 can uniformly distribute the refrigerant to all the refrigerant passages 21 connected to the refrigerant inflow tank 30, achieve the uniform temperature distribution in the heat exchange core 20 and suppress a decrease in heat exchange performance.

[0079] As described above, in the heat exchanger 1 of the first embodiment, the single primary through-hole 102 is formed in the center portion 101 of the fluid distributor 100, and the six secondary through-holes 104 are evenly arranged in the circumferential direction in the peripheral portion 103 of the fluid distributor 100.

[0080] According to the heat exchanger 1 of the first embodiment, by utilizing the primary through-hole 102 and the secondary through-holes 104 of the fluid distributor 100, the refrigerant can be uniformly distributed to the refrigerant passages 21 stacked in the distribution space SD. As a result, the heat exchanger 1 can achieve uniform temperature distribution in the heat exchange core 20, thereby suppressing a decrease in the heat exchange performance of the heat exchanger 1.

[0081] As shown in FIGS. 3 and 4, each communication portion 37 of the refrigerant inflow tank 30 is in communication with the corresponding refrigerant passage 21 over the entire circumferential extent of the refrigerant inflow tank 30. Therefore, when the two-phase refrigerant flows from the refrigerant inflow tank 30 into each refrigerant passage 21, it flows radially over the entire circumferential extent of the distribution space SD and enters the refrigerant passage 21. Thereby, according to the heat exchanger 1, the two-phase refrigerant can be made to flow into each refrigerant passage 21 without the flow of the two-phase refrigerant becoming uneven inside the distribution space SD, and the influence of the flow of the two-phase refrigerant in the distribution space SD on the uniform distribution can be suppressed.

[0082] Furthermore, in the heat exchanger 1 of the first embodiment, the opening cross-sectional area of the primary through-hole 102, the opening cross-sectional area of each secondary through-hole 104, and the arrangement of each secondary through-hole 104 in the fluid distributor 100 are determined such that the index value γ calculated by Equation (1) falls within the range of 0.4 to 1.1. Thereby, according to the heat exchanger 1 of the first embodiment, by appropriately determining the details of the primary through-hole 102 and the secondary through-holes 104, the uniform distribution of the refrigerant to the refrigerant passages 21 in the distribution space SD can be achieved.

[0083] As shown in FIGS. 4 and 7, the interior of the refrigerant inflow tank 30 is formed by the distribution space SD to which all the stacked refrigerant passages 21 constituting the heat exchange core 20 are connected. The fluid distributor 100 is disposed on the flow inlet 35 side of the refrigerant inflow tank 30, and the flow inlet 35 is located at the most upstream portion in the flow direction of the fluid inside the refrigerant inflow tank 30. Therefore, according to the heat exchanger 1 of the first embodiment, the refrigerant can be uniformly distributed from the refrigerant inflow tank 30 to all the refrigerant passages 21 constituting the heat exchange core 20, thereby suppressing the decrease in the heat exchange efficiency of the heat exchanger 1.

(Second Embodiment)

[0084] Next, the second embodiment different from the above-described embodiment will be described with reference to FIG. 8. In the heat exchanger 1 of the second embodiment, the numbers and the arrangement of the primary through-holes 102 and the secondary through-holes 104 in the fluid distributor 100 differ from those in the first embodiment described above. The other configurations (for example, the heat exchange core 20, etc.) in the heat exchanger 1 of the second embodiment are the same as those in the first embodiment described above, and thus repeated description thereof is omitted.

[0085] As shown in FIG. 8, three primary through-holes 102 are formed in the center portion 101 of the fluid distributor 100 according to the second embodiment. The primary through-hole 102 according to the first embodiment is disposed on the center point C of the fluid distributor 100, whereas the primary through-holes 102 according to the second embodiment are evenly arranged in the circumferential direction at a predetermined distance from the center point C of the fluid distributor 100.

[0086] Furthermore, twelve secondary through-holes 104 are formed in the peripheral portion 103 of the fluid distributor 100 according to the second embodiment. The secondary through-holes 104 according to the first embodiment are evenly

arranged in the circumferential direction in the peripheral portion 103 such that the distance from the center point C to the secondary through-hole 104 is the predetermined distance. On the other hand, the secondary through-holes 104 according to the second embodiment include: a first group of six secondary through-holes 104, which are arranged in the peripheral portion 103 such that a distance from the center point C to each of these secondary through-holes 104 is a predetermined distance; and a second group of six secondary through-holes 104, which are arranged in the peripheral portion 103 such that a distance from the center point C to each of these six secondary through-holes 104 is set to be larger than the distance of each of the six secondary through-holes 104 of the first group. In each group, the six secondary through-holes 104, which are at the same distance from the center point C, are evenly arranged in the peripheral portion 103 at predetermined intervals in the circumferential direction.

[0087] In the fluid distributor 100 according to the second embodiment, each primary through-hole 102, similarly to the first embodiment, constricts the flow of the refrigerant in the central portion of the distribution space SD, thereby increasing the flow velocity toward the downstream side in the flow direction in the distribution space SD. Furthermore, each of the secondary through-holes 104 of the second embodiment constricts the flow of the refrigerant on the radially outer side of the distribution space SD (that is, on the inner wall surface side of the refrigerant inflow tank 30) and guides it to the upstream-side refrigerant passages 21 on the upstream side in the flow direction in the distribution space SD.

[0088] Therefore, according to the heat exchanger 1 of the second embodiment, by utilizing the primary through-holes 102 and the secondary through-holes 104 of the fluid distributor 100, the refrigerant can be uniformly distributed to the refrigerant passages 21 stacked in the distribution space SD. As a result, the heat exchanger 1 can achieve uniform temperature distribution in the heat exchange core 20, thereby suppressing a decrease in the heat exchange performance of the heat exchanger 1.

[0089] Furthermore, in the fluid distributor 100 according to the second embodiment, by increasing the number of the primary through-holes 102 and the number of the secondary through-holes 104 and providing the multiple patterns for the distance between the center point C and the secondary through-holes 104, the pattern of the constricted flow of the refrigerant can be controlled in greater detail. Thereby, according to the heat exchanger 1 of the second embodiment, by using the fluid distributor 100, more precise uniform distribution of the refrigerant to the refrigerant passages 21 stacked in the distribution space SD can be achieved.

[0090] As explained above, according to the heat exchanger 1 of the second embodiment, even when the numbers and the arrangement of the primary through-holes 102 and the secondary through-holes 104 in the fluid distributor 100 differ, the advantageous effects achieved from the configuration and operation common to the above-described embodiment can be obtained.

(Third Embodiment)

[0091] Next, the third embodiment different from the above-described embodiments will be described with reference to FIG. 9. In the heat exchanger 1 according to the third embodiment, the manner of connecting a refrigerant inflow pipe 35A to the flow inlet 35 differs from that in the above-described embodiments. The other configurations (for example, the heat exchange core 20, etc.) in the heat exchanger 1 of the third embodiment are the same as those in the embodiments described above, and thus repeated description thereof is omitted.

[0092] As shown in FIGS. 4 and 7, in the heat exchanger 1 according to the first embodiment, the refrigerant pipe is connected to the connector member 36 of the flow inlet 35 of the refrigerant inflow tank 30 so as to extend along the Z-axis direction. Therefore, in the first embodiment, the refrigerant flows along the Z-axis direction from the upstream of the flow inlet 35 into the interior of the distribution space SD.

[0093] On the other hand, as shown in FIG. 9, the refrigerant inflow pipe 35A, which extends along one surface of the heat exchange core 20 facing in the positive Z-axis direction, is connected to the flow inlet 35 of the heat exchanger 1 according to the third embodiment. Therefore, in the third embodiment, the refrigerant flows inside the refrigerant inflow pipe 35A along a direction perpendicular to the Z-axis and then flows along the Z-axis direction from immediately upstream of the flow inlet 35. For this reason, in the second embodiment, the refrigerant flows along the Z-axis direction from the flow inlet 35 into the interior of the distribution space SD.

[0094] Furthermore, the fluid distributor 100 according to the third embodiment is attached to the flow inlet 35 of the refrigerant inflow tank 30 formed by the distribution space SD. Therefore, even in the heat exchanger 1 according to the third embodiment, by utilizing the primary through-hole 102 and the secondary through-holes 104 of the fluid distributor 100, the refrigerant can be uniformly distributed to the refrigerant passages 21.

[0095] As explained above, according to the heat exchanger 1 of the third embodiment, even when the manner of supplying the fluid to the tank is changed, the advantageous effects achieved from the configuration and operation common to the above-described embodiments can be obtained.

(Fourth Embodiment)

[0096] Next, the fourth embodiment different from the above-described embodiments will be described with reference to FIG. 10. In the heat exchanger 1 according to the fourth embodiment, the arrangement of the fluid distributor 100 at the flow inlet 35 differs from that in the above-described embodiments. The other configurations (for example, the outer plate 11, the inner plate 12, etc.) in the heat exchanger 1 according to the fourth embodiment are the same as those in the above-described embodiments, and thus repeated description thereof is omitted.

[0097] In the embodiments described above, the fluid distributor 100 was formed as a part of the top plate 13 and disposed at the flow inlet 35 of the distribution space SD. As shown in FIG. 10, the fluid distributor 100 according to the fourth embodiment is formed as a separate member which is separate from the top plate 13, and the fluid distributor 100 has the primary through-hole 102 and the secondary through-holes 104 similarly to the above-described embodiments.

[0098] The fluid distributor 100 according to the fourth embodiment is attached inside the connector member 36 that is attached to the flow inlet 35. Specifically, the fluid distributor 100 according to the fourth embodiment constricts a flow of the refrigerant flowing inside a refrigerant passage formed in the connector member 36 from the refrigerant inflow pipe 35A toward the flow inlet port of the refrigerant inflow tank 30. That is, the fluid distributor 100 according to the fourth embodiment constricts, through the primary through-hole 102 and the secondary through-holes 104, the flow of the refrigerant directed toward the interior of the distribution space SD via the connector member 36 and the flow inlet port.

[0099] Therefore, even in the heat exchanger 1 according to the fourth embodiment, by utilizing the primary through-hole 102 and the secondary through-holes 104 of the fluid distributor 100, the refrigerant can be uniformly distributed to the refrigerant passages 21 connected to the distribution space SD.

[0100] As explained above, according to the heat exchanger 1 of the fourth embodiment, even when the fluid distributor 100 is disposed in the connector member 36 of the flow inlet 35, the advantageous effects achieved from the configuration and operation common to the above-described embodiments can be obtained.

[0101] As shown in FIG. 10, in the heat exchanger 1 according to the fourth embodiment, the fluid distributor 100 is disposed in the connector member 36 located upstream of the flow inlet port of the refrigerant inflow tank 30 in the flow direction. That is, the fluid distributor 100 is not limited to the arrangement in which it is attached to the flow inlet port of the distribution space SD, and the arrangement in which it is disposed upstream of the flow inlet port of the distribution space SD in the flow direction can also be adopted.

(Fifth Embodiment)

[0102] Next, the fifth embodiment different from the above-described embodiments will be described with reference to FIG. 11. In the heat exchanger 1 according to the fifth embodiment, the manner of fluid circulation inside the heat exchanger 1 differs from that in the above-described embodiments. The other configurations (for example, the refrigerant passages 21, etc.) in the heat exchanger 1 according to the fifth embodiment are the same as those in the above-described embodiments, and thus repeated description thereof is omitted.

[0103] In the heat exchanger 1 according to the above-described embodiments, the refrigerant, upon flowing into the refrigerant inflow tank 30, flows toward the refrigerant discharge tank 40 via the refrigerant passages 21. Then, the refrigerant, which has flowed into the collection space SA of the refrigerant discharge tank 40, flows out to the outside of the heat exchanger 1 and circulates through the refrigeration cycle.

[0104] As for the flow of the refrigerant in the heat exchanger, there is a mode that adopts a manner different from the manner described in the above-described embodiments, and a manner known as a so-called turn-back system is known. The heat exchanger 1 according to the fifth embodiment achieves uniform distribution of the refrigerant to the refrigerant passages 21 when the turn-back system is adopted.

[0105] First, the configuration related to the flow of the refrigerant in the heat exchanger 1 according to the fifth embodiment will be described with reference to the drawing. The heat exchanger 1 according to the fifth embodiment is, similarly to the above-described embodiments, formed by stacking the plate members 10 in the Z-axis direction and includes the refrigerant passages 21, a first refrigerant tank 70 and a second refrigerant tank 80. The first refrigerant tank 70 is a reservoir into which the two-phase refrigerant flowing from the refrigeration cycle flows, and the first refrigerant tank 70 serves as an example of a tank.

[0106] In the fifth embodiment, the first refrigerant tank 70 is arranged similarly to the refrigerant inflow tank 30 in the above-described embodiments. Unlike the refrigerant inflow tank 30 in the above-described embodiments, the first refrigerant tank 70 in the fifth embodiment is partitioned into two sections at a middle portion in the Z-axis direction and thereby has a distribution space SD and a collection space SA.

[0107] The second refrigerant tank 80 is disposed at a position where the second refrigerant tank 80 is opposed to the first refrigerant tank 70 while the refrigerant passages 21 are interposed between the second refrigerant tank 80 and the first refrigerant tank 70. The second refrigerant tank 80 serves as a reservoir into which the refrigerant that has flowed through the refrigerant passages 21 flows. Unlike the refrigerant discharge tank 40 in the above-described embodiments,

which is formed by the collection space SA, the second refrigerant tank 80 in the fifth embodiment is formed by a collection space SA and a distribution space SD.

[0108] Therefore, the flow of the refrigerant in the heat exchanger 1 according to the fifth embodiment is in the order of the distribution space SD of the first refrigerant tank 70, the refrigerant passages 21 constituting an upper portion of the heat exchange core 20, the collection space SA of the second refrigerant tank 80 and the distribution space SD of the second refrigerant tank 80. When the refrigerant flows into the distribution space SD of the second refrigerant tank 80, it flows in the order of the refrigerant passages 21 constituting a lower portion of the heat exchange core 20 and then the collection space SA of the first refrigerant tank 70 and is discharged from the discharge outlet 75 to the outside of the heat exchanger 1. Therefore, in the fifth embodiment, the second refrigerant tank 80 also serves as an example of a tank.

[0109] That is, in a turn-back type heat exchanger such as the heat exchanger 1 according to the fifth embodiment, collection and distribution of the refrigerant are performed inside the second refrigerant tank 80, and the flow of the refrigerant is turned back toward the first refrigerant tank 70.

[0110] Here, the following discusses the case where a configuration is adopted in which the fluid distributor 100 is disposed at the flow inlet port of the tank, as in the above-described embodiments. As shown in FIG. 11, the distribution space SD of the first refrigerant tank 70 is disposed on the downstream side of a flow inlet port of the first refrigerant tank 70 in the refrigerant flow direction. For this reason, the fluid distributor 100 can uniformly distribute the refrigerant to the refrigerant passages 21 connected to the distribution space SD of the first refrigerant tank 70 based on the same principle as in the above-described embodiments.

[0111] It is assumed that a configuration, which corresponds to a flow inlet port of the second refrigerant tank 80, is a connecting portion that connects to the refrigerant passages 21 extending from the distribution space SD of the first refrigerant tank 70. The collection space SA of the second refrigerant tank 80 is disposed on the downstream side of this connecting portion in the flow direction. In the second refrigerant tank 80, the distribution space SD is disposed on the downstream side of the collection space SA in the flow direction. Therefore, even if the fluid distributor 100 is disposed at the flow inlet port of the second refrigerant tank 80, the effect of constricting the refrigerant flow by the primary through-hole 102 and the secondary through-holes 104 does not sufficiently reach the distribution space SD, and uniform distribution of the refrigerant to the refrigerant passages 21 of the second refrigerant tank 80 cannot be ensured.

[0112] In view of the above points, the heat exchanger 1 according to the fifth embodiment achieves uniform distribution of the refrigerant to the refrigerant passages 21 in either of a pair of refrigerant tanks (for example, the first refrigerant tank 70 and the second refrigerant tank 80) in a turn-back type heat exchanger.

[0113] As shown in FIG. 11, in the heat exchanger 1 according to the fifth embodiment, the fluid distributor 100 is disposed at the flow inlet 35 of the first refrigerant tank 70. The fluid distributor 100 has the primary through-hole 102 and the secondary through-holes 104, similarly to the above-described embodiments. Therefore, in the heat exchanger 1 according to the fifth embodiment, by utilizing the primary through-hole 102 and the secondary through-holes 104 of the fluid distributor 100, the refrigerant can be uniformly distributed to the refrigerant passages 21 connected to the distribution space SD of the first refrigerant tank 70.

[0114] Furthermore, a partition plate 14 is disposed at the middle position of the heat exchange core 20 in the heat exchanger 1 according to the fifth embodiment. A tank blocking portion 14A is formed in the partition plate 14 at a location that corresponds to the first refrigerant tank 70. The tank blocking portion 14A partitions the internal space of the first refrigerant tank 70 into two sections in the Z-axis direction.

[0115] In the internal space of the first refrigerant tank 70, one space located on one side of the tank blocking portion 14A in the positive Z-axis direction forms the distribution space SD of the first refrigerant tank 70. In the internal space of the first refrigerant tank 70, another space located on another side of the tank blocking portion 14A in the negative Z-axis direction forms the collection space SA of the first refrigerant tank 70. Thereby, the refrigerant flow in the heat exchanger 1 according to the fifth embodiment becomes a turn-back type flow.

[0116] As shown in FIG. 11, the fluid distributor 100 is disposed at the middle portion of the second refrigerant tank 80 in the heat exchanger 1 according to the fifth embodiment. The fluid distributor 100 in the second refrigerant tank 80 is formed integrally with the partition plate 14 described above. Specifically, the fluid distributor 100 in the second refrigerant tank 80 is disposed at a location on the partition plate 14 corresponding to the second refrigerant tank 80 and has the primary through-hole 102 and the secondary through-holes 104.

[0117] Therefore, in the internal space of the second refrigerant tank 80, the fluid distributor 100 is disposed at a boundary between the collection space SA and the distribution space SD. The boundary between the collection space SA and the distribution space SD in the second refrigerant tank 80 serves as a flow inlet 35 of the distribution space SD in the second refrigerant tank 80.

[0118] Thereby, in the internal space of the second refrigerant tank 80, when the refrigerant flows from the collection space SA into the distribution space SD, it can be made to pass through the fluid distributor 100 having the primary through-hole 102 and the secondary through-holes 104. As a result, similarly to the above-described embodiments, by utilizing the primary through-hole 102 and the secondary through-holes 104 of the fluid distributor 100, the refrigerant can be uniformly distributed to the refrigerant passages 21 connected to the distribution space SD of the second refrigerant tank 80.

[0119] As explained above, according to the heat exchanger 1 of the fifth embodiment, even when the manner of fluid circulation inside the heat exchanger 1 is changed to the turn-back type, the advantageous effects achieved from the configuration and operation common to the above-described embodiments can be obtained.

[0120] That is, according to the heat exchanger 1 of the fifth embodiment, by disposing the fluid distributor 100 at the middle portion of the second refrigerant tank 80 (at the boundary between the collection space SA and the distribution space SD), uniform distribution of the refrigerant to the refrigerant passages 21 in the distribution space SD of the second refrigerant tank 80 can be achieved.

(Sixth Embodiment)

[0121] Next, the sixth embodiment different from the above-described embodiments will be described with reference to FIG. 12. In the heat exchanger 1 according to the sixth embodiment, the shape of the fluid distributor 100 differs from that in the above-described embodiments. The other configurations (for example, the heat exchange core 20, etc.) in the heat exchanger 1 according to the sixth embodiment are the same as those in the above-described embodiments, and thus repeated description thereof is omitted.

[0122] In the above-described embodiments, the fluid distributor 100 is formed by the flat plate member made of the thin plate, but is not limited to this type. For example, the positional relationship of the center portion 101 and the peripheral portion 103 of the fluid distributor 100 with respect to the refrigerant flow direction may be different.

[0123] Specifically, as shown in FIG. 12, the fluid distributor 100 may be formed such that the center portion 101 of the fluid distributor 100 is positioned on the downstream side in the refrigerant flow direction relative to the peripheral portion 103. By positioning the center portion 101, in which the primary through-hole 102 is formed, further on the downstream side in the refrigerant flow direction, it becomes possible to supply the refrigerant even further downstream with respect to the flow direction in the distribution space SD.

[0124] Furthermore, the peripheral portion 103 may be configured to be inclined such that the peripheral portion 103 is positioned further on the downstream side in the refrigerant flow direction as the peripheral portion 103 approaches the center point C of the fluid distributor 100. Thereby, a component in a direction away from the central axis of the distribution space SD can be imparted to the flow direction of the constricted flow passing through the respective secondary through-holes 104 formed in the peripheral portion 103, thereby improving the distribution performance of the refrigerant to the upstream-side refrigerant passages 21 on the upstream side in the distribution space SD.

[0125] As explained above, according to the heat exchanger 1 of the sixth embodiment, even when the shape of the fluid distributor 100 is changed, the advantageous effects achieved from the configuration and operation common to the above-described embodiments can be obtained.

(Seventh Embodiment)

[0126] Next, the seventh embodiment different from the above-described embodiments will be described with reference to FIG. 13. In the heat exchanger 1 according to the seventh embodiment, the configuration of the opening edge of each of the primary through-hole 102 and the secondary through-holes 104 in the fluid distributor 100 differs from that in the above-described embodiments. The other configurations (for example, the heat exchange core 20, etc.) in the heat exchanger 1 according to the seventh embodiment are the same as those in the above-described embodiments, and thus repeated description thereof is omitted.

[0127] In the embodiments described above, the primary through-hole 102 and the secondary through-holes 104 in the fluid distributor 100 are formed by forming the punched holes in the plate member 10 shaped in the thin-plate shape, but the fluid distributor 100 is not limited to this configuration. For example, as shown in FIG. 13, a guide projection 110, which projects toward the downstream side in the refrigerant flow direction, may be formed on the opening edge of each of the primary through-hole 102 and the secondary through-holes 104.

[0128] By forming the guide projection 110 on the opening edge of each of the primary through-hole 102 and the secondary through-holes 104, the flow direction of the constricted refrigerant passing through the primary through-hole 102 and the secondary through-holes 104 can be adjusted. Thereby, according to the heat exchanger 1 of the seventh embodiment, by utilizing the primary through-hole 102 and the secondary through-holes 104 of the fluid distributor 100, the refrigerant can be uniformly distributed with higher accuracy to the refrigerant passages 21 connected to the distribution space SD.

[0129] As explained above, according to the heat exchanger 1 of the seventh embodiment, even when the shape of the opening edge of each of the primary through-hole 102 and the secondary through-holes 104 in the fluid distributor 100 is changed, the advantageous effects achieved from the configuration and operation common to the above-described embodiments can be obtained.

(Eighth Embodiment)

[0130] Next, the eighth embodiment different from the above-described embodiments will be described with reference to FIG. 14. In the heat exchanger 1 according to the eighth embodiment, the shapes of the primary through-hole 102 and the secondary through-holes 104 in the fluid distributor 100 differ from those in the above-described embodiments. The other configurations (for example, the heat exchange core 20, etc.) in the heat exchanger 1 according to the eighth embodiment are the same as those in the above-described embodiments, and thus repeated description thereof is omitted.

[0131] In the embodiments described above, the opening shape of each of the primary through-hole 102 and the secondary through-holes 104 in the fluid distributor 100 is circular, but the fluid distributor 100 is not limited to this configuration. As long as the constituent member of the fluid distributor 100 is opened to allow the refrigerant to flow therethrough, various shapes can be adopted as the opening shape of the primary through-hole 102 and the secondary through-holes 104. For example, as shown in FIG. 14, the opening shape of the primary through-hole 102 and the secondary through-holes 104 may be a rectangular shape with four rounded corners.

[0132] As explained above, according to the heat exchanger 1 of the eighth embodiment, even when the shapes of the primary through-hole 102 and the secondary through-holes 104 in the fluid distributor 100 are changed, the advantageous effects achieved from the configuration and operation common to the above-described embodiments can be obtained.

[0133] The present disclosure is not limited to the above-described embodiments and may be modified in various ways as follows without departing from the spirit of the present disclosure.

[0134] In the embodiments described above, the heat exchanger according to the present disclosure is applied to the chiller that performs heat exchange between the refrigerant circulating in the refrigeration cycle and the coolant circulating in the coolant circuit, but the heat exchanger is not limited to this application. The technology according to the present disclosure can be applied to various heat exchangers as long as the heat exchanger is intended for a two-phase fluid having a gas phase and a liquid phase. For example, it is also possible to configure the heat exchanger according to the present disclosure as an evaporator that evaporates the refrigerant by absorbing heat from outside the heat exchanger (for example, air blown into a vehicle cabin, etc.) into the refrigerant circulating in the refrigeration cycle.

[0135] Furthermore, in the embodiments described above, the heat exchanger 1 was formed by stacking the plate members 10 in the stacking direction Z, but the heat exchanger is not limited to this configuration. The heat exchanger 1 according to the present disclosure may adopt various configurations as long as it has the tank into which the two-phase fluid flows (for example, the refrigerant inflow tank 30, etc.) and the refrigerant passages 21 connected to the distribution space SD of the tank and stacked in the stacking direction Z. For example, the technology according to the present disclosure may also be applied to a heat exchanger adopting a tank-and-tube type configuration. Furthermore, the center point in the cross-section of the distribution space may be a centroid of the cross-section of the distribution space.

[0136] The features of the heat exchanger disclosed in the present specification are as follows.

(Aspect 1)

[0137] According to aspect 1, there is provided a heat exchanger including:

a plurality of fluid passages (21) that are stacked in layers in a stacking direction that is predetermined, wherein the plurality of fluid passages are configured to conduct a fluid that has a gas phase and a liquid phase; and
a tank (30, 70, 80) that extends in the stacking direction of the plurality of fluid passages and is connected to the plurality of fluid passages, wherein:

the tank has:

a distribution space (SD) that is configured to distribute the fluid to the plurality of fluid passages; and
a flow inlet (35) that is configured to introduce the fluid into the distribution space;

a fluid distributor (100), which is configured to control flow of the fluid to the plurality of fluid passages, is disposed at a location adjacent to the flow inlet of the distribution space of the tank;
the fluid distributor has:

a primary through-hole (102) that is configured to guide the fluid to one or more of the plurality of fluid passages, which are connected to a downstream portion of the distribution space located on a downstream side in a flow direction of the fluid flowing in the distribution space; and
a secondary through-hole (104) that is configured to guide the fluid to another one or more of the plurality of fluid passages, which are connected to an upstream portion of the distribution space located on an upstream side in the flow direction of the fluid flowing in the distribution space;

the primary through-hole is disposed in a center portion (101) of the fluid distributor, wherein the center portion is formed in a predetermined range centered on a center point (C) in a cross-section of the distribution space; and the secondary through-hole is disposed in a peripheral portion (103) of the fluid distributor, wherein the peripheral portion is formed in a range between an inner wall surface of the distribution space and the center portion.

(Aspect 2)

[0138] According to aspect 2, there is provided the heat exchanger according to aspect 1, wherein:

the plurality of fluid passages and the tank in the heat exchanger are formed by a plurality of plate members (10) which are respectively formed in a plate shape and are joined together in a state where the plurality of plate members are stacked in layers in the stacking direction;
each of the plurality of fluid passages is formed between corresponding adjacent two of the plurality of plate members; a plurality of openings (11A, 12A), each of which is formed by a corresponding one of the plurality of plate members at a predetermined location of the corresponding one of the plurality of plate members, are used to extend the distribution space of the tank in the stacking direction; and
each of a plurality of communication portions (37), each of which communicates the distribution space of the tank with a corresponding one of the plurality of fluid passages, is formed over an entire circumferential extent of the tank.

(Aspect 3)

[0139] According to aspect 3, there is provided the heat exchanger according to aspect 1 or 2, wherein:

the primary through-hole is formed as a single primary through-hole in the center portion of the fluid distributor at a location centered in the cross-section of the distribution space;
the secondary through-hole is one of a plurality of secondary through-holes, which are formed in the peripheral portion of the fluid distributor under a condition where each of the plurality of secondary through-holes is spaced by a predetermined distance (d) from the center point; and
the primary through-hole and the plurality of secondary through-holes of the fluid distributor are formed such that an index value (γ), which is derived from the following Equation (1), is larger than 0.4 and is smaller than 1.1:

$$\gamma = 0.91 \times \left(\frac{A_a}{A_b} \right)^{0.5} + 0.05 \times \left[\frac{A_t}{(A_a + A_b)} \right]^{1.5} + 0.26 \times (D - d)^{1.5} \dots \text{Equation (1)}$$

where A_a is an opening cross-sectional area of the primary through-hole;
 A_b is a total opening cross-sectional area of the plurality of secondary through-holes;
 A_t is a cross-sectional area of the distribution space of the tank;
 D is a diameter of the distribution space of the tank; and
 d is a position of the plurality of secondary through-holes in the cross-section of the distribution space of the tank.

(Aspect 4)

[0140] According to aspect 4, there is provided the heat exchanger according to any one of aspects 1 to 3, wherein:

an inside of the tank is formed by the distribution space (SD) provided for all of the plurality of fluid passages that are stacked; and
the fluid distributor is disposed at the flow inlet located at a most upstream portion in the flow direction of the fluid in the inside of the tank.

(Aspect 5)

[0141] According to aspect 5, there is provided the heat exchanger according to aspect 4, wherein:

a connector member (36), which is configured to connect with a supply pipe for supplying the fluid into the tank, is attached to the flow inlet of the tank, and
the fluid distributor is disposed in a fluid passage of the fluid formed in the connector member.

(Aspect 6)

[0142] According to aspect 6, there is provided the heat exchanger according to any one of aspects 1 to 3, wherein:

an inside of the tank has: a collection space (SA), which is configured to collect the fluid which has flowed through corresponding one or more of the plurality of fluid passages; and the distribution space (SD), which is for the fluid that has flowed through the collection space (SA); and the fluid distributor is disposed in the flow inlet through which the fluid flowed out from the collection space flows into the distribution space.

[0143] Although the present disclosure has been described with reference to the embodiments and the modifications, it is understood that the present disclosure is not limited to the embodiments and the modifications and structures described therein. The present disclosure also encompasses various modifications and changes within the scope of equivalents. Also, various combinations and forms, as well as other combinations and forms that include only one element, more, or less, are within the scope and ideology of the present disclosure.

Claims

1. A heat exchanger comprising:

a plurality of fluid passages (21) that are stacked in layers in a stacking direction that is predetermined, wherein the plurality of fluid passages are configured to conduct a fluid that has a gas phase and a liquid phase; and a tank (30, 70, 80) that extends in the stacking direction of the plurality of fluid passages and is connected to the plurality of fluid passages, wherein:

the tank has:

a distribution space (SD) that is configured to distribute the fluid to the plurality of fluid passages; and a flow inlet (35) that is configured to introduce the fluid into the distribution space;

a fluid distributor (100), which is configured to control flow of the fluid to the plurality of fluid passages, is disposed at a location adjacent to the flow inlet of the distribution space of the tank;

the fluid distributor has:

a primary through-hole (102) that is configured to guide the fluid to one or more of the plurality of fluid passages, which are connected to a downstream portion of the distribution space located on a downstream side in a flow direction of the fluid flowing in the distribution space; and

a secondary through-hole (104) that is configured to guide the fluid to another one or more of the plurality of fluid passages, which are connected to an upstream portion of the distribution space located on an upstream side in the flow direction of the fluid flowing in the distribution space;

the primary through-hole is disposed in a center portion (101) of the fluid distributor, wherein the center portion is formed in a predetermined range centered on a center point (C) in a cross-section of the distribution space; and

the secondary through-hole is disposed in a peripheral portion (103) of the fluid distributor, wherein the peripheral portion is formed in a range between an inner wall surface of the distribution space and the center portion.

2. The heat exchanger according to claim 1, wherein:

the plurality of fluid passages and the tank in the heat exchanger are formed by a plurality of plate members (10) which are respectively formed in a plate shape and are joined together in a state where the plurality of plate members are stacked in layers in the stacking direction;

each of the plurality of fluid passages is formed between corresponding adjacent two of the plurality of plate members;

a plurality of openings (11A, 12A), each of which is formed by a corresponding one of the plurality of plate members at a predetermined location of the corresponding one of the plurality of plate members, are used to

extend the distribution space of the tank in the stacking direction; and
 each of a plurality of communication portions (37), each of which communicates the distribution space of the tank
 with a corresponding one of the plurality of fluid passages, is formed over an entire circumferential extent of the
 tank.

3. The heat exchanger according to claim 1, wherein:

the primary through-hole is formed as a single primary through-hole in the center portion of the fluid distributor at a
 location centered in the cross-section of the distribution space;
 the secondary through-hole is one of a plurality of secondary through-holes, which are formed in the peripheral
 portion of the fluid distributor under a condition where each of the plurality of secondary through-holes is spaced
 by a predetermined distance (d) from the center point; and
 the primary through-hole and the plurality of secondary through-holes of the fluid distributor are formed such that
 an index value (γ), which is derived from the following Equation (1), is larger than 0.4 and is smaller than 1.1:

$$\gamma = 0.91 \times \left(\frac{Aa}{Ab} \right)^{0.5} + 0.05 \times \left[\frac{At}{(Aa + Ab)} \right]^{1.5} + 0.26 \times (D - d)^{1.5} \dots \text{Equation (1)}$$

where Aa is an opening cross-sectional area of the primary through-hole;
 Ab is a total opening cross-sectional area of the plurality of secondary through-holes;
 At is a cross-sectional area of the distribution space of the tank;
 D is a diameter of the distribution space of the tank; and
 d is a position of the plurality of secondary through-holes in the cross-section of the distribution space of the tank.

4. The heat exchanger according to any one of claims 1 to 3, wherein:

an inside of the tank is formed by the distribution space (SD) provided for all of the plurality of fluid passages that
 are stacked; and
 the fluid distributor is disposed at the flow inlet located at a most upstream portion in the flow direction of the fluid in
 the inside of the tank.

5. The heat exchanger according to claim 4, wherein:

a connector member (36), which is configured to connect with a supply pipe for supplying the fluid into the tank, is
 attached to the flow inlet of the tank, and
 the fluid distributor is disposed in a fluid passage of the fluid formed in the connector member.

FIG. 1

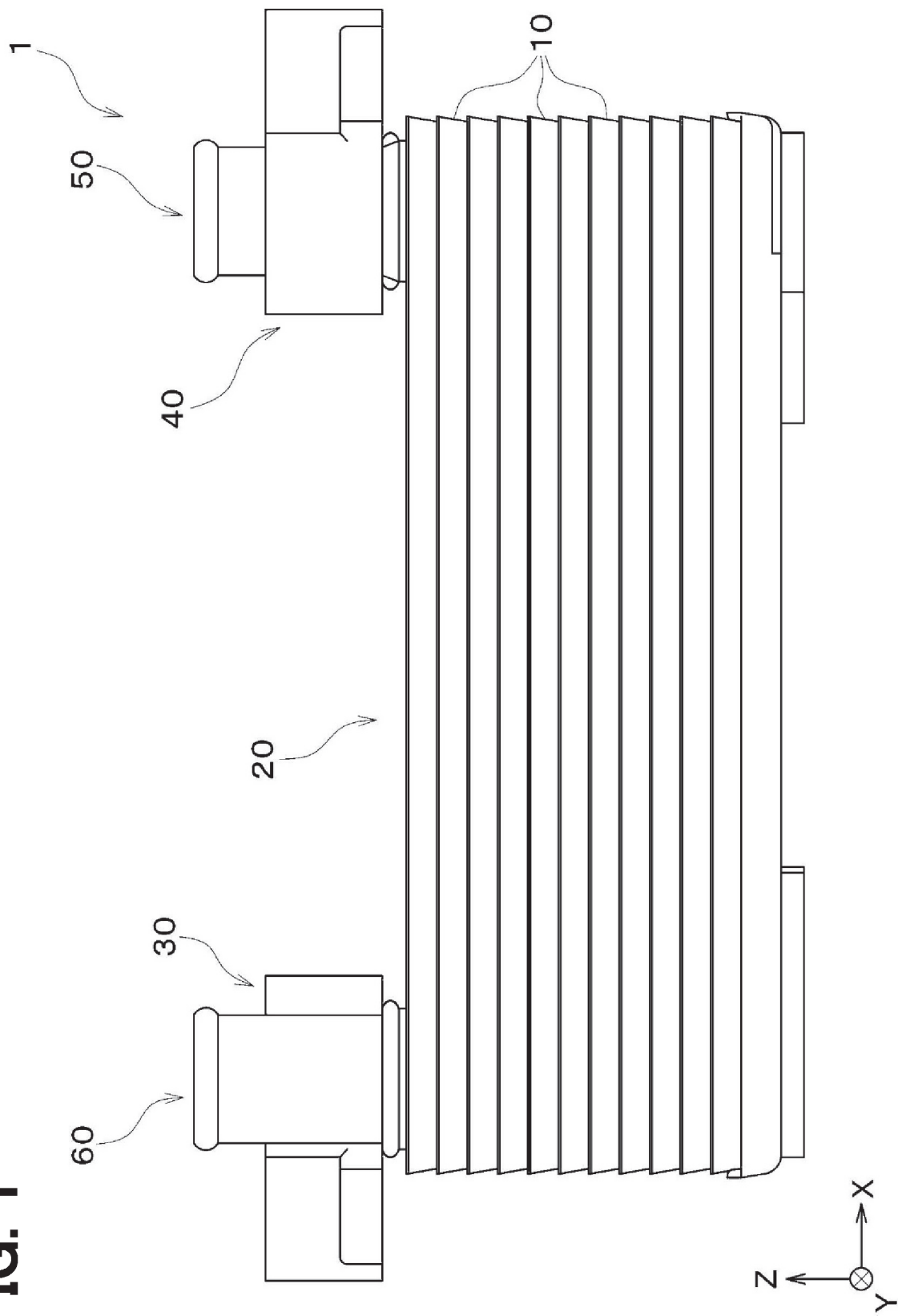


FIG. 2

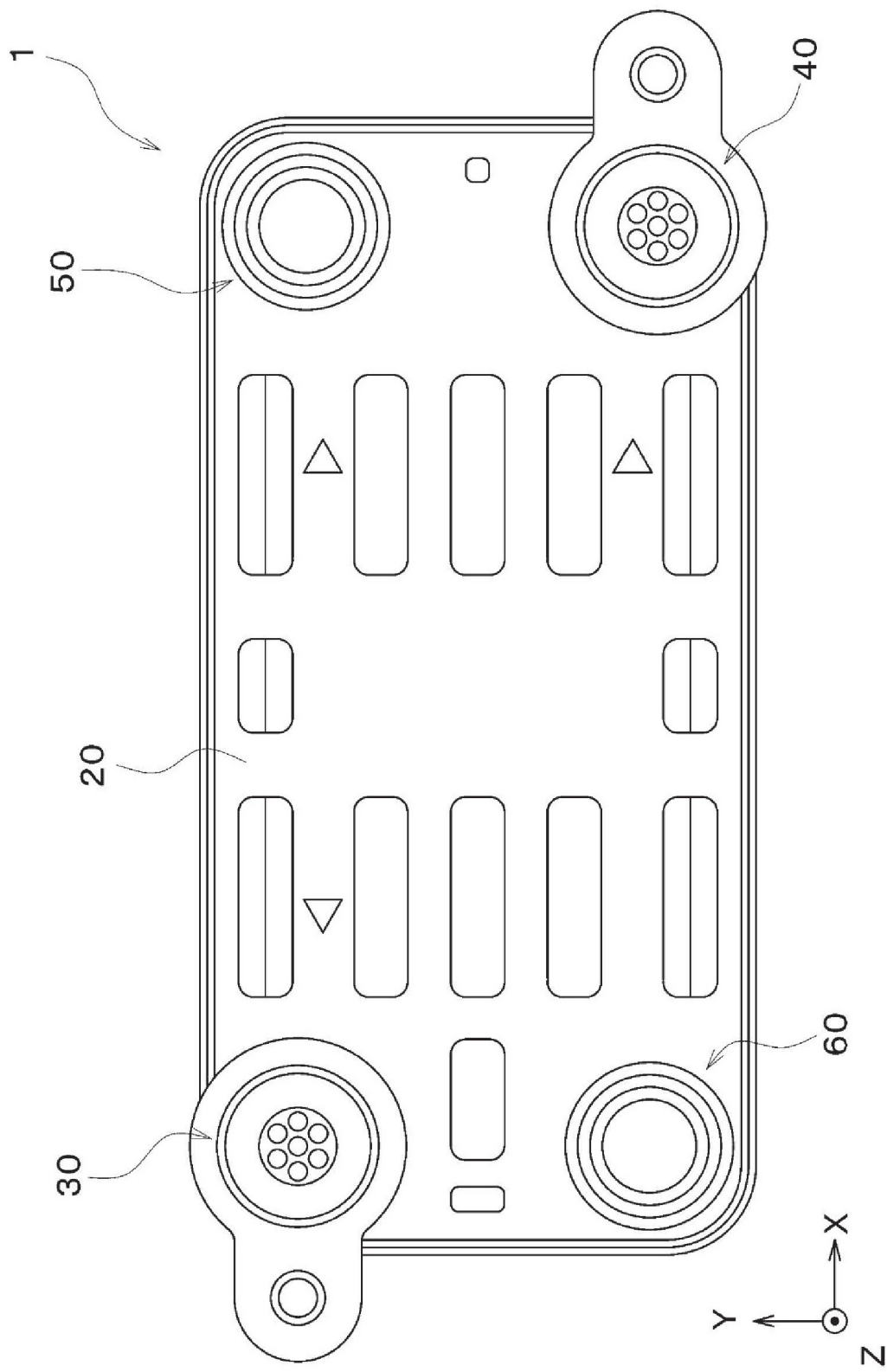


FIG. 3

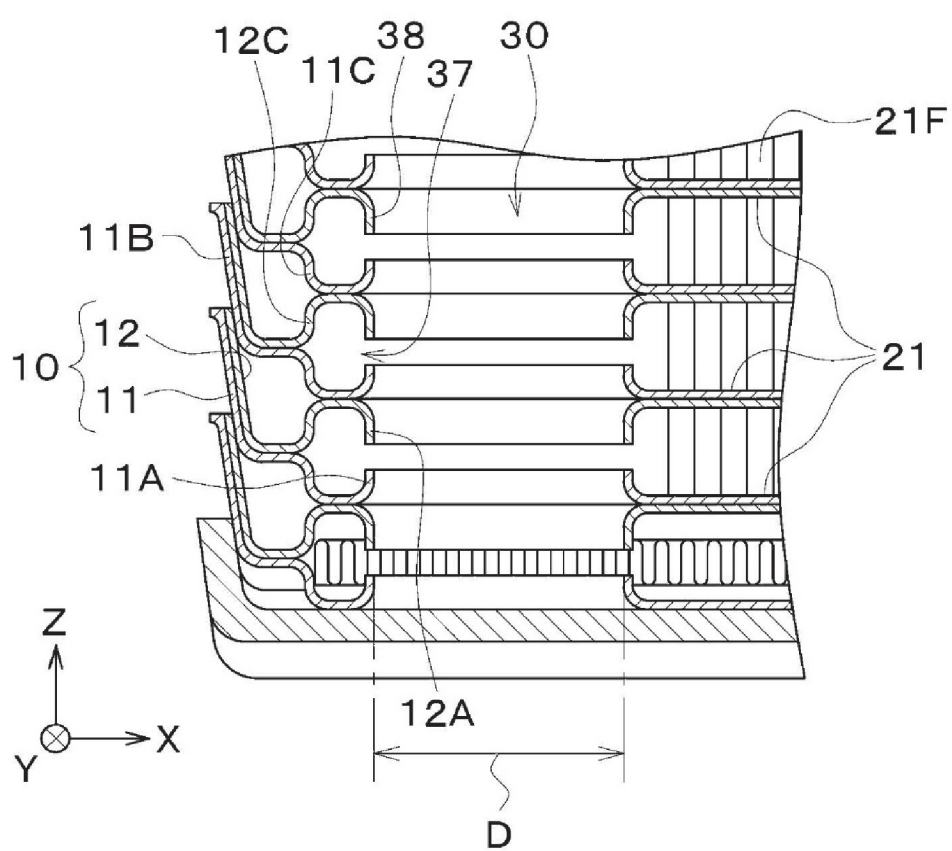


FIG. 4

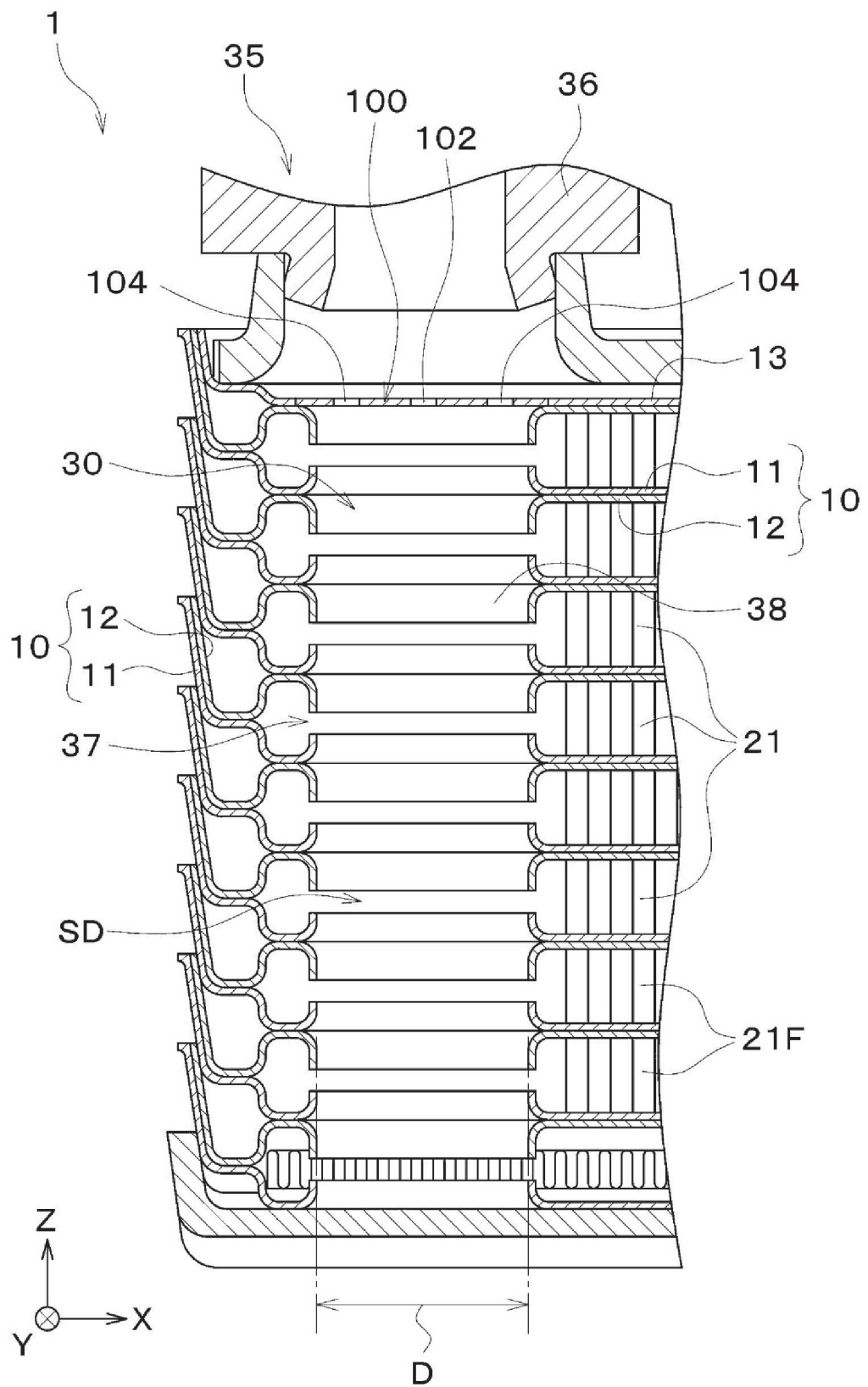


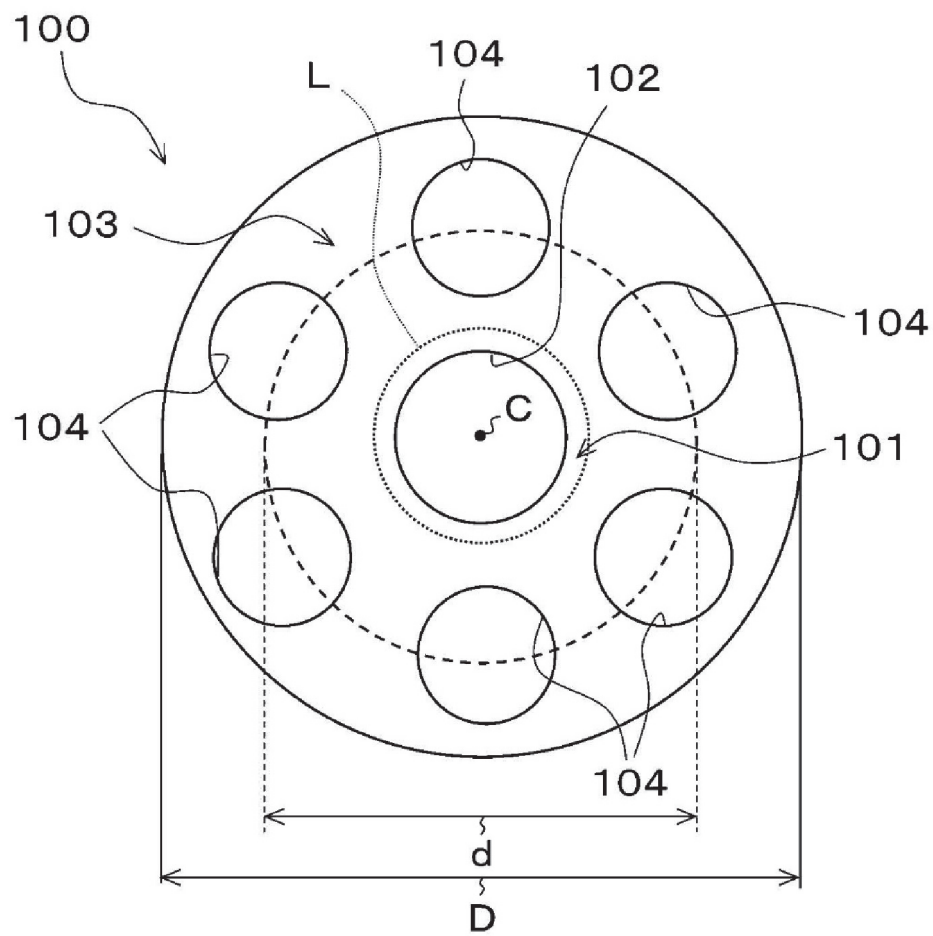
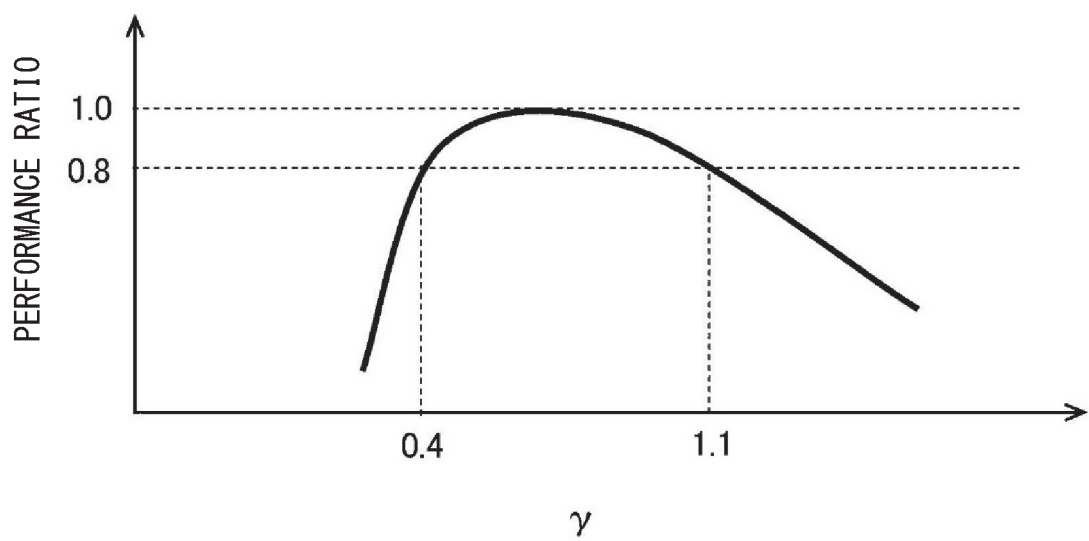
FIG. 5**FIG. 6**

FIG. 7

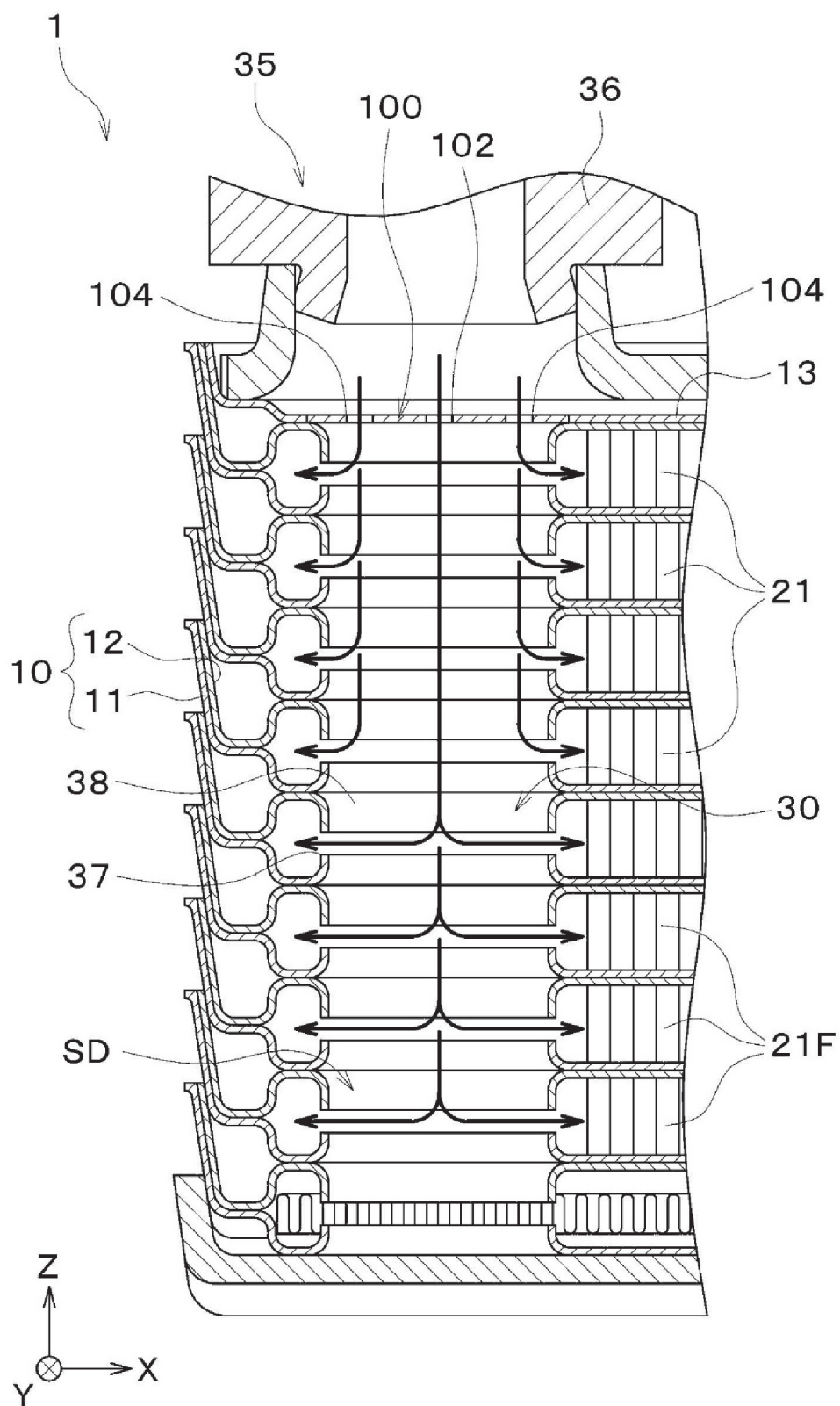


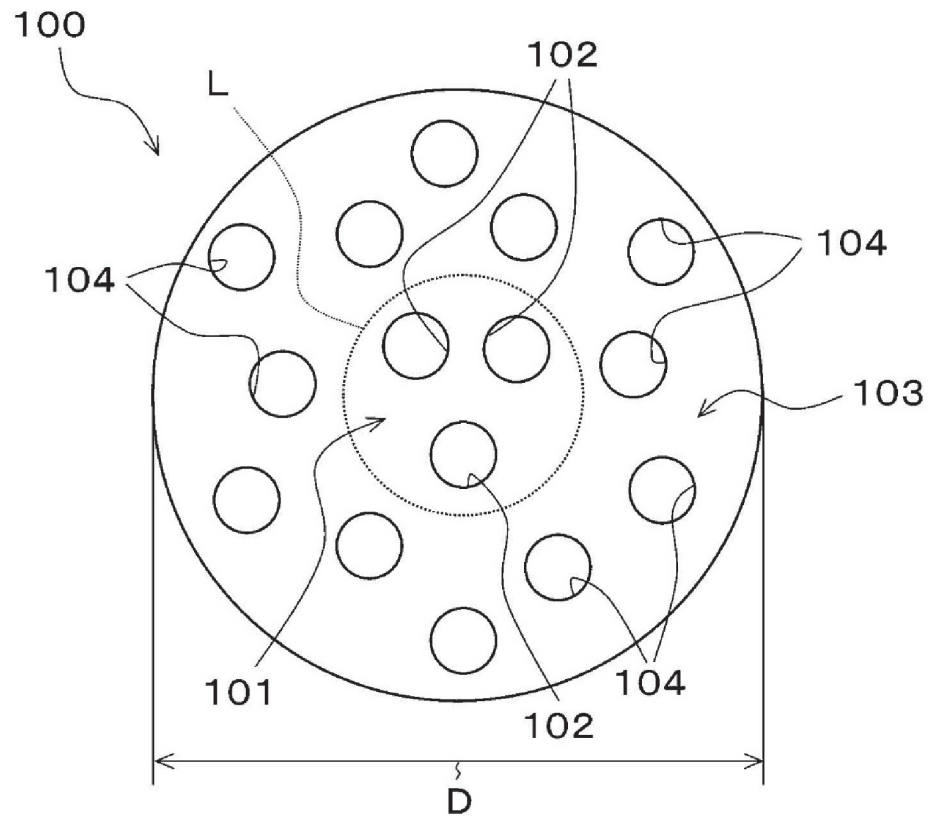
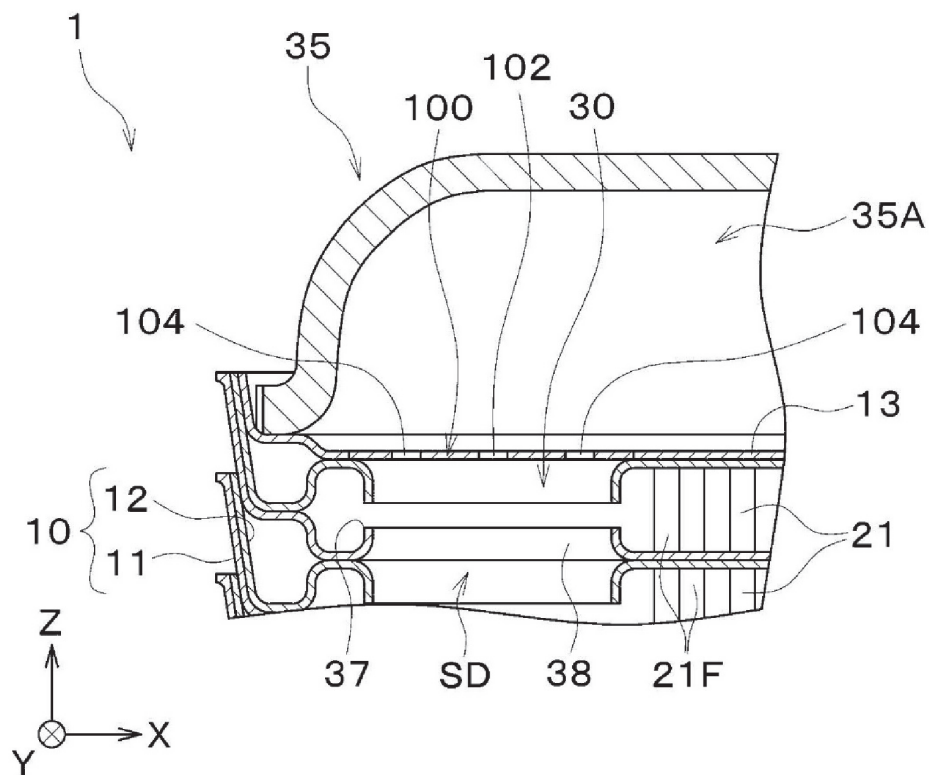
FIG. 8**FIG. 9**

FIG. 10

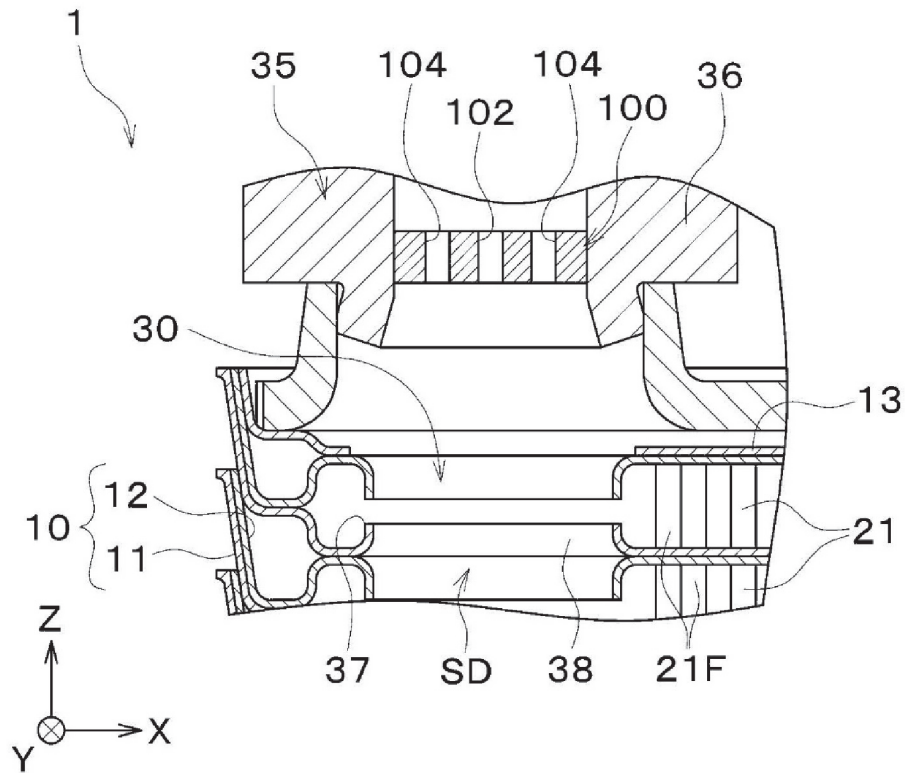


FIG. 11

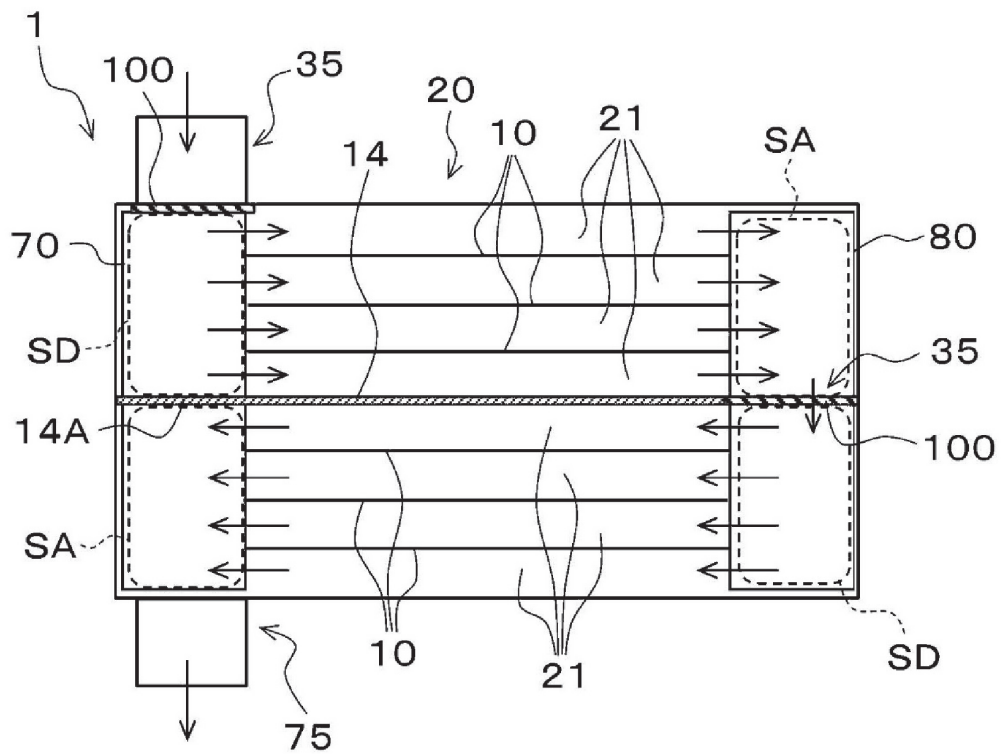


FIG. 12

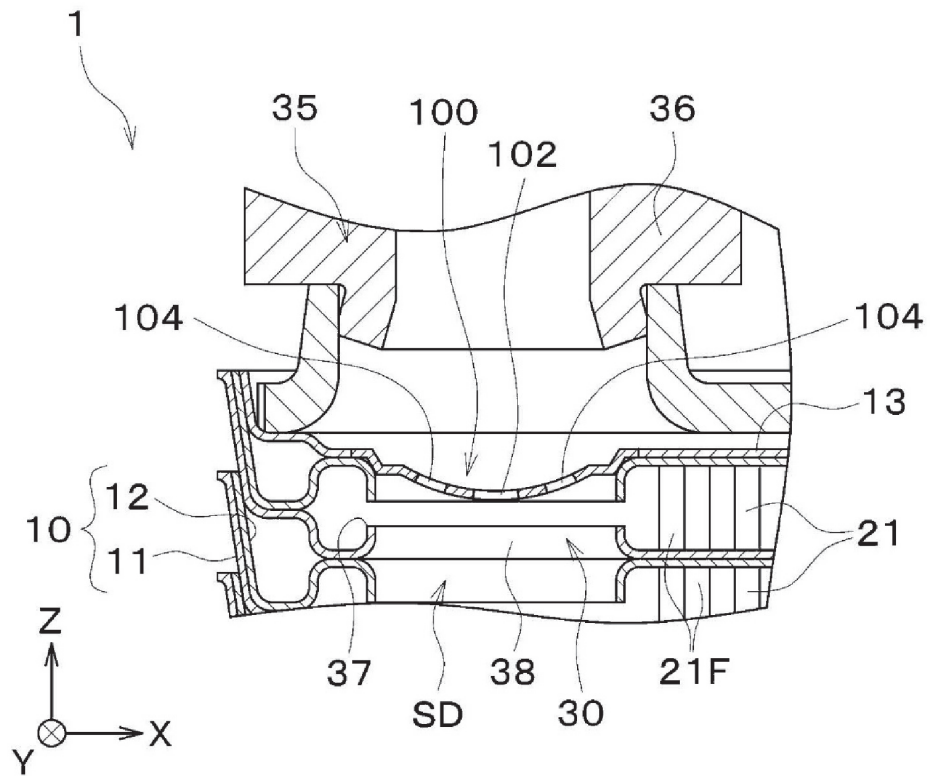


FIG. 13

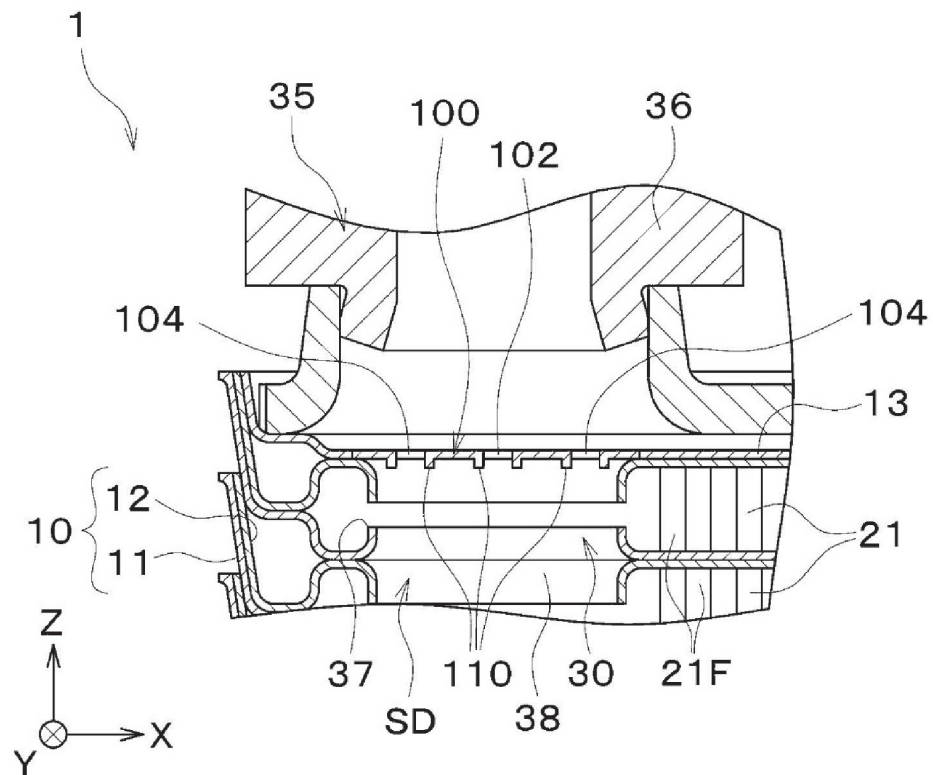
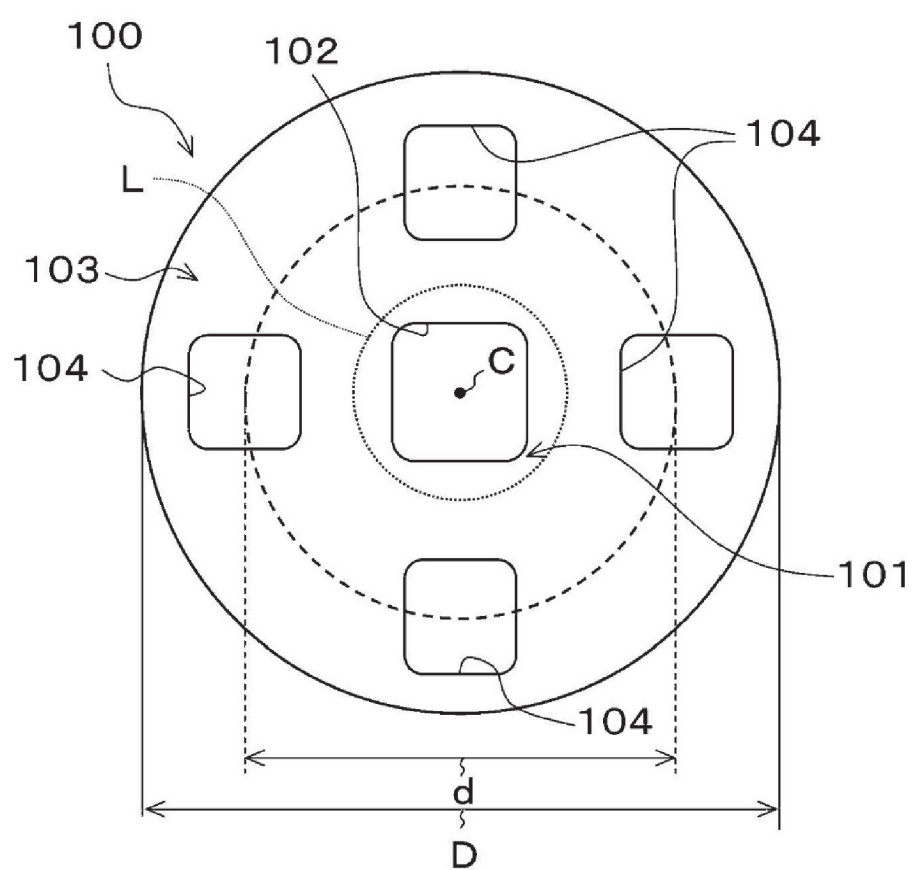


FIG. 14



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/025217

A. CLASSIFICATION OF SUBJECT MATTER

F28F 9/22(2006.01)i; **F28D 9/02**(2006.01)i; **F28F 3/00**(2006.01)i; **F28F 3/08**(2006.01)i
 FI: F28F9/22; F28D9/02; F28F3/00 311; F28F3/08 311

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F28F9/22; F28D9/02; F28F3/00; F28F3/08

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	JP 10-300384 A (DAIKIN INDUSTRIES, LTD.) 13 November 1998 (1998-11-13) paragraphs [0002], [0017]-[0025], fig. 1-3, 7	1, 3
Y		2, 4-5
X	JP 2002-340495 A (SHOWA DENKO K.K.) 27 November 2002 (2002-11-27) paragraphs [0028]-[0042], [0046], fig. 1-4, 7	1, 3
Y		2, 4-5
Y	WO 2021/025151 A1 (DENSO CORPORATION) 11 February 2021 (2021-02-11) paragraphs [0011]-[0030], fig. 1-3	2, 4-5
A	entire text, all drawings	1-5
A	JP 2021-085534 A (DAIKIN INDUSTRIES, LTD.) 03 June 2021 (2021-06-03) paragraphs [0026]-[0044], fig. 1-2, 5	1-5

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

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“&” document member of the same patent family

Date of the actual completion of the international search

05 August 2024

Date of mailing of the international search report

10 September 2024

Name and mailing address of the ISA/JP

Japan Patent Office (ISA/JP)
 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915
 Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/025217

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JP 10-300384 A	13 November 1998	(Family: none)	
JP 2002-340495 A	27 November 2002	US 2005/0126770 A1 paragraphs [0038]-[0052], [0056], fig. 1-4, 7 WO 2002/073114 A1 EP 1373821 A1 CN 1526063 A KR 10-2003-0080081 A	
WO 2021/025151 A1	11 February 2021	US 2022/0155021 A1 paragraphs [0034]-[0053], fig. 1-3 JP 2021-025764 A DE 112020003756 T5 CN 114270115 A	
JP 2021-085534 A	03 June 2021	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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