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(54) LAMINATED TYPE HEAT EXCHANGER

(57) A guide plate (19) which causes a heat exchanging medium traveling along the laminating direction to advance straight toward the communicating 'point at which the tank portions to which the heat exchanging medium is moving and the corresponding passage portions communicate with each other is provided. In a single-side tank type laminated heat exchanger, a guide plate (19) is provided at the shifting area over which an even-numbered pass shifts into an odd-numbered pass, to cause the heat exchanging medium traveling along the laminating direction to advance straight toward the communicating point at which the tank portions in the odd-numbered pass communicate with the passage portions in communication with the tank portions. The angle of inclination at the guide plate (19) is set within the range of 5 ~ 65° relative to the laminating direction, and the length of the inclined portion is set within the range of 1 ~ 15mm. Thus, the extent of an uneven flow of heat exchanging medium is minimized in the laminated heat exchanger in which the heat exchanging medium flows from the tank portions into the passage portions after it travels along the laminating directions through the tank portions which are in communication with each other, to achieve an improvement in the heat exchanging efficiency with the heat exchanging medium almost completely evenly distributed to the individual tube elements. By forming the guide plate in a curved shape or by providing a bead at the guide plate, the guide plate is reinforced. In addition, by rounding the two shoulders of the guide plate, the guide plate is prevented from vibrating.

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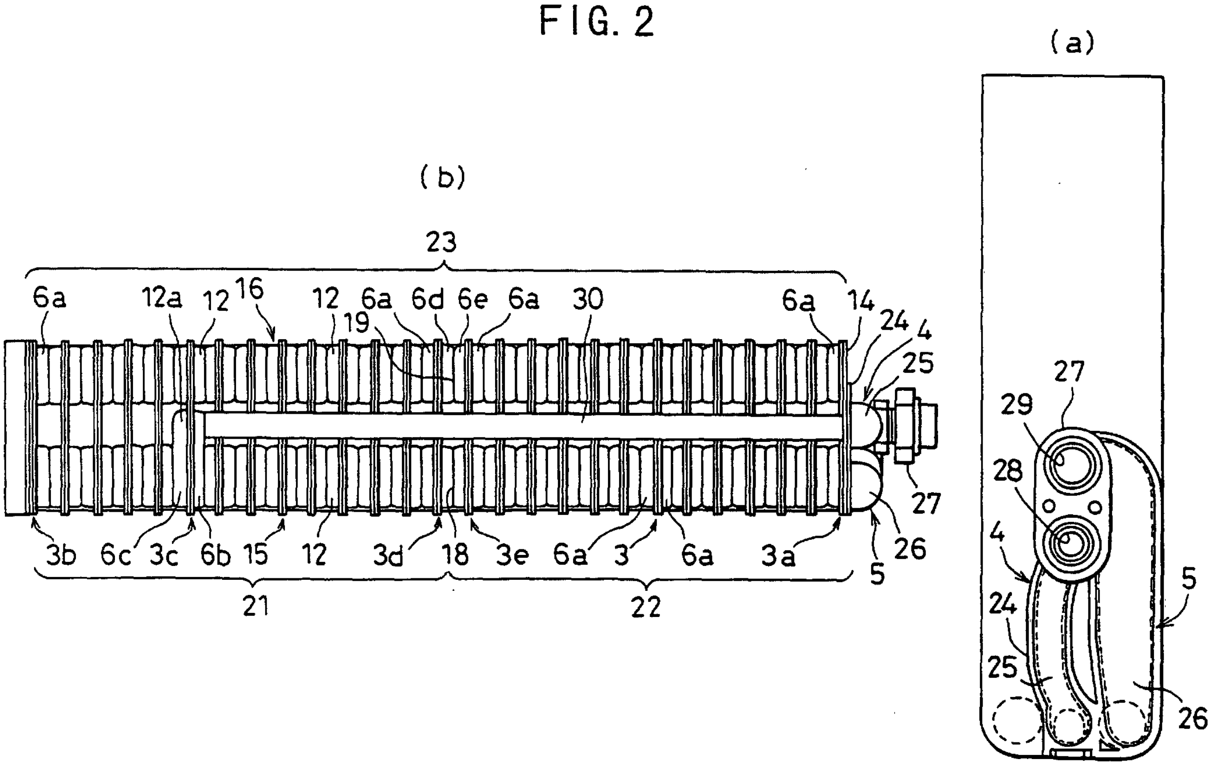
FIG. 2


(b)
23
6a
12a
12
16
12
6a
6d
6e
6a
30
6a
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4
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27
3b
6c
3c
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15
12
3d
18
3e
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(a)
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Description

TECHNICAL FIELD

[0001] The present invention relates to a laminated heat exchanger constituted by laminating numerous tube elements, which is utilized in a freezing cycle or the like of an air-conditioning system for vehicles, and is ideal in application in a laminated heat exchanger constituted by laminating tube elements via fins to allow a heat exchanging medium to pass through a plurality of times.

BACKGROUND ART

[0002] Heat exchangers in the known art include the heat exchanger illustrated in FIGS. 1 and 2 and the single-side tank type heat exchanger illustrated in FIGS. 15 and 16.

[0003] In the heat exchanger shown in FIGS. 1 and 2, a core main body is formed by laminating tube elements via fins 2, a pair of tank portions 12 provided on one side of each tube elements are made to communicate with each other through a turnaround passage portion 13, a heat exchanging medium path with a plurality of passes is formed at the core main body by communicating the tank portions 12 of adjacent tube elements as appropriate, a heat exchanging medium intake portion 4 and a heat exchanging medium outlet portion 5 are provided at one end of the core main body along the laminating direction, the intake portion 4 is made to communicate with a tank block 21 located on the upstream-most side via a communicating pipe 30 and the outlet portion 5 is made to directly communicate with a tank block 22 on the downstream-most side.

[0004] The heat exchanger shown in FIGS. 15 and 16, in which a core main body is formed by laminating tube elements via fins 2, a pair of tank portions 12 provided on one side (the lower side) of each tube element are made to communicate with each other through a turnaround passage portion 13 and a heat exchanging medium path with a plurality of passes is formed at the core main body by communicating the tank portions 12 of adjacent tube elements as appropriate, differs from the heat exchanger described above in that a heat exchanging medium intake portion 4 and a heat exchanging outlet portion 5 are provided at the front of the core main body.

[0005] In the heat exchangers described above, the heat exchanging medium having flowed in through the intake portion 4 enters the tank block 21 on the upstream-most side in the heat exchanging medium path either via the communicating pipe 30 or directly, reaches the tank block 22 on the downstream-most side in the heat exchanging medium path after making a plurality of passes and flows out through the outlet portion 5 communicating with the tank block 22. In this context, the flow of the heat exchanging medium along one direction, i.e., the heat exchanging medium flowing from the tank portions into the turnaround passage portions or flowing from the turnaround passage portions into the tank portions, is counted as one pass and, for instance, a heat exchanger in which the heat exchanging medium passes through the turnaround passage portions 13 twice and a heat exchanger in which the heat exchanging medium passes through the turnaround passage portions three times while it travels from the tank block on the upstream-most side to the tank block on the downstream-most side in the heat exchanging medium path are respectively referred to as a four-pass a heat exchanger and a six-pass heat exchanger.

[0006] However, in the four-pass heat exchanger described above, for instance, in which the heat exchanging medium flows along the laminating direction via the tank portions in communication with each other while moving from the second pass into the third pass, as illustrated in FIG. 54(a), the heat exchanging medium concentrates further into the third pass due to the inertial force of the heat exchanging medium and, as a result, the flow rate of the heat exchanging medium becomes reduced at the tube elements near a partitioning portion 18 in the third and the fourth passes. Thus, the temperature of the air having passed through the space between tube elements near the partitioning portion becomes higher than the temperature at other positions, as indicated by the dotted lines in FIG. 55, to result in a reduction in the heat exchanging efficiency when a coolant is used as the heat exchanging medium.

[0007] It is to be noted that the term "tube number" (TUBE No.) in the figure refers to the position of a given tube element counted from the right side in FIG. 1. In addition, the passing air temperature (AIR TEMP.) refers to the temperature of the air having passed through the space between the tube elements and having undergone heat exchange with the fins, which is measured at a position 1 ~ 2 cm away from the end surface of the core main body on the downstream side.

[0008] The problem described above also occurs in the six-pass heat exchanger and the uneven flow of the heat exchanging medium occurring as shown in FIG. 54 (b) results in a large deviation in the temperature of the passing air in the area where the heat exchanging medium switches from the third pass to the fourth pass and where it switches from the fifth pass to the sixth pass at positions close to partitioning portions 18, relative to the passing air temperature in other areas. In addition, in the six-pass heat exchanger, too, the heat exchanging medium concentrates unevenly when it switches from an even-numbered pass to an odd-numbered pass and, as a result, the flow rate of the heat exchanging medium becomes reduced over the areas close to the partitioning portions 18.

[0009] As a means for eliminating such uneven distribution of the heat exchanging medium, the applicant of the present invention has previously proposed a structure in which the heat exchanging medium is allowed to flow in sufficient quantity to tube elements near partitioning portions by providing a constriction which constricts the flow passage cross section where an even-numbered pass shifts to an odd-numbered pass (see Japanese Unexamined Patent Publication No. H 8-285407). However, this structure proposed previously, which prevents uneven distribution of the heat exchanging medium by constricting the flow passage cross section to lower the speed of the flow or by causing the heat exchanging medium to flow in a complex pattern, requires careful design, in order to ensure that the passage resistance does not become excessive.

[0010] In addition, there is a structure in the known art achieved by providing a rotational flow generating plate at the flow path between tanks through which the heat exchanging medium is delivered from the upstream side heat exchanging block to the downstream side heat exchanging block to cause the heat exchanging medium to rotate around the center line of the flow path as disclosed in Japanese Unexamined Patent Publication No. H 8-178581, proposed as a measure for eliminating uneven flow of the heat exchanging medium.

[0011] However, while this structure, which achieves a consistent gas-liquid mixed state by agitating the heat exchanging medium with the rotational flow generating plate to prevent the heat exchanging medium from entering a gas-liquid two phase state in the flow path between the tanks to eliminate an uneven distribution of the heat exchanging medium and achieves consistent heat exchanging performance at all the tanks regardless of their locations, i.e., whether they are provided at upper positions or lower positions, is effective in that coolant in a gas-liquid mixed state is guided into the individual tube elements, it does not prevent the heat exchanging medium from becoming concentrated further into the third pass due to the inertial force of the heat exchanging medium itself as illustrated in FIG. 54(a) in the case of a four-pass heat exchanger, for instance, since it simply mixes gas and liquid by rotating the heat exchanging medium. Rather, if the rotating heat exchanging medium advances through the flow path between the tanks, it becomes a concern that the heat exchanging medium may concentrate in even greater quantity further into the third pass since it is more difficult for the heat exchanging medium to flow into the individual passage portions due to the inertia of the rotation and to change its direction while it advances along the center line of the flow path between the tanks and, as a result, the problem of the reduction in the flow rate of the heat exchanging medium at tube elements close to the partitioning portion 18 is expected to become even more pronounced at the third and fourth passes.

[0012] Accordingly, an object of the present invention is to provide a laminated heat exchanger capable of achieving an improvement in the heat exchanging efficiency by minimizing uneven flow of the heat exchanging medium and achieving an almost completely uniform distribution of the heat exchanging medium to all the tube elements along the laminating direction. Another object of the present invention is to provide a laminated heat exchanger capable of reducing inconsistent distribution of the heat exchanging medium by dispersing the heat exchanging medium more aggressively while minimizing the passage resistance.

DISCLOSURE OF THE INVENTION

[0013] Accordingly, the laminated heat exchanger according to the present invention, assuming a structure in which tube elements each having a plurality of tank portions and a passage portion communicating with the tank portions are laminated over numerous levels by sequentially abutting the tank portions, all the tank portions or a plurality of the tank portions thus abutted are made communicate with each other via communicating holes formed at the individual tank portions, a pass through which a heat exchanging medium is allowed to flow from a plurality of contiguous tank portions into passage portions communicating with the tank portions is provided and the heat exchanging medium is caused to travel along the laminating direction via the communicating holes over an area where another pass shifts to this pass, a guide plate that causes the flow of the heat exchanging medium traveling along the laminating direction to advance straight toward the communicating point at which the tank portions to which the heat exchanging medium is traveling and the passage portions communicating with the tank portion communicate with each other is provided at, at least, one position over the shifting area where the other pass shifts into the pass or in the vicinity of the shifting area.

[0014] In this structure, in which the direction in which the heat exchanging medium traveling along the laminating direction via the communicating holes is actively changed by the guide plate to advance straight toward the communicating point at which the tank portions to which the heat exchanging medium is moving a and of the passage portions communicating with the tank portions, the heat exchanging medium is distributed in all the passage portions so as to avoid concentration of the heat exchanging medium at the area near the ends along the laminating direction.

[0015] In particular, when adopting the present invention in the single-side tank type laminated heat exchanger, i.e., in a laminated heat exchanger constituted by laminating tube elements each having a pair of tank portions provided on one side and a turnaround passage portion communicating between the pair of tank portions over numerous levels via fins, sequentially abutting the tank portions of adjacent tube elements, communicating the abutted tank portions via communicating holes in units of individual blocks, setting as appropriate the number of tank portions constituting each block to provide an odd-numbered pass through which the heat exchanging medium flows from the tank portions of the tube elements into the passage portions and an even-numbered pass in which the heat exchanging medium flows from the passage portions of the tube elements into the tank portions and allowing the heat exchanging medium to move along the laminating direction via the communicating holes over the shifting area in which the even-numbered pass shifts to the odd-numbered pass, a guide plate that causes the flow of the heat exchanging medium traveling along the laminating direction to advance straight toward the communicating points at which the tank portions in the odd-numbered pass communicate with the corresponding passage portions should be provided at, at least, one location over the shifting area or in the vicinity of the shifting area.

[0016] As a result, since the heat exchanging medium having flowed into the block on the upstream-most side flows out through the block on the downstream-most side after traveling over a plurality of passes and the guide plate is provided at the shifting area where the even-numbered pass shifts into the odd-numbered pass in this structure, the direction in which the heat exchanging medium advances straight is actively changed by the guide plate so that the heat exchanging medium advances straight to be almost completely evenly distributed into the individual passage portions constituting the odd-numbered pass. Thus, the heat exchanging medium is supplied into all the tube elements in sufficient quantity and, consequently, the passing air temperature does not greatly deviate at different positions as indicated by the solid lines in FIG. 55, thereby achieving the objects described above.

[0017] In this single-side tank type laminated heat exchanger, a heat exchanging medium intake portion and a heat exchanging medium outlet portion may be provided at one end along the direction in which the tube elements are laminated with the intake portion made to communicate with the block on the upstream-most side and the outlet portion made to communicate with the block on the downstream-most side or an intake portion and an outlet portion may be respectively provided at the block on the upstream-most side and the block on the downstream-most side, both at a right angle to the laminating direction.

[0018] In addition, in a heat exchanger having tube elements each constituted by bonding two formed plates and having the boundary of a pass in which the heat exchanging medium flows from the tank portions to the corresponding passage portions defined by providing at a specific position a formed plate having a partitioning portion for disallowing communication between tank portions along the laminating direction, the guide plate to be provided at the shifting area may be either located at a formed plate adjacent to the formed plate having the partitioning portion or at the formed plate having the partitioning portion itself. In addition, the partitioning portion and the guide plate may be offset from each other to the front and to the rear along the laminating direction within a range over which an improvement is achieved in the flow rate of the heat exchanging medium flowing near the partitioning portion, and the guide plate provided in the vicinity of the shifting area may adopt such a structure.

[0019] If the angle of inclination of the guide plate relative to the laminating direction is too small, a change that is effective enough to eliminate the unbalanced flow of the heat exchanging medium cannot be achieved, whereas if the angle of inclination is too large, the passage resistance increases to lower the flow rate of the heat exchanging medium and a reduction in the heat exchanging efficiency occurs. For this reason, with the length of the guide plate over the inclined portion set within a range of 1 ~ 15mm in consideration of the effectiveness for changing the flow direction and due to the manufacturing restrictions, it is desirable to select the angle of inclination within a range of 5 ~ 65°. In addition, while the guide plate may be constituted as a member which is independent of the tank portions, it may be formed as an integrated part of the member constituting the tank portions in order to achieve a reduction in the number of manufacturing steps and to facilitate the production process.

[0020] In specific application modes of the guide plate practical use, the guide plate may be constituted of a bridge provided across the communicating hole and an inclined portion which is bent from an end edge of the bridge and extends at an angle, the guide plate may be constituted of a portion bent from the circumferential edge of the communicating hole and extending at an angle or it may be constituted by twisting a portion extending across the communicating hole so as to cause the entire portion to become inclined. Furthermore, numerous guide plates may be formed at the shifting area or in its vicinity in order to ensure that the direction along which the heat exchanging medium advances straight is changed with a high degree of reliability.

[0021] In the laminated heat exchanger adopting the structure described above having a pass in which the heat exchanging medium is allowed to flow from a plurality of contiguous tank portions into the passage portions communicating with the tank portions and a guide plate that changes the direction of the flow of the heat exchanging medium traveling along the laminating direction toward the communicating points at which the tank portions to which the heat exchanging medium is moving and the passage portions communicating with the tank portions communicate with each other provided at, at least, one location at the area over which the heat exchanging medium moves into the pass, e.g., at the shifting area over which the second pass shifts into the third pass, or in the vicinity of the shifting area, the guide plate, which is provided at a communicating hole formed at a distended portion for tank formation at a formed plate constituting a tube element, is manufactured by leaving on the cut section that is created when punching the communicating hole and is disposed of as waste in the prior art. However, since the coolant flows at a high speed and in a great quantity through the communicating holes in the shifting area, force is applied to the guide portion to cause vibration and such vibration may be communicated to the outside as noise via the tube elements or it may deform the guide portion to offset the guiding direction.

[0022] Accordingly, the strength of the guide plates used to reduce the unbalanced flow of heat exchanging medium needs to be improved and vibration at the guide plate must be prevented.

[0023] Thus, as a means for eliminating these problems, a guide plate provided at a plurality of the tube elements in a laminated heat exchanger constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating between the tank portions over numerous levels, which is located at a communicating hole formed at a distended portion for tank formation at a formed plate constituting a tube element, should be formed in a curved shape along the lateral direction of the formed plate.

[0024] By forming the guide plate in such a curved shape, its strength is improved to achieve greater durability. In addition, the curved shape of the guide plate enables it to change the direction of the flow of the heat exchanging medium effectively, and also achieves improvements in the ease of forming and dimensional accuracy.

[0025] The guide portion may be formed in a curved shape by bending it at a specific curvature, a curved shape may be formed at areas close to the two ends along the lateral direction of the guide portion or a curved surface may be formed as a reservoir. Furthermore, a straight portion may be formed at the two ends along the lateral direction of the guide plate formed in a curved shape, and these straight portions may be formed at the bridge provided over the communicating hole.

[0026] Alternatively, in the laminated heat exchanger according to the present invention constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating between the tank portions over numerous levels, a guide plate is provided at some of the tube elements, which is located at a communicating hole formed in a distended portion for tank formation at a formed plate constituting a tube element and a bead may be provided at, at least, one location at the guide plate along the direction in which it projects out from the formed plate.

[0027] The presence of the bead at the guide plate improves its strength to achieve greater durability. In addition, improvements in the ease of formation and the dimensional accuracy are achieved.

[0028] The length of the bead at the guide plate may be set equal to the length over which the guide portion projects out or shorter than the length over which the guide portion projects out. The bead may be formed in a diamond shape as well.

[0029] Alternatively, in the laminated heat exchanger according to the present invention constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating between the tank portions over numerous levels, a guide plate is provided at some of the tube elements, which is located at a passage formed in a distended portion for tank formation at a formed plate constituting a tube element and the two shoulders of the guide plate at the front end along the direction in which the guide plate projects out from the formed plate may be rounded.

[0030] By forming the two shoulders of the guide portion in a rounded shape, any angularity is eliminated and, as a result, vibration is prevented from occurring at the guide portion when the heat exchanging medium flows to suppress the occurrence of the vibration noise. In addition, improvements in the ease of forming and the dimensional accuracy are achieved.

[0031] Alternatively, in the laminated heat exchanger according to the present invention constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating between the tank portions over numerous levels, a guide plate is provided at some of the tube elements, which is located at a communicating hole formed in a distended portion for tank formation at a formed plate constituting a tube element and the guide plate may be formed in a curved shape along the lateral direction of the formed plate with a bead provided at, at least, one location along the direction in which the guide plate projects out.

[0032] In this example, the strength of the guide plate is improved by forming it in a curved shape and providing the bead at the guide plate.

[0033] Alternatively, in the laminated heat exchangers according to the present invention constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating between the tank portions over numerous levels, a guide plate is provided at some of the tube elements, which is located at a passage formed in a distended portion for tank formation at a formed plate constituting a tube element and the guide plate may be formed in a curved shape along the lateral direction of the formed plate with the two shoulders of the guide plate at the front end along the direction in which the guide plate projects out from the formed plate formed in a rounded shape. In this example, an improvement in the strength of the guide plate is achieved and, at the same time, vibration is prevented by forming the guide plate in a curved shape and rounding the two shoulders.

[0034] Alternatively, in the laminated heat exchanger according to the present invention constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating between the tank portions over numerous levels, a guide plate is provided at some of the tube elements, which is located at a passage formed in a distended portion for tank formation at a formed plate constituting a tube element and a bead may be provided at, at least, one position at the guide plate along the direction in which the guide plate projects out from the formed plate with the two shoulders of the guide plate at the front end along the direction in which it projects out from the formed plate formed in a rounded shape.

[0035] In this example, an improvement in the strength is achieved and the occurrence of the vibration is prevented by forming the bead at the guide plate and rounding the two shoulders.

[0036] Alternatively, in the laminated heat exchanger according to the present invention constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating between the tank portions over numerous levels, a guide plate is provided at some of the tube elements, which is located at a passage formed in a distended portion for tank formation at a formed plate constituting a tube element, the guide plate may be formed in a curved shape along the lateral direction of the formed plate and a bead may be provided at, at least, one position at the guide plate along the direction in which the guide plate projects out from the formed plate with the two shoulders of the guide plate at the front end along the direction in which it projects out from the formed plate formed in a rounded shape.

[0037] In this example, an improvement in the strength is achieved and the occurrence of vibration is prevented by forming the bead at the guide plate, forming the guide plate in a curved shape and rounding the two shoulders of the guide plate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038]

FIG. 1 illustrates an end surface of the laminated heat exchangers in a first embodiment of the present invention, which is set perpendicular to the direction of air flow;

FIG. 2(a) illustrates a side surface of the laminated heat exchanger shown in FIG. 1, where the intake and outlet portions are provided, and FIG. 2(b) illustrates the bottom surface of the laminated heat exchanger in FIG. 1;

FIG. 3 illustrates formed plates constituting the tube elements in the laminated heat exchanger, with FIG. 3(a) showing a regular formed plate 6a, FIG. 3(b) showing a formed plate 6d having a partitioning portion and FIG. 3(c) showing a formed plate 6e having a guide plate;

FIG. 4 presents an example in which a guide plate is formed at an approximate center of the communicating hole, with FIG. 4(a) presenting an enlarged front view of a portion of a formed plate having a guide plate formed therein and FIG. 4(b) showing the tube element having the guide plate and tube elements laminated on the downstream side relative to the tube element with the guide plate and illustrating the shape of the guide plate and the flow of the heat exchanging medium;

FIG. 5 is an enlargement of the tank portion of the tube element having the guide plate;

FIG. 6 is a front view of a formed plate in a structural example achieved by forming a guide plate at a position lower than the center of the communicating hole;

FIG. 7 is a front view of a formed plate in a structural example achieved by forming a guide plate at a position higher than the center of a communicating hole;

FIG. 8 is a front view of a formed plate in a structural example achieved by forming a guide plate as an integrated part of the distended portion for tank formation at the lower end of the distended portion for tank formation;

FIG. 9 presents another example in which a guide plate is formed at an approximate center of the communicating hole, with FIG. 9(a) presenting an enlarged front view of the portion of a formed plate having a guide plate formed therein and FIG. 9(b) showing the tube element having the guide plate and tube elements laminated on the downstream side relative to the tube element with the guide plate and illustrating the shape of the guide plate and the flow of the heat exchanging medium;

FIG. 10 presents a structural example in which a guide plate is bent toward the outside of the tank portion where the guide plate is located;

FIG. 11 presents a structural example achieved by gradually increasing the angle of inclination of the guide plate;

FIG. 12 presents a structural example achieved by forming a plurality of guide plates over the upper half of the communication hole, with FIG. 12(a) presenting an enlarged front view of a portion of a formed plate having guide plates formed therein and FIG. 12(b) showing the tube elements having the guide plates and tube elements. laminated the downstream side of the tube element with the guide plates and illustrating the shape of the guide plates and the flow of the heat exchanging medium;

FIG. 13 presents a structural example achieved by forming a plurality of guide plates over the entire communication hole, with FIG. 13(a) presenting an enlarged front view of a portion of a formed plate having guide plates formed therein and FIG. 13(b) showing the tube elements having the guide plates and tube elements laminated on the downstream side relative to the tube element with the guide plates and illustrating the shape of the guide plates and the flow of the heat exchanging medium;

FIG. 14 presents a structural example achieved by forming the guide plates horizontally over the lower half of the communication hole in the structure shown in FIG. 13, with FIG. 14(a) presenting an enlarged front view of the portion of a formed plate having guide plates formed therein and FIG. 14(b) showing the tube elements having the guide plates and tube elements laminated on the downstream side relative to the tube element with the guide plates and illustrating the shape of the guide plates and the flow of the heat exchanging medium;

FIG. 15 illustrates an end surface of the laminated heat exchanger in a second embodiment of the present invention, which is set perpendicular to the direction of air flow;

FIG. 16(a) illustrates a side surface of the laminated heat exchanger shown in FIG. 15 and FIG. 16(b) illustrates the bottom surface of the laminated heat exchanger in FIG. 15;

FIG. 17 is an enlarged front view of a portion of a formed plate in which a guide plate and a partitioning portion are formed as an integrated part;

FIG. 18 illustrates a structure achieved by providing a guide plate at two locations in adjacent tube elements, with the guide plates placed in contact with each other so as to allow their inclined portions to extend continuously;

FIG. 19 presents an example in which a guide plate is provided at two locations, in adjacent tube elements, with the guide plates formed over a distance from each other;

FIGS. 20 ~ 52 present individual embodiments of the guide plate 19 according to the present invention, with FIG. 20 presenting an enlarged front view of a portion of a formed plate having a guide plate formed in a curved shape achieving a specific curvature;

FIG. 21 is a lateral cross section of the guide plate in FIG. 20;

FIG. 22 is a longitudinal cross section of the guide plate in FIG. 20;

FIG. 23 shows the tube element having the guide plate in FIG. 20 and tube elements laminated on the downstream side relative to the tube element with the guide plate and illustrates the shape of the guide plate and the flow of the heat exchanging medium;

FIG. 24 is an enlargement of a portion of a formed plate having a guide plate assuming a curved shape in areas close to the two ends along the lateral direction;

FIG. 25 is a lateral cross section of the guide plate in FIG. 24;

FIG. 26 is a longitudinal cross section of the guide plate in FIG. 24;

FIG. 27 is an enlarged front view of a portion of a formed plate having a guide plate with a reservoir formed at its curved surface;

FIG. 28 is a lateral cross section of the guide plate in FIG. 27;

FIG. 29 is a longitudinal cross section of the guide plate in FIG. 27;

FIG. 30 is an enlarged front view of a portion of a formed plate with a straight portion formed at the two ends along the lateral direction of a guide plate formed in a curved shape;

FIG. 31 is a lateral cross section of the guide plate in FIG. 30;

FIG. 32 is a longitudinal cross section of the guide plate in FIG. 30;

FIG. 33 is an enlarged front view of a portion of a formed plate having a guide plate with two shoulders thereof formed in a rounded shape;

FIG. 34 is a lateral cross section of the guide plate in FIG. 33;

FIG. 35 is a longitudinal cross section of the guide plate in FIG. 33;

FIG. 36 is an enlarged front view of a portion of a formed plate having a guide plate with a bead formed therein;

FIG. 37 is a lateral cross section of the guide plate in FIG. 36;

FIG. 38 is a longitudinal cross section of the guide plate in FIG. 36;

FIG. 39 is an enlarged longitudinal sectional view of a portion of a formed plate having a guide plate with a short bead formed therein;

FIG. 40 is an enlarged front view of a formed plate having a guide plate assuming a curved shape in the areas close to the two ends along the lateral direction and with a bead formed therein;

FIG. 41 is a lateral cross section of the guide plate in FIG. 40;

FIG. 42 is a longitudinal cross section of the guide plate in FIG. 40;

FIG. 43 is an enlarged front view of a portion of a formed plate having a guide plate with a reservoir formed at its curved surface and a bead formed therein;

FIG. 44 is a lateral cross section of the guide plate in FIG. 43;

FIG. 45 is a longitudinal cross section of the guide plate in FIG. 43;

FIG. 46 is an enlarged front view of a portion of a formed plate having a straight portion at the two ends along the lateral direction of the guide plate with a reservoir formed at its curved surface and a bead formed therein;

FIG. 47 is a lateral cross section of the guide plate in FIG. 46;

FIG. 48 is a longitudinal cross section of the guide plate in FIG. 46;

FIG. 49 is an enlarged front view of a portion of a formed plate having a guide plate with a diamond-shaped bead formed therein;

FIG. 50 is an enlarged front view of a portion of a formed plate having a guide plate constituted of an inclined portion formed by cutting through the lower circumferential edge of the communicating hole;

FIG. 51 is a lateral cross section of the guide plate in FIG. 50;

FIG. 52 is a longitudinal cross section of the guide plate in FIG. 50;

FIG. 53 is an enlarged front view of a portion of a formed plate achieved by forming a guide portion and a partitioning portion as an integrated part;

FIG. 54(a) is a diagram illustrating the concept of the flow of the heat exchanging medium in a four-pass laminated heat exchanger in the prior art having the heat exchanging medium intake and outlet portions at one end of the core main body along the laminating direction and FIG. 54(b) illustrates the concept of the flow of the heat exchanging medium in a six-pass laminated heat exchanger in the prior art; and

FIG. 55(a) is a characteristics diagram of the temperature of the air having passed through the upper portion of the laminated heat exchanger in the first embodiment (representative temperature of the air having passed through the upper half of the tube elements) and FIG. 55(b) is a characteristics diagram of the temperature of the air having passed through the upper portion of the laminated heat exchangers in the first embodiment (representative-temperature of the air having passed through the lower half of the tube elements).

THE BEST MODE FOR CARRYING OUT THE INVENTION

[0039] The following is an explanation of the embodiments of the present invention, given in reference to the drawings. In FIGS. 1 and 2, a laminated heat exchanger 1 may be, for instance a four-pass evaporator with its core main body formed by alternately laminating fins 2 and tube elements 3 over a plurality of levels and an intake portion 4 and an outlet portion 5 through which the heat exchanging medium flows provided at one end along the direction in which the tube elements 3 are laminated. The tube elements 3 are each constituted by bonding two formed plates 6a shown in FIG. 3(a), except for tube elements 3a and 3b at the two ends along the laminating direction, a tube element 3c having an enlarged tank portion which is to be detailed later, a tube element 3d located at an approximate center and a tube element 3e adjacent to the tube element 3b.

[0040] The formed plates 6a are each formed by press machining an aluminum plate and are each provided with two bowl-like distended portions for tank formation 7 and 7 formed at one end thereof, a distended portion for passage formation 8 continuous to the distended portions for tank formation 7 and 7, an indented portion 9 formed between the distended portions for tank formation, at which a communicating pipe to be detailed later is mounted and a projection 10 formed at the distended portion for passage formation 8, which extends from the area between the two distended portions for tank formation 7 and 7 to the area near the other end of the formed plate 6a. In addition, a projected piece 11 (see FIG. 1) for preventing fins 2 from falling out during the assembly work prior to the brazing process is provided at the other end of the formed plate 6.

[0041] The distended portions for tank formation 7 are formed to distend further than the distended portion for passage formation 8 and the projection 10 projects out so as to be set on the same plane as the bonding margin at the circumferential edge of the formed plate, so that when two formed plates 6a are bonded at their circumferential edges, their projections 10, too, become bonded with each other to form a pair of tank portions 12 and 12 with the distended portions for tank formation 7 facing opposite each other and a turnaround passage portion 13 to communicate between the tank portions with the distended portions for passage formation 8 facing opposite each other.

[0042] The tube element 3a at an end along the laminating direction is constituted by bonding a flat plate 14 to a formed plate 6a shown in FIG. 3(a), whereas the tube element 3b at the other end is constituted by bonding a formed plate 6a in FIG. 3(a) and a formed plate flattened by eliminating the distended portions for tank formation at a front plate 6a. In addition, in each of formed plates 6b and 6c constituting the tube element 3c, one of the distended portions for tank formation is enlarged so that the enlarged distended portion for tank formation lies close to the other distended portion for tank formation. As a result, at the tube element 3c, a tank portion 12 identical to those formed at the regular tube elements 3 and an enlarged tank portion 12a which is enlarged so as to fill the indented portion are formed. Since the other structural features of the formed plates 6b and 6c, i.e., the distended portions for passage formation 8 formed continuous to the distended portions for tank formation, the projections 10 extending from the areas between the distended portions for tank formation 7 to the areas near the other ends of the formed plates and the projected pieces 11 provided to prevent the fins 2 from falling out at the other ends of the formed plates, are identical to those of the formed plate 6 in FIG. 3(a), their. explanation is omitted.

[0043] In addition, the tube element 3d is constituted by using a formed plate 6a in FIG. 3(a) and a formed plate 6d shown in FIG. 3(b), whereas the tube element 3e is constituted by using a formed plate 6a in FIG. 3(a) and a formed plate 6e shown in FIG. 3(c).

[0044] At the formed plate 6d, no communicating hole is formed at one of its distended portions for tank formation, i.e., a distended portion for tank formation 7a, and this non-communicating area forms a partitioning portion 18 which partitions one of the tank groups, i.e., a tank group 15. The partitioning portion may also be constituted by forming a blind tank with no communicating hole at the adjacent tube element 3e as well and bonding the distended portions for tank formation without a communicating hole with each other to provide greater strength or by placing a thin plate between the tube element 3d and the tube element 3e to block the communicating hole communicating between the tank portions instead of using a blind tank. In addition, at the formed plate 6e adjacent to the formed plate 6d, a guide plate

19 to be detailed later is provided at one of its distended portions for tank formation.

[0045] As illustrated in FIGS. 1 and 2, adjacent tube elements are abutted at their tank portions in the heat exchanger, thereby forming two tank groups, i.e., a first tank group 15 and a second tank group 16, extending along the laminating direction (perpendicular to the direction of air flow) with the individual tank portions in communication with each other via communicating holes 17 formed at the distended portions for tank formation 7 except for the formed plate 6d located at an approximate center along the laminating direction in one of the tank groups, i.e., the tank group 15, which includes the enlarged tank portion 12a and all the tank portions in the other tank group 16 in communication with each other via communicating holes 17 with no partition.

[0046] As a result, the first tank group 15 is divided by the partitioning portion 18 into a first tank block 21 containing the enlarged tank portion 12a and a second tank block 22 in communication with the outlet portion 5, whereas the second tank group 16 with no partition constitutes a third tank block 23 having the guide plate 19. In this embodiment, the tube elements are laminated over a total of 27 levels, and the tube element 3c, the tube element 3d and the tube element 3e are respectively positioned at the sixth level, the fourteenth level and the fifteenth level counting from the left side of the figure.

[0047] The intake portion 4 and the outlet portion 5 provided at one end along the laminating direction are constituted by bonding a plate for intake/outlet passage formation 24 with the flat plate 14 constituting an end plate. By bonding these plates 14 and 24, an intake passage 25 and an outlet passage 26 extending along the lengthwise direction are formed, with an inflow port 28 and an outflow port 29 provided at the upper portion of the plate for intake/outlet passage formation 24 to respectively connect with the intake passage 25 and the outlet passage 26 via an expansion valve fixing joint 27. The intake passage 25 and the enlarged tank portion 12a are made to communicate with each other by bonding the communicating pipe 30 secured at the indented portions 9 to the holes formed at the plate 14 and the formed plate 6b, and the tank block 22 and the outlet passage 26 are made to communicate with each other via a hole formed at the flat plate 14.

[0048] Thus, the coolant having flowed in through the intake portion 4 travels through the communicating pipe 30 to enter the enlarged tank portion 12a, then becomes dispersed over the entire first tank block 21, and travels upward along that projections 10 through the turnaround passage portions 13 of the tube elements in the first tank block 21 (first pass). Then, it makes a U-turn over the projections can and travels downward (second pass) to enter the tank group (third tank block 23) on the opposite side. Subsequently, it moves along the laminating direction toward the remaining tube elements constituting the third tank block 23 via the communicating holes 17, and travels upward along the projections 10 through the turnaround passage portions 13 of the tube elements (third pass). Next, it makes a U-turn over the projections 10 and travels downward (fourth pass), is guided to the tank portions constituting the second tank block 22 and finally flows out through the outlet portion 5. As a result, the coolant undergoes heat exchange with the air via the fins 2 while it flows through the turnaround passage portions 13 constituting the first ~ fourth passes.

[0049] The guide plate 19 at the formed plate 6e is provided to promote a more even flow of the coolant over the area where the second pass shifts into the third pass and an unbalanced flow tends to occur as explained earlier. As illustrated in FIGS. 4 and 5, the guide plate 19 is constituted of a bridge 19a extending along the horizontal direction at an approximate center of the communicating holes 17 formed at the distended portion for tank formation 7 and an inclined portion 19b bent from the upper edge of the bridge 19a toward the inside of the tank portion 12. The guide plate 19 is formed as an integrated part of the formed plate by leaving a portion of the distended portion for tank formation 7, which would normally be disposed of as waste when punching the distended portion for tank formation 7 to form the communicating hole 17, and the angle of inclination (q) of the inclined portion 19b relative to the laminating direction is set within a range of 5 ~ 65° and, more desirably, it should be set within the range of 5 ~ 30° in the case of the heat exchanger described above. In addition, the length of the portion inclining inside the tank portion (L: the length of the inclined portion 19b projecting out from the bridge in this example) should be set within a range of 1 ~ 15mm, and in the structural example described above, it is set at approximately 2 - 6mm.

[0050] If the angle of the inclined portion 19b was set too large, the passage resistance would increase to result in a greater pressure loss and a reduction in the quantity of discharged heat (the heat exchanging quantity) due to the lower coolant flow rate, where as if the angle was set too small, the direction of the coolant flow would not be changed to a full extent and, therefore, the problem of the unbalanced flow of the coolant observed in the prior art would not be eliminated. In addition, structural differences among individual heat exchangers affect the flow of the coolant. By taking into consideration these factors, it is determined that the angle of inclination must be set within the range of 5 q 65°, in order to achieve an improvement in the coolant flow. At the same time, the direction of the coolant flow can be changed to a significant degree even when the length L of the inclined portion is small as long as q is large enough within this angle range, whereas it is necessary to set the coolant flow direction by increasing L by an appropriate degree if q is small. In addition, the inclined portion must be formed by cutting up the distended portion for tank formation during the manufacturing process. Thus, L must be set within a range of 1 L 15mm. Accordingly, the optimal guide plate 19 must be formed by combining q and L within these ranges, and the numerical values mentioned above have been set for the four-pass heat exchanger by considering various combinations.

[0051] As a result, the guide plate 19 changes the direction of the flow of the coolant moving through the third tank block 23 via the communicating holes 17 along the laminating direction during the process of shifting from the second pass into the third pass, to allow the coolant to advance straight toward the communicating point at which the tank portions 12 constituting the third pass communicate with the corresponding passage portions 13. Consequently, the coolant is allowed to flow in sufficient quantity even in the area near the partitioning portion 18.

[0052] The improvement in the coolant flow achieved by providing such a guide plate 19 allows the coolant to flow into the individual tube elements in an even manner, to eliminate any significant inconsistency in the heat exchanging quantities at various locations. The results of a test conducted by measuring the passing air temperature, which are presented in FIG. 55, confirm that the temperature of the air having passed through the upper level tube elements (in particular TUBE Nos. 5 ~ 13) near the partitioning portion is lower than the air temperature measured in an heat exchanger in the prior art without the guide plate 19, as indicated by the solid line to achieve a temperature distribution with overall consistency.

[0053] While only one guide plate 19, which is constituted of the bridge 19a and the inclined portion 19b bent away from the bridge 19e in the example described above is formed at an approximate center of the communicating hole 17, similar advantages may be achieved even when such a guide plate is formed at a different location or in a different shape, or two or more such guide plates are provided. The following is an explanation of such variations, given in reference to FIGS. 6 ~ 14. In the structure shown in FIG. 6, a guide plate 19 constituted of the bridge 19a and the inclined portion 19b is formed at that position lower than the center of the communicating holes 17, whereas in the structure shown in FIG. 7, a guide plate 19 constituted of the bridge 19a and the inclined portion 19b is formed at a position higher than the center of the communicating holes 17. In the structural example shown in FIG. 8, an inclined portion 19b bent toward the inside of the tank portion from the lower circumferential edge of the communicating hole 17 formed at the distended portion for tank formation 7 is constituted as an integrated part of the lower circumferential edge.

[0054] In addition, the guide plate 19 may take on a shape achieved by twisting the portion extending across the communicating hole 17 along the horizontal direction with its two ends used as fulcrums to cause it to incline in its entirety as illustrated in FIG. 9, may assume a structure achieved by bending the upper edge of the bridge 19a at an acute angle toward the outside of the tank portion 12 where the guide plate 19 is located to form an inclined portion 19b as illustrated in FIG. 10 or may assume a structure in which the angle of inclination of the inclined portion 19b is gradually increased to form the inclined portion 19b in a curved shape as illustrated in FIG. 11.

[0055] By forming a plurality of guide plates 19, the direction in which the coolant advances straight can be changed even more effectively, and, as illustrated in FIG. 12, a plurality (three in this example) of guide plates 19 inclining upward from the upstream side to the downstream side may be formed over the upper half of the communicating hole 17 with no guide plate 19 formed over the lower half. These guide plates 19 should be formed as an integrated part of the distended portion for tank formation 7, parallel to each other by setting their angles of inclination equal to each other.

[0056] In a heat exchanger adopting this structure, the coolant having passed through the lower half of the communicating hole 17 advances straight along the laminating direction to be delivered further into the third tank block 23, whereas the coolant having passed through the upper half is caused to change the direction in which it advances by the guide plates 19 to flow toward the inflow positions of the individual passage portions 13 of the tube elements constituting the third pass. As a result, the coolant flows in sufficient quantity into the tube elements near the partitioning portion to achieve advantages similar to those described earlier.

[0057] As an alternative, a plurality (five in this example) of guide plates 19 inclining upward on the downstream side may be formed as an integrated part over the entire communicating hole by providing guide plates 19 over the lower half of the communicating hole 17 as well, to change the direction of the entire flow of the coolant shifting into the third pass, as shown in FIG. 13. Or, as illustrated in FIG. 14, the guide plates 19 formed horizontally over the lower half may be extended to ensure that a sufficient quantity of coolant flows along the laminating direction instead. The former structure is particularly effective when the number of tube elements constituting the third pass is small, whereas the latter structure is particularly effective when the number of tube elements constituting the third pass is large and the coolant needs to be distributed evenly to the area further toward the front and also to the area further inward.

[0058] It is to be noted that the structures that may be assumed for the guide plates are not limited to the examples described above and similar advantages may be achieved in variations achieved by varying as appropriate the number of guide plates and the positions at which they are formed in the individual structures explained above.

[0059] FIGS. 15 and 16 illustrate the second embodiment of the laminated heat exchanger, and the following explanation mainly focuses on the differences from the first embodiment by assigning the same reference numbers to identical members in the figures to preclude the necessity for a repeated explanation thereof.

[0060] In this laminated heat exchanger, which may be, for instance, a four-pass evaporator having a heat exchanging medium intake portion 4 and a heat exchanging medium outlet portion 5 provided at an end surface (the front surface in FIG. 15) of the core main body, the tube elements 3 are each constituted by bonding two formed plates 6a shown in FIG. 3(a) except for tube elements 3a and 3b located at the two ends along the laminating direction, a tube element 3d located at an approximate center and a tube element 3e adjacent to the tube element 3d and tube elements 3f each having the intake portion 4 or at outlet portion 5 formed as an integrated part thereof.

[0061] In this structure, the tube elements 3a and 3b at the two ends are each formed by bonding a formed plate 6a in FIG. 3(a) and a formed plate flattened by eliminating the distended portions for tank formation of the formed plate 6a. In addition, at each of the tube elements 3f, the intake portion 4 or the outlet portion 5 is formed by opening up the upstream side distended portions for tank formation 7, so as to allow them to project out along the direction of airflow placing these opened projecting portions to face each other and bonding the opened portions with each other. Since the other structural features of the tube elements 3f, i.e., the communicating holes formed at the distended portions for tank formation, the distended portions for passage formation formed continuous to the distended portions for tank formation, the projections formed extending from the areas between the distended portions for tank formation to the areas near the other ends of the formed plates and the projected pieces provided at the other ends of the formed plates to prevent the fins 2 from falling out are similar to those of the formed plate 6 in FIG. 3(a) and the other tube elements assume similar structures to those described above, their explanation is omitted.

[0062] In addition, while the partitioning portion 18 and the guide plates 19 assume structures similar to those described earlier, the tube elements. are laminated over 26 levels in this heat exchanger, with the intake portion 4 and the outlet portion respectively formed at of the seventh level and the twentieth level counting from the left side in the figure and the partitioning portion 18 and the constricting portion 19 formed between the thirteenth level (tube element 3e) and the fourteenth level (tube element 3d) counting from the left side. In this heat exchanger, the guide plate 19 may assume any of the various structures illustrated in FIGS. 4 ~ 14 with or without quantity and the forming position varied. The angle q relative to the horizontal direction and the length L of the inclined portion are set within the ranges of 5 q 65° and 1 L 15mm respectively as explained earlier.

[0063] Thus, in the heat exchanger structured as described above, the coolant having flowed in through the intake portion 4 is dispersed over the entire first tank block 21 and then travels upward along the projections 10 through the turnaround passage portions 13 at the tube elements in the first tank block 21 (first pass). The coolant then moves downward after making a U-turn over the projections 10 (second pass) to reach the tank group (third tank block 23) on the opposite side. Subsequently, it moves along the laminating direction toward the remaining tube elements constituting the third tank block 23, and travels upward along the projections 10 through the turnaround passage portion 13 of the tube elements (third pass). Next, it travels downward after making a U-turn over the projections 10 (fourth pass), is guided to the tank portions constituting the second tank block 22 and finally flows out through the outlet portion 5. As a result, while the coolant flows through the turnaround passage portions 13 constituting the first pass ~ fourth pass, it undergoes heat exchange with the air via the fins 2. During this process, the coolant shifting from the second pass into the third pass is caused to change the direction in which it advances straight by the guide plate 19 formed at the shifting area as in the structure described earlier so that it flows into the tube elements near the partitioning portion in a sufficient quantity.

[0064] It is to be noted that while the formed plate at which the partitioning portion 18 is provided and the formed plate at which the guide plate 19 is provided are formed independently of each other, the partitioning portion 18 and the guide plate 19 may be formed on a single formed plate in order to reduce the number of different types of formed plates required in assembling the heat exchanger. When adopting such a structure, the formed plate 6e shown in FIG. 3(c) may be replaced with the formed plate 6e' in FIG. 17 with a formed plate 6a shown in FIG. 3(a) placed adjacent to the formed plate 6e'.

[0065] In addition, while the guide plate 19 provided at the shifting area over which an even-numbered pass shifts into an odd-numbered pass is provided at the formed plate adjacent to the partitioning portion 18 or at the formed plate where the partitioning portion is provided in the structures described above, the present invention is not limited to these examples, and a guide plate may be provided in the vicinity of the shifting area where the second pass shifts into the third pass (e.g., at a tube element distanced from the tube element having the partitioning portion 18 by one or two positions).

[0066] The guide plate 19 in the various modes described above is unique in that it prevents an unbalanced flow of the heat exchanging medium by aggressively changing the direction in which the heat exchanging medium advances straight while minimizing the passage resistance, in that it changes the direction in which the heat exchanging medium advances straight with a high degree of reliability by suppressing the rotating flow of the heat exchanging medium and in that it allows the heat exchanging medium to flow into the turnaround passage portions 13 of the individual tube elements with ease to prevent an uneven flow and, therefore, it achieves specific advantages which cannot be obtained by providing the constricting portion disclosed in Japanese Unexamined Patent Publication No. H 8-285407 or the guide plate disclosed in Japanese Unexamined Patent Publication No. H 8-178581. However, the guide plate 19 according to the present invention may be employed in conjunction with the constricting portion disclosed in Japanese Unexamined Patent Publication No. H 8-285407, for instance. Since the constricting portion disclosed in the publication is provided to achieve a similar advantage of minimizing an uneven flow of the heat exchanging medium, the combined use of the constricting portion and the guide plate 19 is expected to prevent an uneven flow to the full extent.

[0067] Furthermore, the guide plate 19 may be constituted as a member separate from the formed plate or a plurality of guide plates may be provided offset from each other along the laminating direction it may be provided in the vicinity of the formed plate having the partitioning portion 18 or at the formed plate having the partitioning portion 18 and in the vicinity of the formed plate. The description "the guide plate is provided at, at least, one location at the shifting area or in its vicinity" allows for a variation in which a plurality of guide plates are provided offset from each other along the laminating direction as well as the variations illustrated in FIGS. 12 ~ 14.

[0068] A plurality of guide plates may be provided offset along the laminating direction by assuming the structure illustrated in FIG. 18 or 19, for instance. In these examples, guide plates are provided at the formed plates 6e and 6f located on the upstream side relative to the flow of the heat exchanging medium travelling through the third tank block 23 along the laminating direction in the tube element 3e and a tube element 3g adjacent to the tube element 3e, and these guide plates 19 are each constituted by forming the inclined portion 19b bent toward the inside of the tank portion from the lower circumferential edge of the communicating hole 17 formed at the distended portion for tank formation 7 as an integrated part.

[0069] In particular, in the example shown in FIG. 18, the guide plate 19 formed at the formed plate 6e is made to extend to the communicating hole at the other formed plate, i.e., the formed plate 6a, constituting the tube element 3e so that it comes in contact with the guide plate 19 formed at the formed plate 6f to provide the two inclining guide plates continuously. As a result, the length L of the inclined portion is a total length of the length L1 of the guide plate 19 formed at the formed plate 6e and the length L2 of the guide plate 19 formed at the formed plate 6f.

[0070] Thus, the range 1 L 15mm set for the length L of the inclined portion is the range used to set the length of the inclined portion 19b of each guide plate 19 and also the range used to set the total length of the inclined portions of a plurality of guide plates provided continuously to each other when a sufficient length cannot be achieved with a single inclined portion.

[0071] By providing the inclined portions of a plurality of guide plates continuously to each other in this manner, the flow of the heat exchanging medium traveling along the laminating direction can be guided along the intended direction with a high degree of reliability, and with the coolant supplied to the tube elements near the partitioning portion 18 in a sufficient quantity, an almost completely uniform temperature distribution can be achieved with ease.

[0072] In addition, the example shown in FIG. 19 is achieved by reducing the length L1 of the inclined portion 19b of the guide plate 19 formed at the formed plate 6e in the structure shown in FIG. 18 to allow a distance to be created from the guide plate 19 formed at the adjacent tube element. It is similar to the example in FIG. 18 in that the guide plate 19 formed at the formed plate 6f is provided on an extended line of the guide plate 19 formed at the formed plate 6e.

[0073] In this structure, too, the coolant having had the direction of its flow changed by the frontward guide plate smoothly moves toward the rearward guide plate due to the inertia, and is further guided by the guide plate to which it has moved to become distributed to the individual tube elements, thereby achieving a similar advantage.

[0074] It is to be noted that there are various other structures that may be adopted when providing a plurality of guide plates offset along the laminating direction in addition to the structures explained above, and the positions at which they are formed may be varied within the scope of the teaching of the present invention or any of them may be adopted in combination with the various examples explained earlier.

[0075] The guide plate 19 may be formed in a curved shape along the lateral direction of the formed plate 6e as shown in FIGS. 20 ~ 23. This curved shape achieves a specific curvature. By assuming such a curved shape for the guide plate 19, an improvement in the strength of the guide plate 19 is achieved and, at the same time, the direction of the flow of the heat exchanging medium (coolant) can be changed in a desirable manner. In this example, the two shoulders of the guide plate 19 at the front end along the direction in which it projects out from the formed plate (the laminating direction) are formed in a rounded shape (an R shape). With any angularity at the shoulders eliminated by forming them in a rounded shape, the guide plate 19 is not caused to vibrate by the flow of the coolant.

[0076] Alternatively, the guide plate 19 may be formed to have a curved shape only over areas close to the two ends along the lateral direction of the formed plate 6e, as illustrated in FIGS. 24 ~ 26, with the portion between the rounded areas formed in a flat shape. In this example, too, the two shoulders of the guide plate are curved.

[0077] In FIGS. 27 ~ 29, the guide plate 19 is formed in a curved shape along the lateral direction of the formed plate 6e and the curved shape forms a reservoir (a bowl) toward the projecting end. In this example, too, the two shoulders of the guide plate 19 are rounded.

[0078] In FIGS. 30 ~ 32, the guide plate 19 is formed in a curved shape along the lateral direction of the formed plate 6e and the curved shape forms a reservoir (a bowl) toward the projecting end as in the previous example. It differs from the previous example in that straight portions 33 and 33 located at the two sides of the guide plate are provided at the bridge 19a extending across the communicating hole 17. In this example, too, the two shoulders of the guide plate 19 are rounded.

[0079] While the rounded shoulders are included in the curved shape of the guide plate 19 in the examples presented above, they may be provided at a flat surface instead, as illustrated in FIGS. 33 ~ 35.

[0080] In FIGS. 36 ~ 38, the inclined portion 19b is bent at a specific angle relative to the bridge 19a with the guide surface constituted as a flat surface at the guide plate 19, and a continually bent portion (referred to as a bead) 35 projecting downward from the formed plate 6e along the direction in which the guide plate projects out from the formed plate 6e is formed extending from the bridge 9a through the inclined portion 9b. The length of the bead 35 is set equal to the length of the guide plate 19 extending along the direction in which it projects out (the laminating direction). By providing the bead 35, the strength of the guide plate 19 is improved and, at the same time, the presence of the bead 35 contributes to improvement in the ease of forming and the dimensional accuracy. In this case, too, the two shoulders of the guide plate are rounded. While the length of the bead 35 formed at the guide plate 19 may be set equal to the length of the guide plate 19 extending along the projecting direction as explained earlier, it may be set shorter than the length of the guide plate extending along the projecting direction as shown in FIG. 39.

[0081] As shown in FIGS. 40 ~ 42, the bead may be formed at a guide plate 19 formed in a curved shape over areas close to the two ends along the lateral direction of the formed plate 6e. Through the combination of the bead 35 and the curved shape, the strength of the guide plate is further improved.

[0082] As illustrated in FIGS. 43 ~ 45, the bead 35 may be provided at a guide plate 19 formed in a curved shape along the lateral direction of the formed plate 6e and having a reservoir (bowl) formed toward the projecting end. In this case, too, the two shoulders of the guide plate 19 are rounded. Likewise, as illustrated in FIGS. 46 ~ 48, the guide plate 19 may assume a structure similar to those adopted in the preceding examples, but with straight portions 33 and 33 provided at the two sides of the bridge 19a. In this example, too, the two shoulders of the guide plate 19 are rounded.

[0083] As shown in FIG. 49, the bead may be formed in a diamond shape at the area where the inclined portion 19b becomes bent from the bridge 19a, to improve the strength of the guide plate 19. It is to be noted that although only a single bead 35 is presented in the illustrated examples, a plurality of beads 35 e.g., two beads, may be provided.

[0084] While the guide plate 19 is constituted of the bridge 19a extending across the communicating hole 17 and the inclined portion 19b bent from a side edge of the bridge and extends at an angle, an alternative structure shown in FIGS. 50 ~ 52 in which the inclined portion 19b inclines from the lower circumferential edge of the communicating hole, with the communicating hole 17 present in the upper section of the figure may be adopted instead. Any of the structures shown in FIG. 20 and subsequent drawings may be assumed in the guide plate 19 and, in this example, it is formed in rounded shape and a continuously bent portion (bead) 35 is formed ranging from of the formed plate to the inclined portion 19b along the projecting direction in which the guide plate projects out from the formed plate 6d.

[0085] This structure improves the strength due to the presence of the bead 35, and prevents occurrence of vibration through rounding (R machining). It is to be noted that straight portions 33 and 33 are formed at the two sides of the guide plate 19. In addition, although not shown, the inclined portion 19b may be bent to give it a curved shape.

[0086] In the heat exchanger shown in FIGS. 15 and 16, too, a guide plate 19 similar to any of those described above may be provided. Namely, by forming the guide plate 19 in a curved shape, forming a bead at the guide plate 19 or rounding the two shoulders of the guide plate 19 as in any of the embodiments illustrated in FIGS. 20 ~ 49, an improvement in the strength is achieved and occurrence of vibration is prevented.

[0087] It is to be noted that while the formed plate having the partitioning portion 18 and the formed plate having the guide plate 19 are formed independently of each other in the structures described above, the partitioning portion 18 and the guide plate 19 may be formed on a single formed plate to reduce the number of different types of formed plates required in assembling the heat exchanger. When adopting such a structure, the formed plate 6e shown in FIG. 3(c) should be replaced with the formed plate 6e' shown in FIG. 53 with a formed plate 6a shown in FIG. 3(a) placed adjacent to the formed plate 6e'.

Industrial applicability

[0088] As explained above, according to the present invention provided with a guide plate that causes the heat exchanging medium traveling along the laminating direction to flow straight toward the communicating point at which the tank portions to which the heat exchanging medium is traveling and the corresponding passage portions communicate with each other when the heat exchanging medium is flowing from the tank portions into the passage portions in communication with the tank portions after the heat exchanging medium travels along the laminating direction through the tank portions which are in communication, the heat exchanging medium is distributed into the individual tube elements in an almost completely uniform manner, to avoid great deviations occurring in the passing air temperature at different locations due to an uneven flow of the heat exchanging medium. In addition, since the guide plate aggressively changes the direction in which the heat exchanging medium advances straight, an uneven distribution of the heat exchanging medium is minimized without increasing the passage resistance and, at the same time, occurrence of a rotating flow is also prevented, so that the heat exchanging medium is guided to the passage portions near the shifting area with ease.

[0089] In a single-side tank type heat exchanger, in particular, by providing the guide plate at the shifting area where an even-numbered pass shifts into an odd-numbered pass, the heat exchanging medium is guided into the passage portions located immediately into the odd-numbered pass, to achieve a consistent distribution of the heat exchanging medium.

[0090] In addition, by providing the guide plate at a formed plate adjacent to the formed plate having the partitioning portion which constitutes the boundary of the pass in which the heat exchanging medium flows from the tank portions to the passage portions among the formed plates constituting the tube elements or by providing the guide plate at the formed plate having the partitioning portion formed therein, the heat exchanging medium can be guided into the passage portions in the vicinity of the partitioning portion with ease. In particular, by providing the guide plate and the partitioning portion on a single formed plate, the number of different types of formed plates required in assembling the heat exchanger can be reduced.

[0091] While the degree to which the flow of the heat exchanging medium can be improved by the guide plate depends upon how the angle of inclination of the guide plate and the length of the inclined portion are combined, by setting the angle of inclination within the range of 5 ~ 65° and the length of the inclined portion within the range of 1 ~ 15mm respectively, the unbalanced flow of heat exchanging medium can be reduced to improve the heat exchanging efficiency. Furthermore, by forming the guide plate as an integrated part of the member constituting the tank portion, the number of manufacturing steps can be reduced and the manufacturing process is facilitated.

[0092] While the guide plate may assume any of various shapes, by constituting the guide plate with a bridge provided across the communicating hole and an inclined portion bent from the side edge of the bridge and extending at an angle, by directly bending the circumferential edge of the communicating hole to achieve an inclining shape or by twisting the portion extending across the communicating hole to achieve an inclining shape for the entire guide plate, a guide plate that can be manufactured easily and can be put into practical use with ease is provided. In addition, by forming numerous guide plates at the shifting area or in its vicinity, the flow of the heat exchanging medium can be changed with a high degree of reliability to effectively prevent an unbalanced flow of heat exchanging medium.

[0093] Moreover, in the structure described above and achieved by providing the guide plate at the communicating hole of a tube element at a specific position to change the direction of the flow of the heat exchanging medium traveling along the laminating direction toward the communicating point at which the tank portions to which the heat exchanging medium is moving and the corresponding passage portions communicate with each other when the heat exchanging medium flows from the tank portions to the passage portions in communication with the tank portions after the heat exchanging medium flows along the laminating direction through the tank portions which are in communication with each other, the guide plate may be formed in a curved shape or a bead may be provided at the guide plate to improve the strength and the two shoulders of the guide plate may be rounded to prevent occurrence of vibration.

Claims

1. A laminated heat exchanger constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating with said tank portions over numerous levels with said tank portions sequentially abutted, by making all of said tank portions or a plurality of said tank portions thus abutted communicate with each other via communicating holes formed at individual tank portions, by providing a pass in which a heat exchanging medium is allowed to flow from a plurality of contiguous tank portions into passage portions communicating with said tank portions and by causing the heat exchanging medium to travel along the laminating direction via said communicating holes over a shifting area where another pass shifts into said pass, characterized in that;

   a guide plate that causes the flow of the heat exchanging medium traveling along the laminating direction to advance straight toward a communicating point at which tank portions to which the heat exchanging medium is traveling and passage portions communicating with said tank portions communicate with each other is provided at, at least, one position at said shifting area or in the vicinity of said shifting area.

2. A laminated heat exchanger constituted by laminating tube elements each having a pair of tank portions provided on one side and a turnaround passage portion communicating between said pair of tank portions over numerous levels via fins, by sequentially abutting tank portions of adjacent tube elements, by communicating said tank portions thus

abutted via communicating holes in units of individual blocks, by setting as appropriate the number of tank portions constituting each block to provide an odd-numbered pass through which a heat exchanging medium flows from said tank portions of said tube elements into said passage portions and an even-numbered pass in which the heat exchanging medium flows from said passage portions of said tube elements into said tank portions and by allowing the heat exchanging medium to move along the laminating direction via said communicating holes over a shifting area in which an even-numbered pass shifts to an odd-numbered pass, characterized in that;

a guide plate that causes the flow of the heat exchanging medium traveling along the laminating direction to advance. straight toward a communicating point at which said tank portions in said odd-numbered pass communicate with corresponding passage portions is provided at, at least, one location at said shifting area or in the vicinity of said shifting area.

3. A laminated heat exchanger according to claim 1 or 2, characterized in that:

said tube elements are each constituted by bonding two formed plates, the boundary of said pass in which the heat exchanging medium flows from said tank portions to said passage portions is defined by providing a formed plate having a partitioning portion for disallowing communication between tank portions along the laminating direction at a specific position and said guide plate provided at said shifting area is located at a formed plate adjacent to said formed plate having said partitioning portion.

4. A laminated heat exchanger according to claim 1 or 2, characterized in that:

said tube elements are each constituted by bonding two formed plates, the boundary of said pass in which the heat exchanging medium flows from said tank portions to said passage portions is defined by providing a formed plate having a partitioning portion for disallowing communication between tank portions along the laminating direction at a specific position and said guide plate provided at said shifting area is located at said formed plate having said partitioning portion.

5. A laminated heat exchanger according to any of claims 1 ~ 4, characterized in that:

said guide plate is made to incline at an angle within a range of 5 ~ 60° relative to the direction along which said tube elements are laminated with the length of the inclined portion set within a range of 1 ~ 15mm.

6. A laminated heat exchanger according to any of claims 1 ~ 4, characterized in that:

said guide plate is formed as an integrated part of a member constituting said tank portion.

7. A laminated heat exchanger according to any of claims 1 ~ 6, characterized in that:

said guide plate is constituted of a bridge provided across said communicating hole and an inclined portion formed by bending a side edge of said bridge and made to extend at an angle.

8. A laminated heat exchanger according to any of claims 1 ~ 6, characterized in that:

said guide plate inclines from a circumferential edge of said communicating hole.

9. A laminated heat exchanger according to any of claims 1 ~ 6, characterized in that:

said guide plate is formed by twisting a portion extending across said communicating hole to achieve an inclined shape for the entirety of said guide plate.

10. A laminated heat exchanger according to any of claims 1 ~ 6, characterized in that:

numerous guide plates are formed at said shifting area or in the vicinity thereof.

11. A laminated heat exchanger constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating with said tank portions over numerous levels, characterized in that:

a guide plate is provided at some of said tube elements, which is located at a communicating hole formed in a distended portion for tank formation at a formed plate constituting said tube element and is formed in a curved shape along the lateral direction of said formed plate.

12. A laminated heat exchanger according to any of claims 1 ~ 8, characterized in that:

said guide plate is formed in a curved shape along the lateral direction of said formed plate.

13. A laminated heat exchanger according to claim 11 or 12, characterized in that:

said curved shape achieves a specific curvature.

14. A laminated heat exchanger according to claim 11 or 12, characterized in that:

a curved shape is formed over areas close to the two ends along the lateral direction.

15. A laminated heat exchanger according to any of claims 11 ~ 14, characterized in that:

a reservoir is formed in said curved shape.

16. A laminated heat exchanger according to any of claim 11 or 12, characterized in that:

a straight portion is formed at the two ends of said guide plate formed in a curved shape along the lateral direction.

17. A laminated heat exchanger according to claim 16, characterized in that

said straight portion is formed at said bridge provided across said communicating hole.

18. A laminated heat exchanger constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating with said tank portions over numerous levels, characterized in that:

a guide plate is provided at a plurality of said tube elements, which is located at a communicating hole formed in a distended portion for tank formation at a formed plate constituting said tube element, with a bead provided at, at least, one location at said guide plate along the direction in which said guide plate projects out from said formed plate.

19. A laminated heat exchanger according to any of claims 1 ~ 8, characterized in that:

a bead is provided at, at least, one location, at said guide plate along the direction in which said guide plate projects out from said formed plate.

20. A laminated heat exchanger according to claim 18 or 19, characterized in that:

the length of said bead is set equal to the length of said guide plate along the direction in which said guide plate projects out.

21. A laminated heat exchanger according to claim 18 or 19, characterized in that

the length of said bead is less than the length of said guide plate along the direction in which said guide plate projects out.

22. A laminated heat exchanger according to claim 18 or 19, characterized in that:

said bead is formed in a diamond shape.

23. A laminated heat exchanger constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating with said tank portions over numerous levels, characterized in that:

a guide plate is provided at a plurality of said tube elements, which is located at a communicating hole formed in a distended portion for tank formation at a formed plate constituting said tube element, two shoulders of said guide plate at a front end thereof along the direction in which said guide plate projects out from said formed plate, formed in a rounded shape.

24. A laminated heat exchanger according to any of claims 1 ~ 8, characterized in that:

two shoulders of said guide plate at a front end thereof along the direction in which said guide plate projects out from said formed plate are rounded.

25. A laminated heat exchanger constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating with said tank portions over numerous levels, characterized in that:

a guide plate is provided at a plurality of said tube elements, which is located at a communicating hole formed in a distended portion for tank formation at a formed plate constituting said tube element, and is formed in a curved shape along the lateral direction of said formed plate, with a bead provided at, at least, one location of said guide plate along the direction in which said guide plate projects out.

26. A laminated heat exchanger according to any of claims 1 ~ 8, characterized in that:

said guide plate is formed in a curved shape along the lateral direction of said formed plate and a bead is provided at, at least, one location along the direction in which said guide plate projects out.

27. A laminated heat exchanger constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating with said tank portions over numerous levels, characterized in that:

a guide plate is provided at a plurality of said tube elements, which is located at a communicating hole formed in a distended portion for tank formation at a formed plate constituting said tube element, and is formed in a curved shape along the lateral direction of said formed plate, with two shoulders of said guide plate at a front end thereof along the direction in which said guide plate projects out from said formed plate, formed in a rounded shape.

28. A laminated heat exchanger according to any of claims 1 ~ 8, characterized in that:

said guide plate is formed in a curved shape along the lateral direction of said front plate and two shoulders of said guide plate at a front end thereof along the direction in which said guide plate projects out from said formed plate are rounded.

29. A laminated heat exchanger constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating with said tank portions over numerous levels, characterized in that:

said guide plate is provided at some of said tube elements, which is located in a passage formed in a distended portion for tank formation of a formed plate constituting the tube element with a bead provided at, at least, one location of said guide plate along the direction in which said guide plate projects out from said formed plate and two shoulders of said guide plate at a front end thereof along the direction in which said guide plate projects out from said formed plate, formed in a rounded shape.

30. A laminated heat exchanger according to any of claims 1 ~ 8, characterized in that:

a bead is provided at, at least, one location at said guide plate along the direction in which said guide plate projects out from said formed plate and the two shoulders of said guide plate at a front end thereof along the direction in which said guide plate projects out from said formed plate are rounded.

31. A laminated heat exchanger constituted by laminating tube elements each having a plurality of tank portions and a passage portion communicating with said tank portions over numerous levels, characterized in that:

said guide plate is provided at some of said tube elements, which is located in a passage formed in a distended portion for tank formation of a formed plate constituting the tube element and is formed in a curved shape along the lateral direction of said formed plate with a bead provided at, at least, one location of said guide plate along the direction in which said guide plate projects out from said formed plate and two shoulders of said guide plate at a front end thereof along the direction in which said guide plate projects out from said formed plate, formed in a rounded shape.

32. A laminated heat exchanger according to any of claims 1 ~ 8, characterized in that:

said guide plate is formed in a curved shape along the lateral direction of said formed plate, a bead is provided at, at least, one location at said guide plate along the direction in which said guide plate projects out and two shoulders of said guide plate at a front end thereof along the direction in which said guide plate projects out from said formed plate are rounded.

FIG. 1

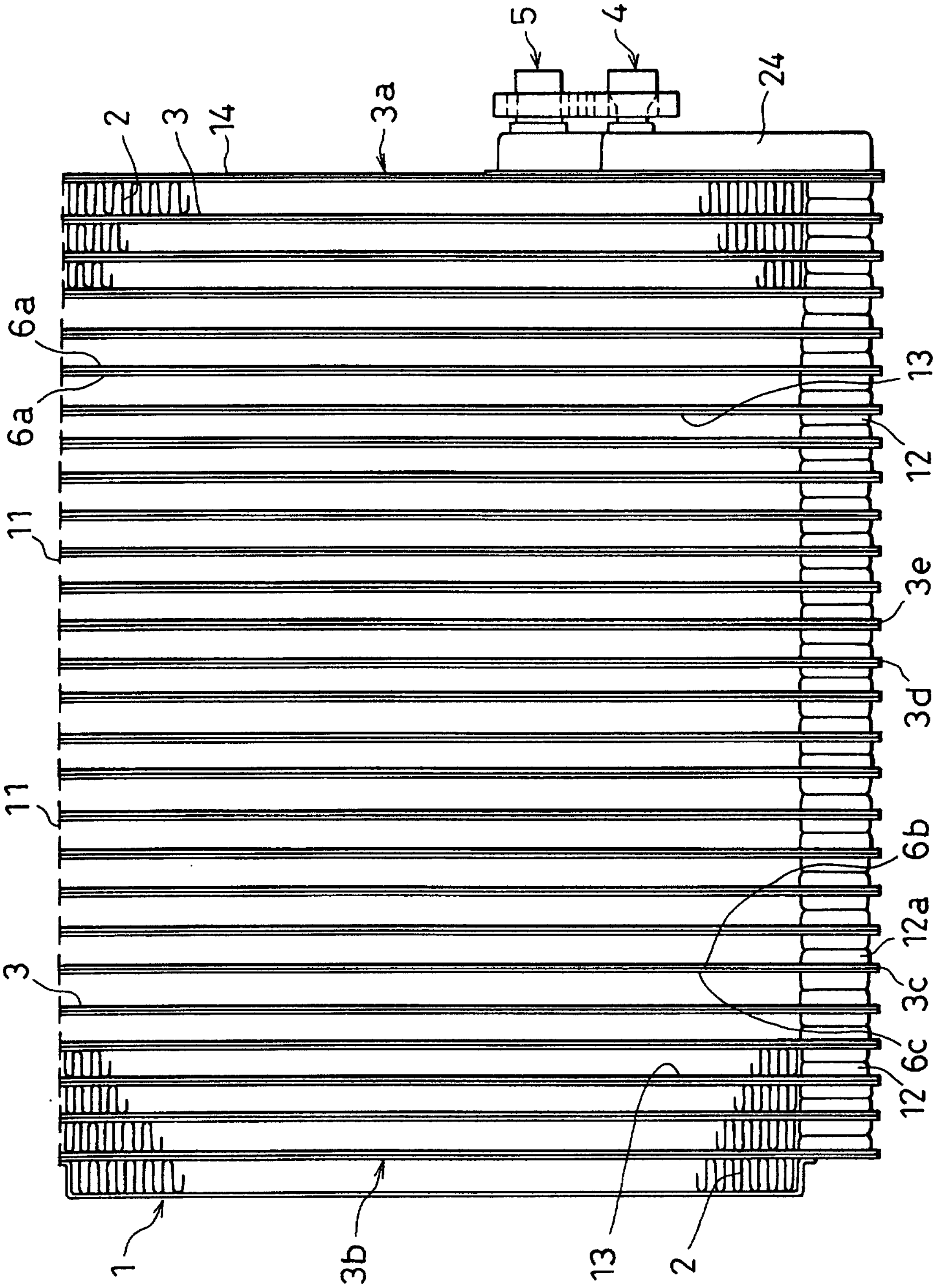
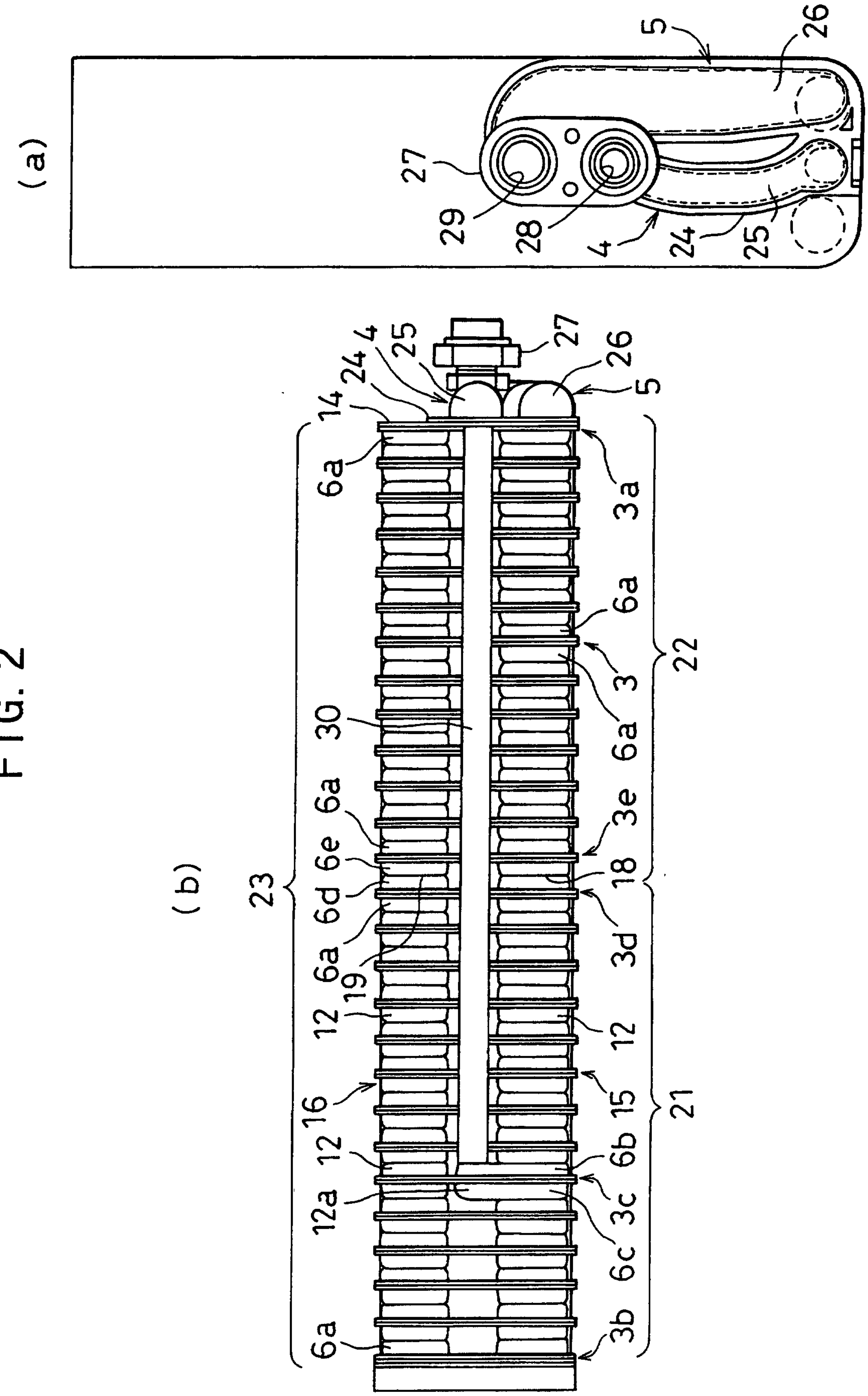


FIG. 2


(a)
(b)
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26
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6a
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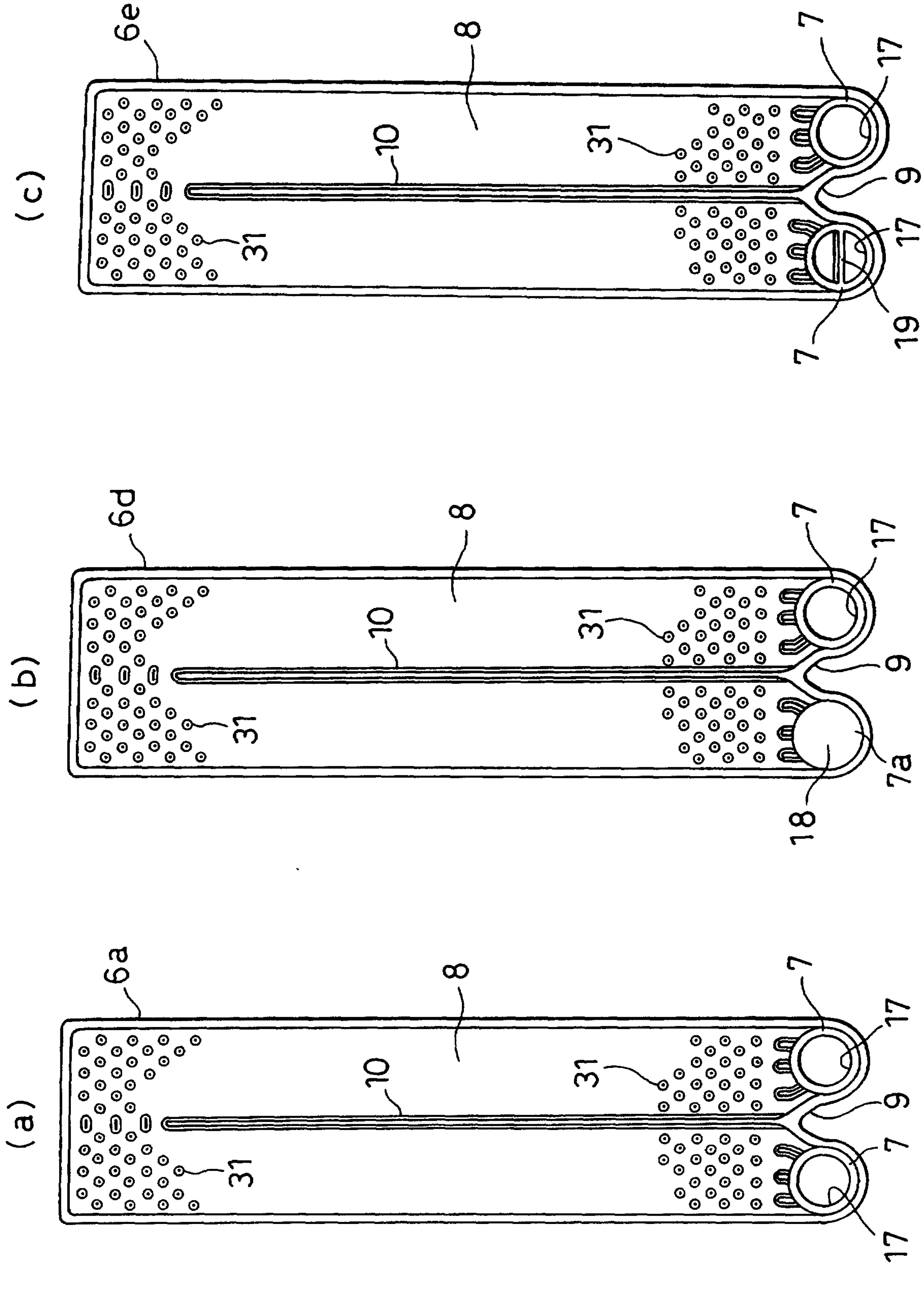
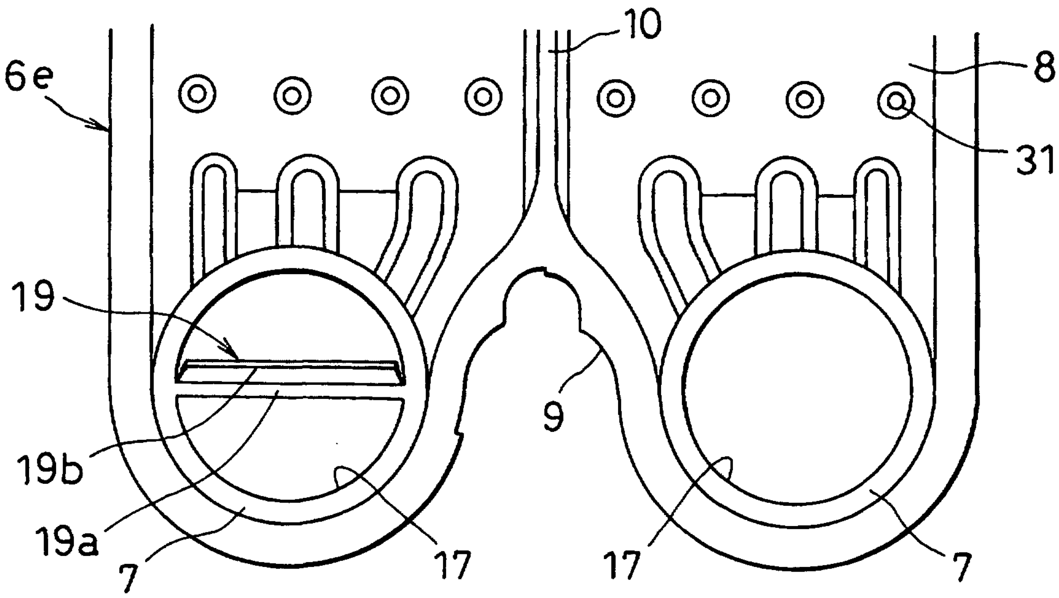


FIG. 3

FIG. 4

(a)



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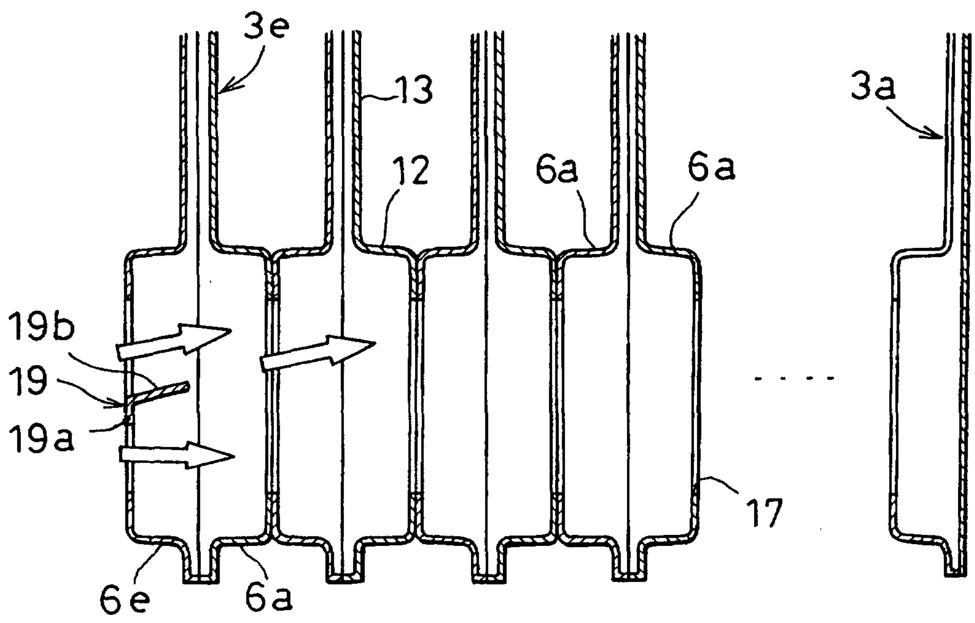


FIG. 5

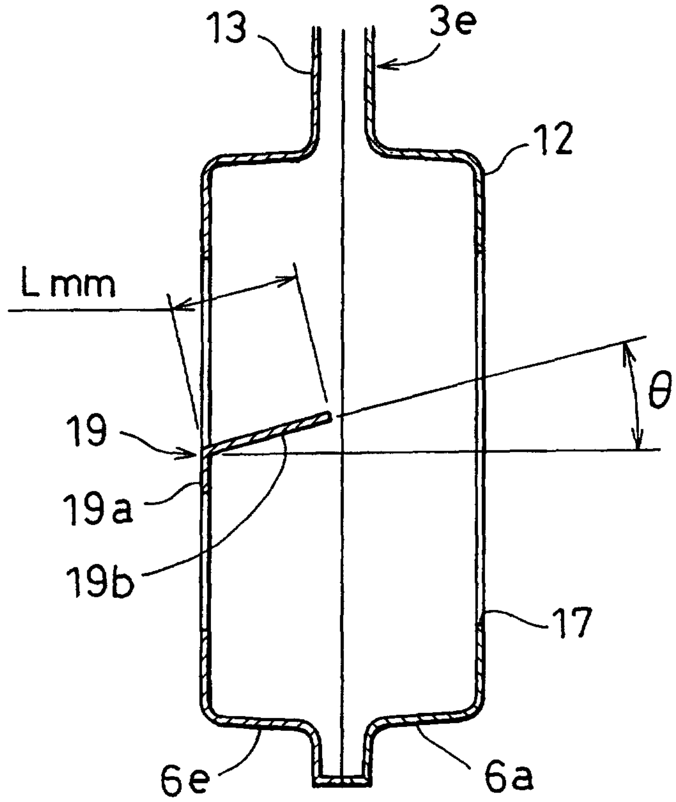


FIG. 6

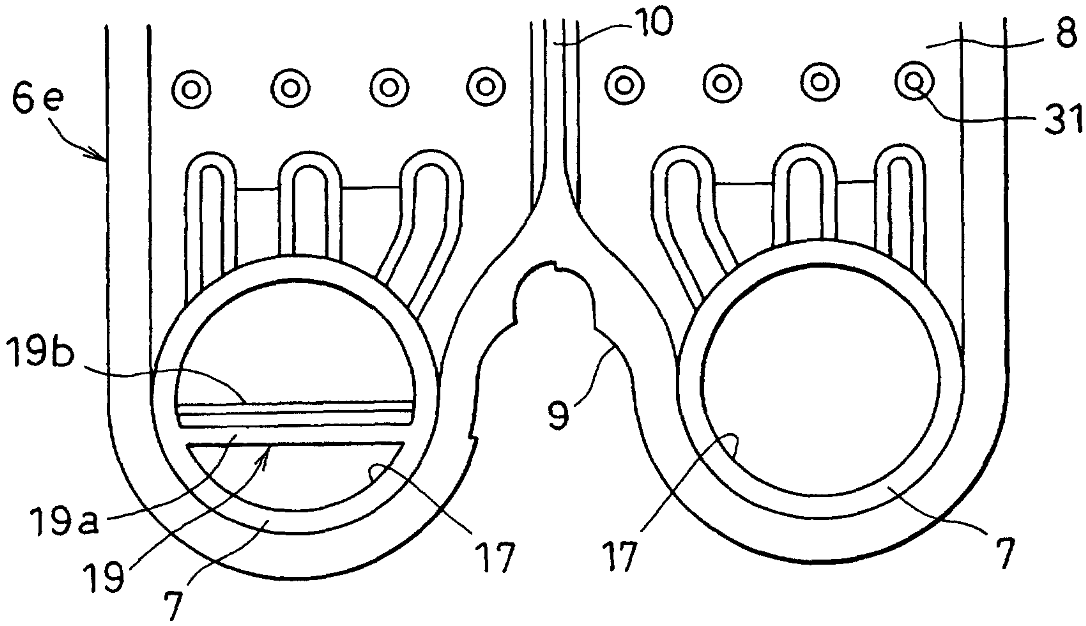


FIG. 7

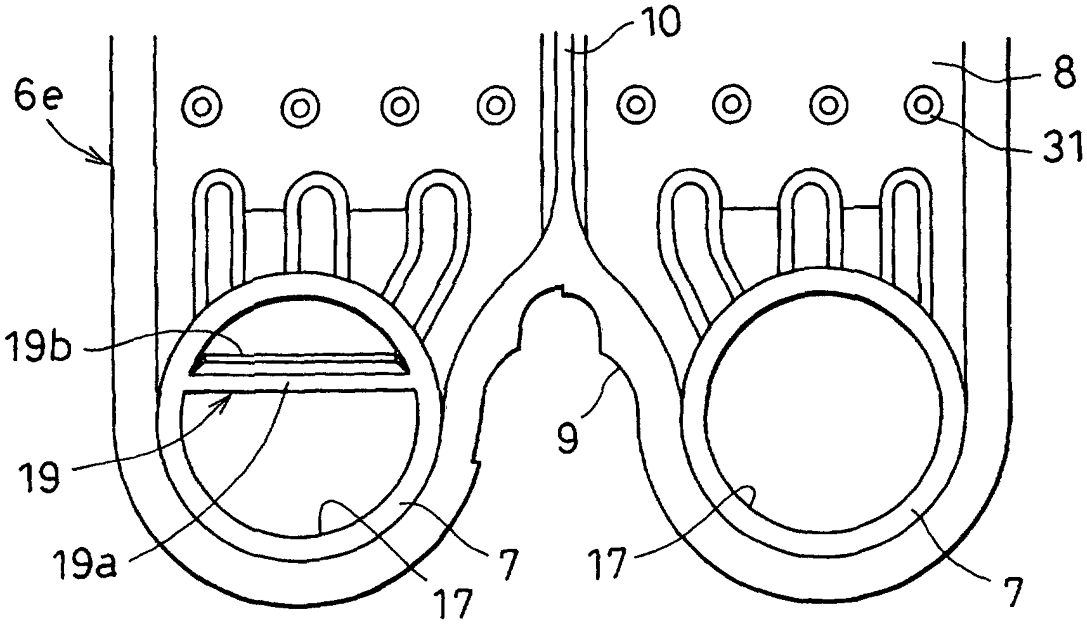


FIG. 8

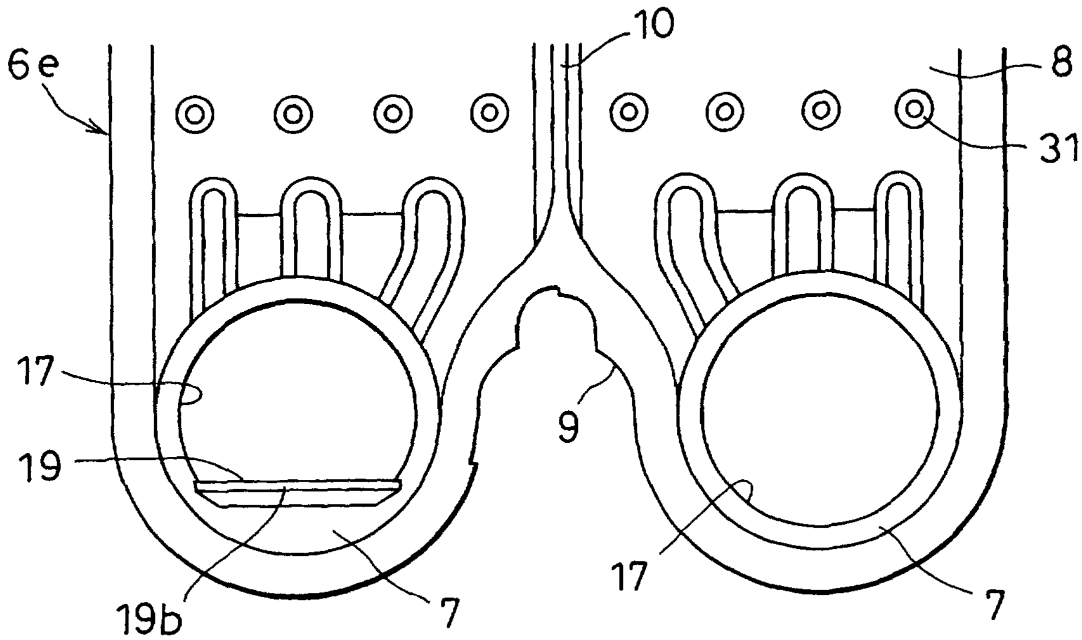
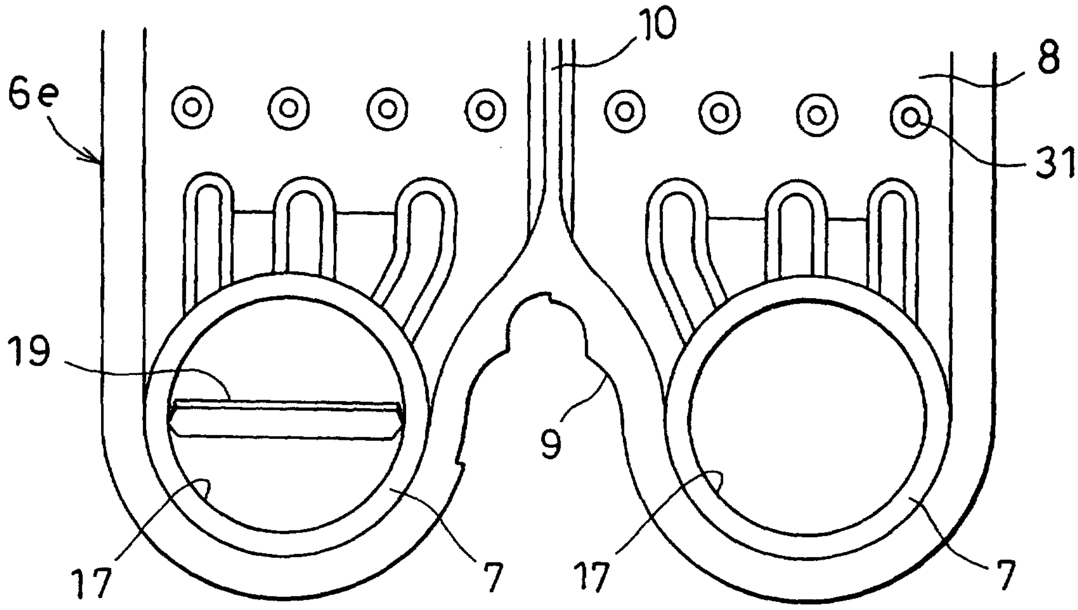


FIG. 9

(a)



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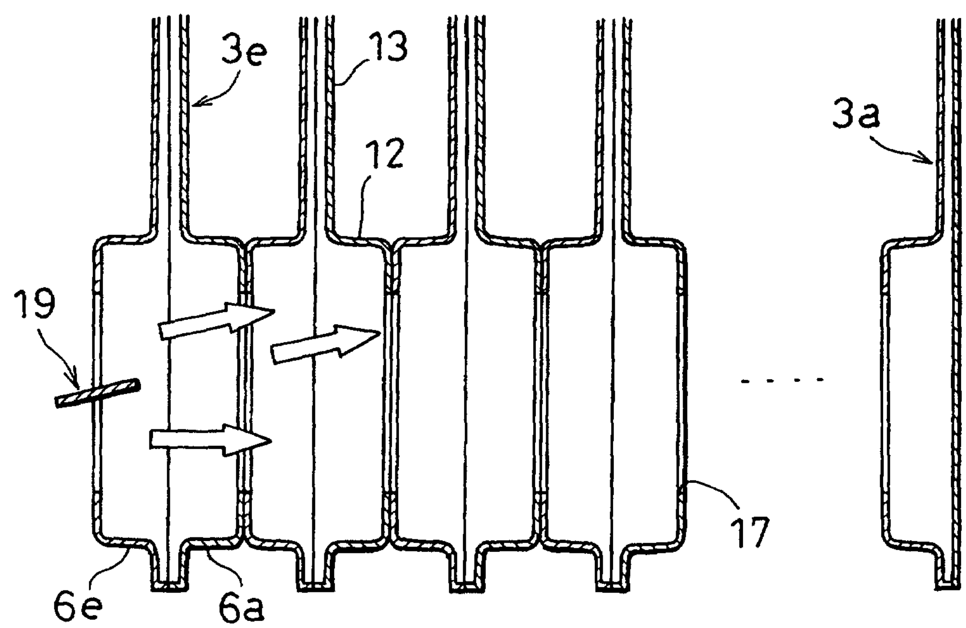


FIG. 10

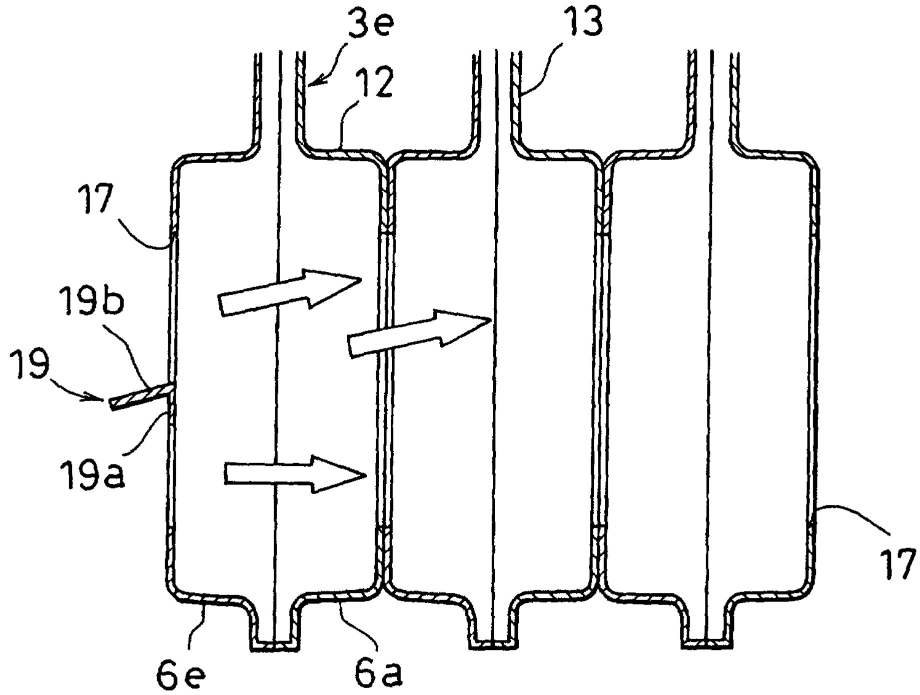


FIG. 11

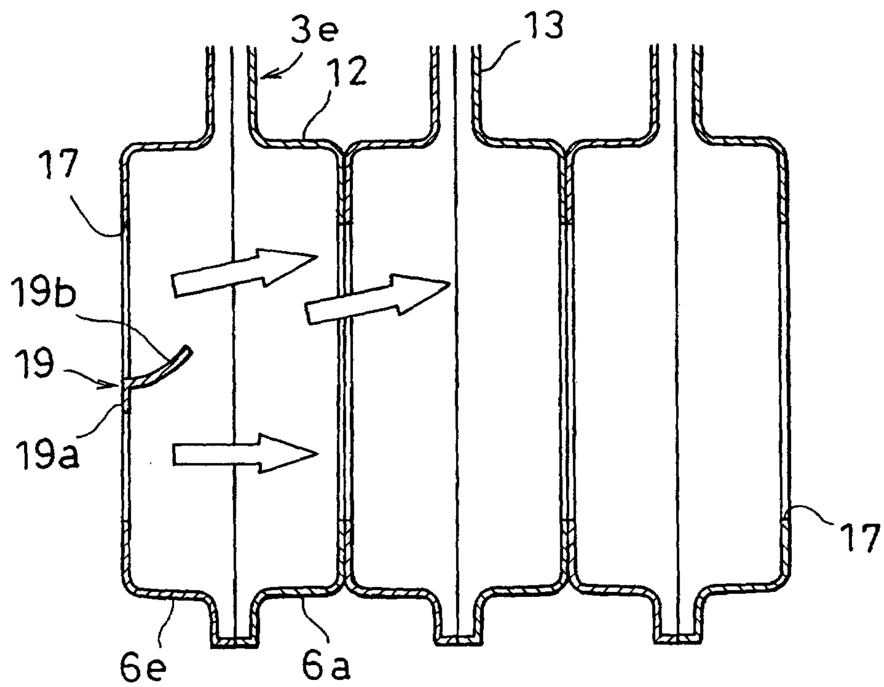
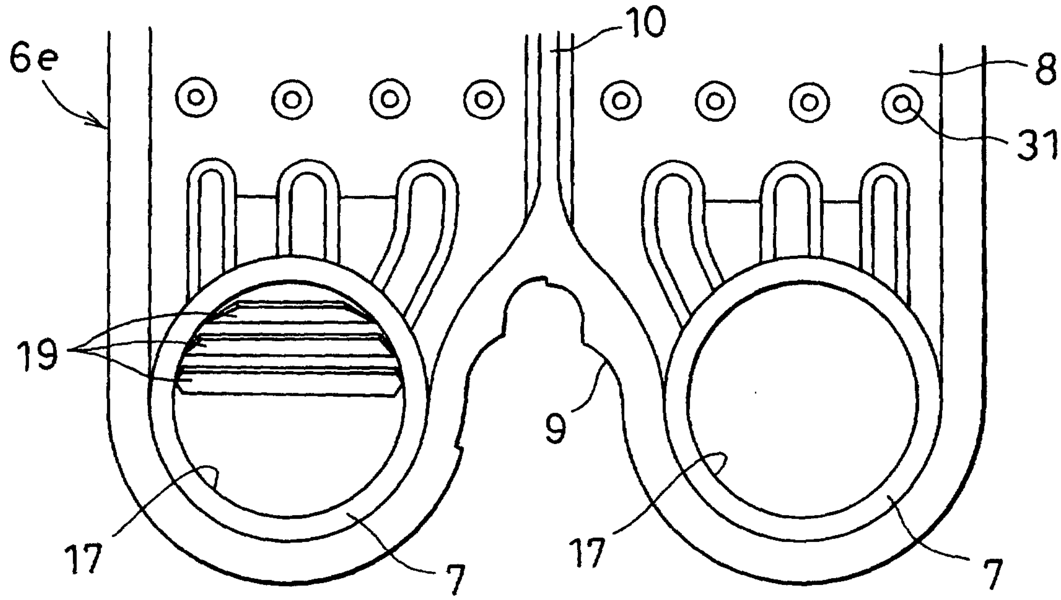


FIG. 12

(a)



(b)

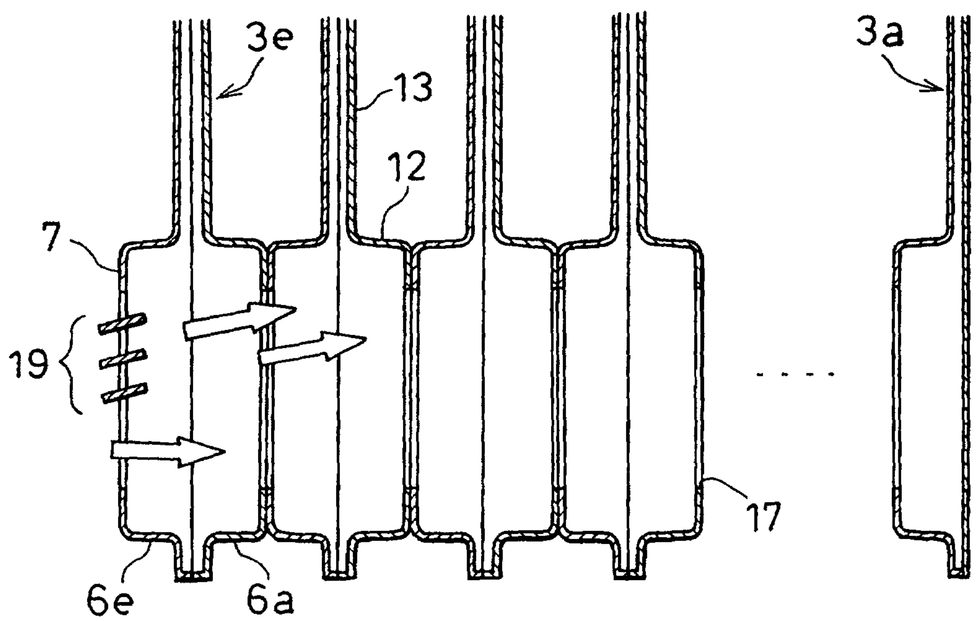
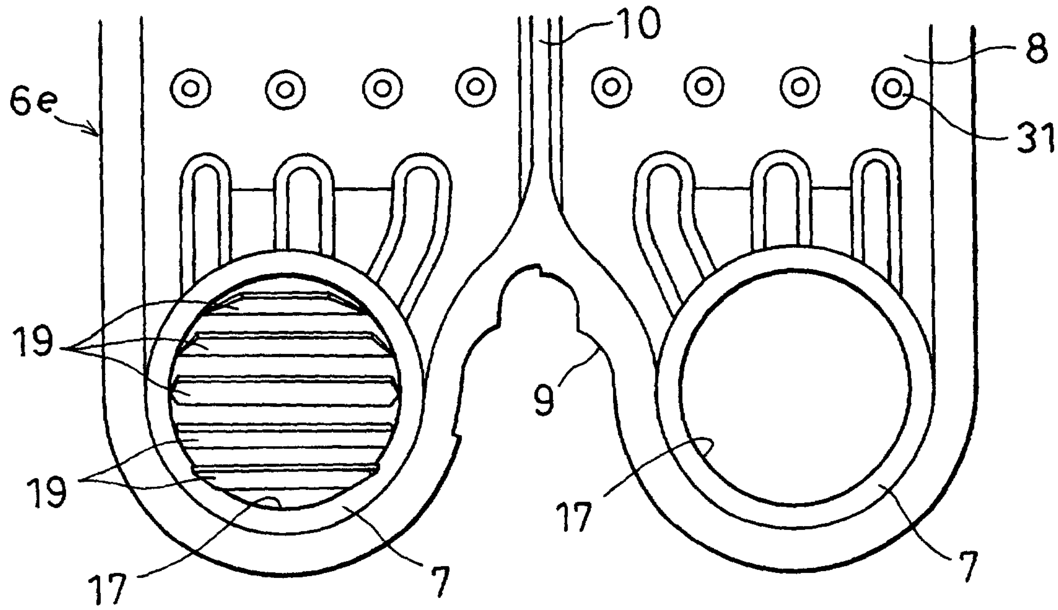


FIG. 13

(a)



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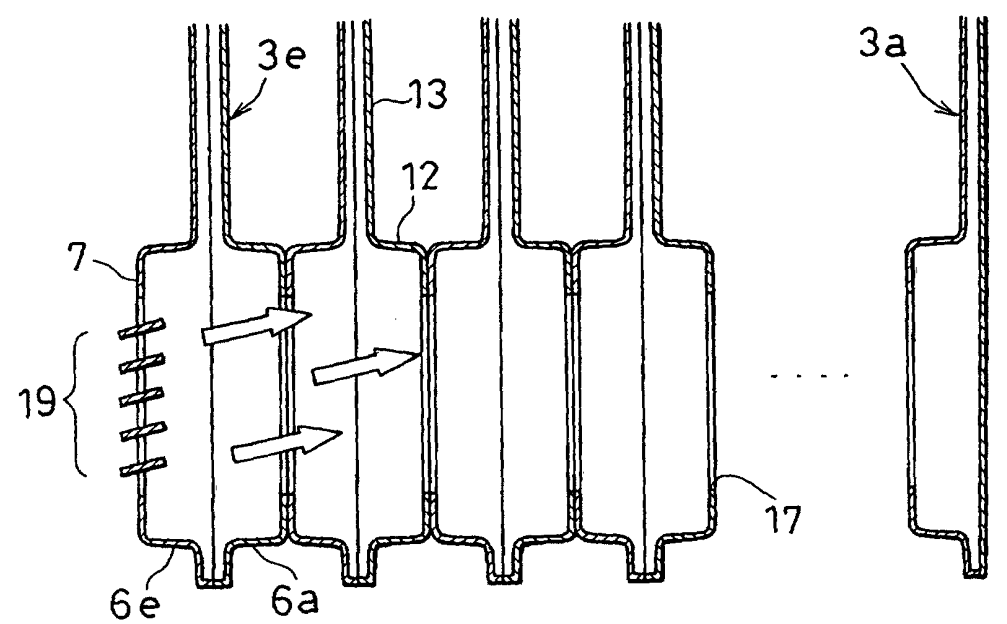
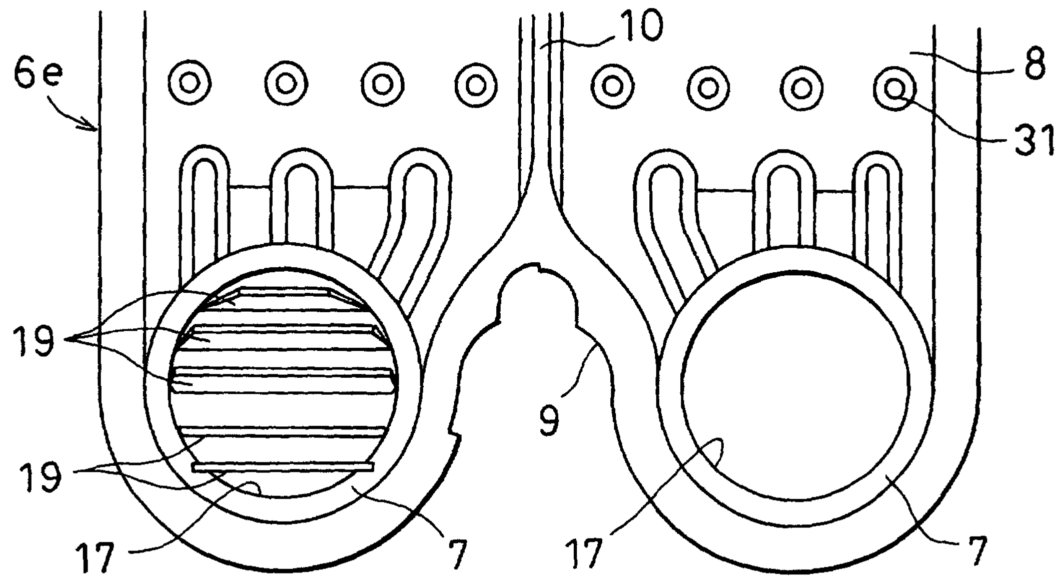
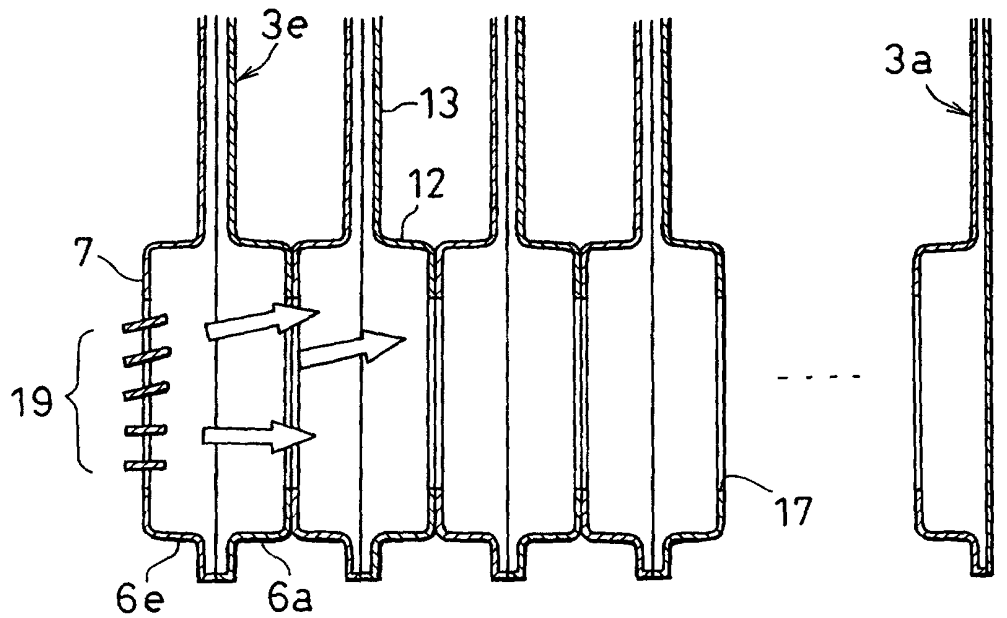


FIG. 14

(a)



(b)



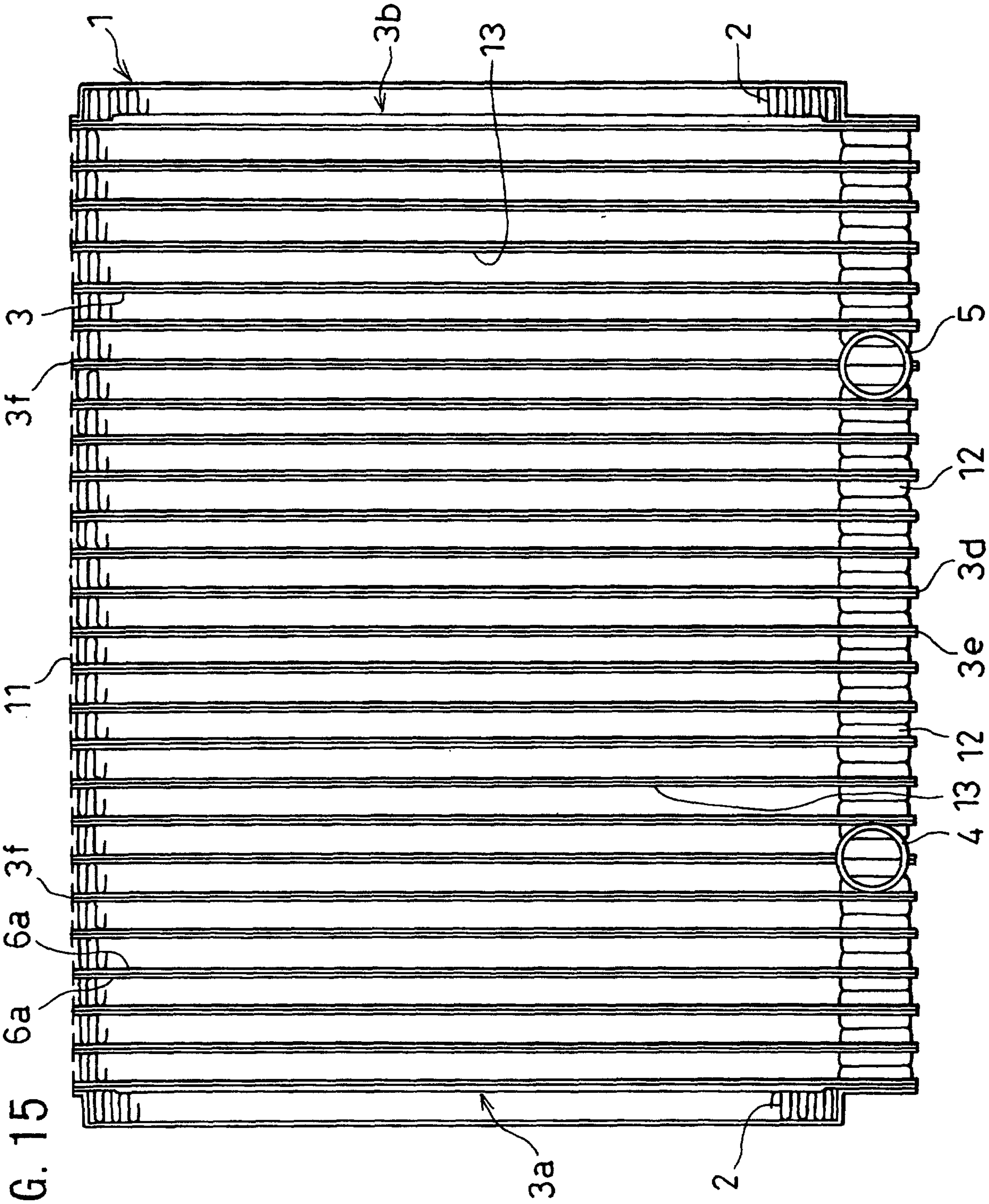


FIG. 15

FIG. 16

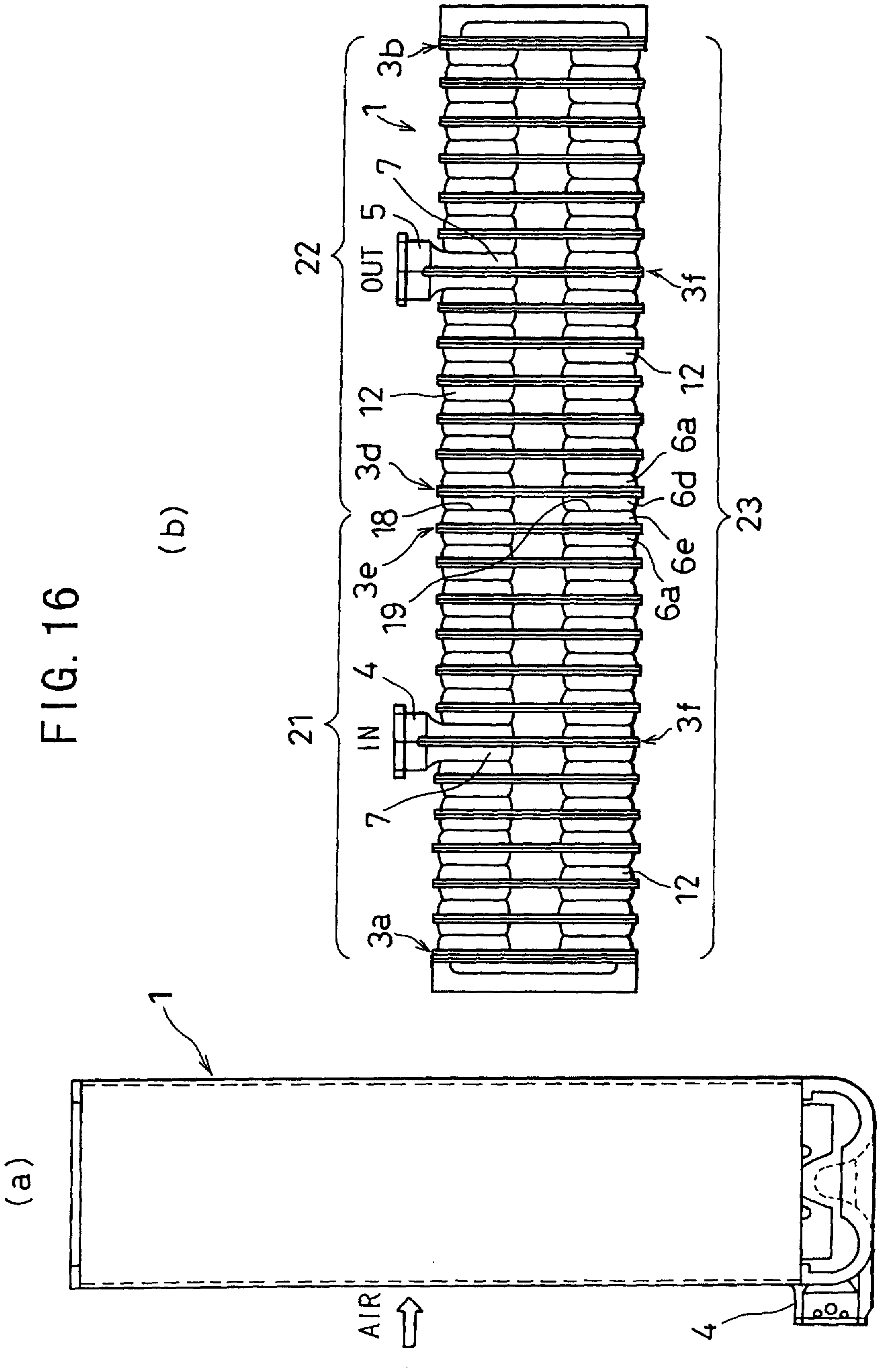


FIG. 17

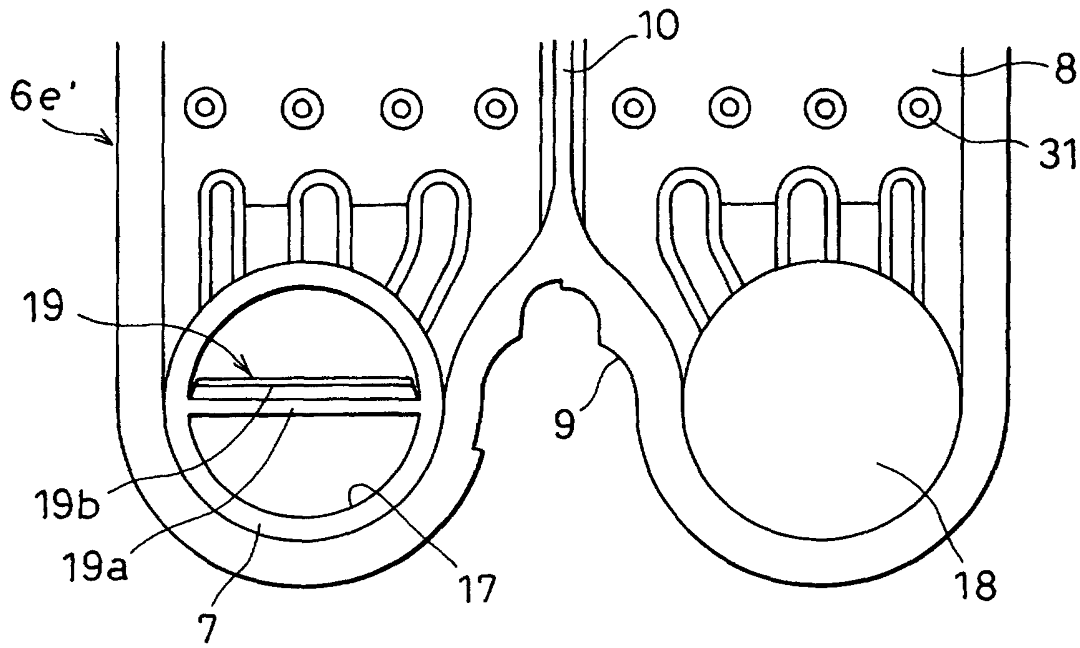
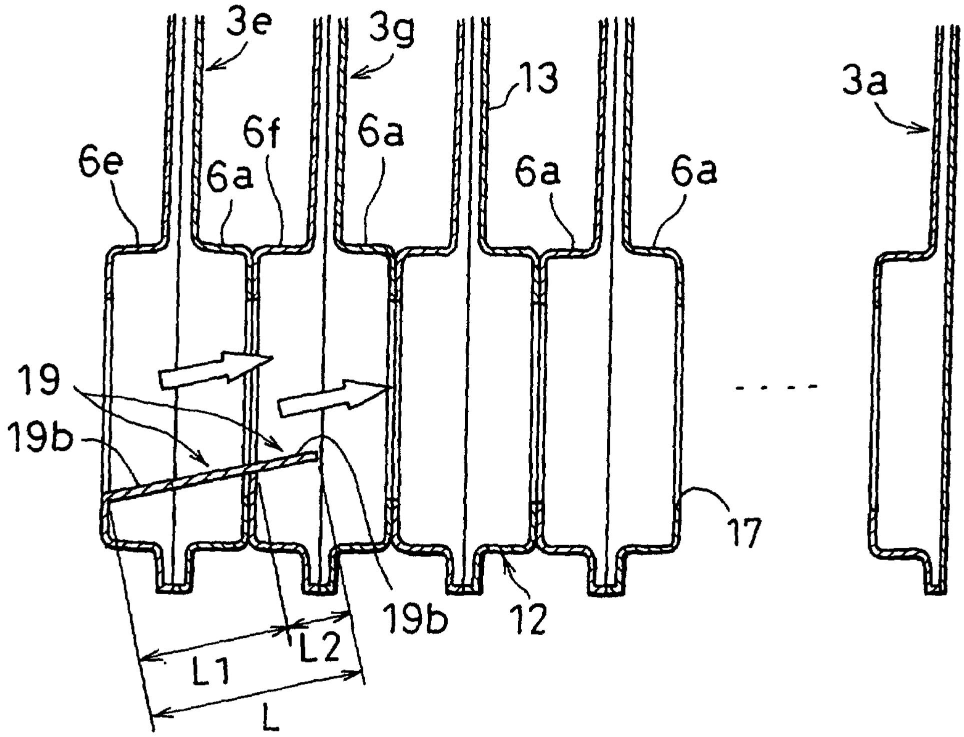


FIG. 18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3g
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3a
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6a
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19b
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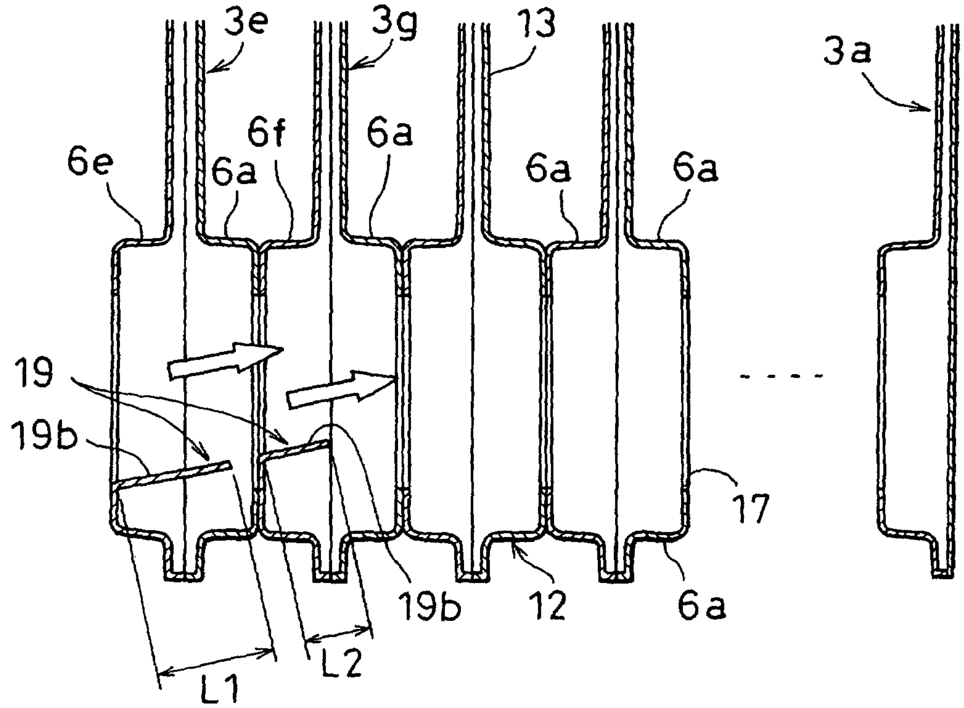
19b
12
L1
L2
L

FIG. 19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L1
L2

F.IG. 20

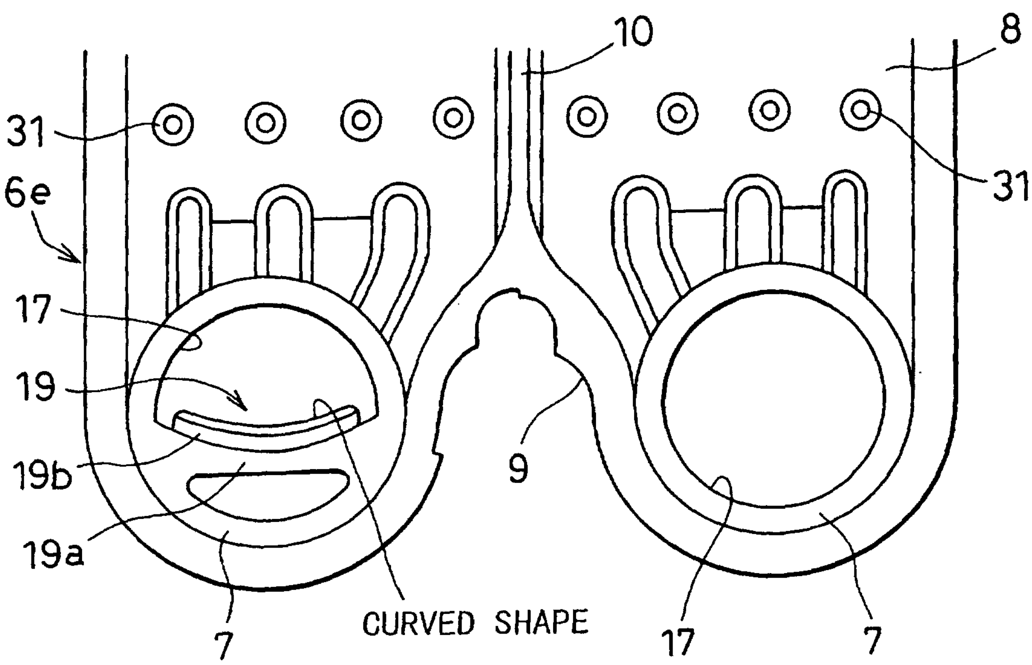


FIG. 21

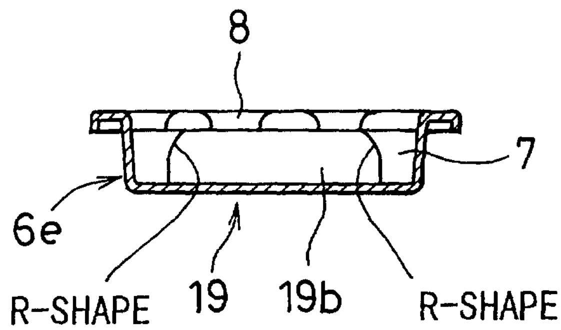


FIG. 22

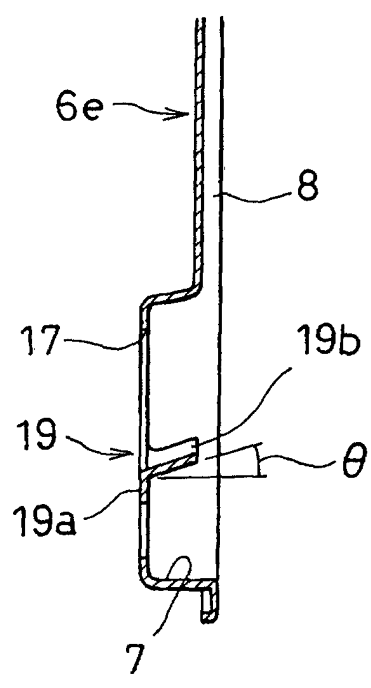


FIG. 23

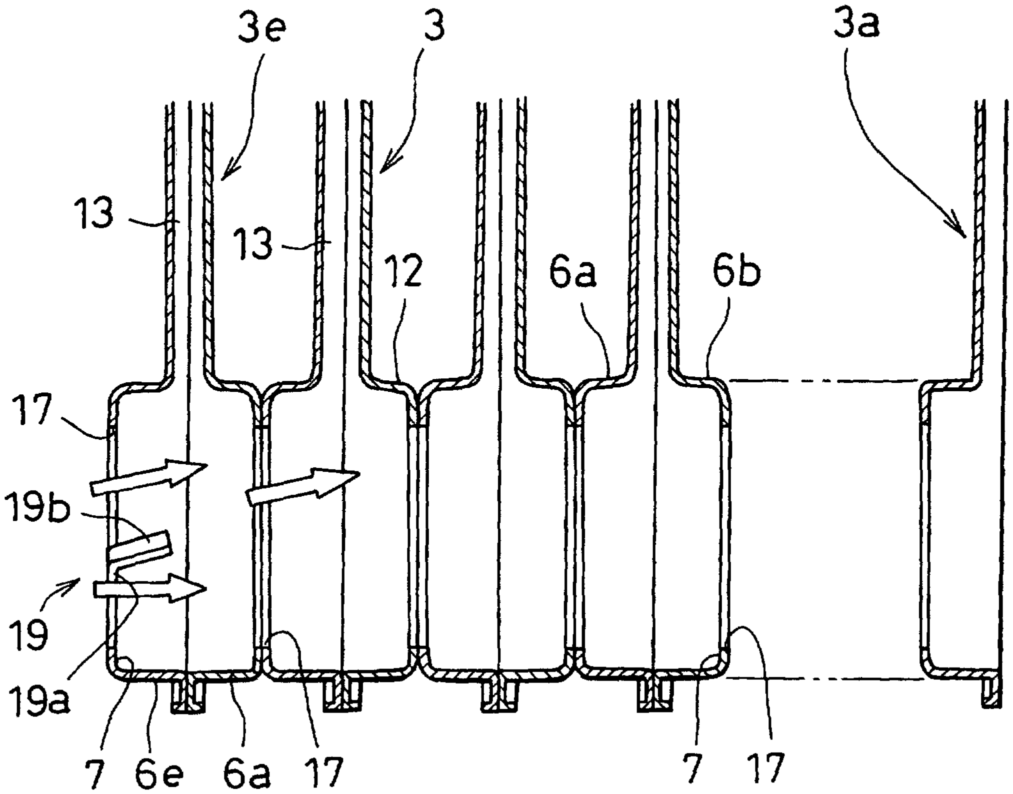


FIG. 24

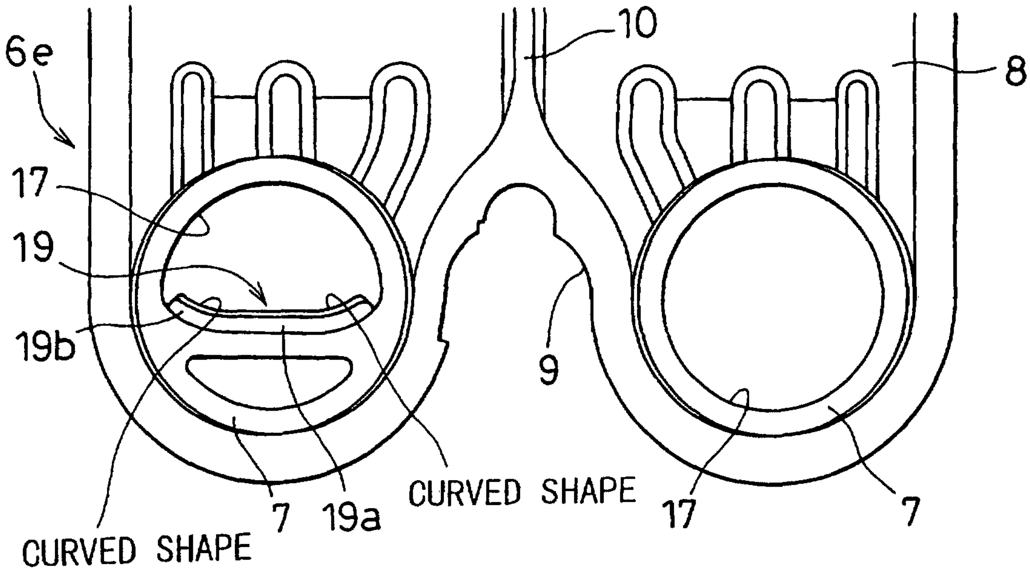


FIG. 25

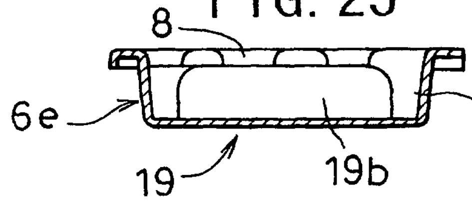


FIG. 26

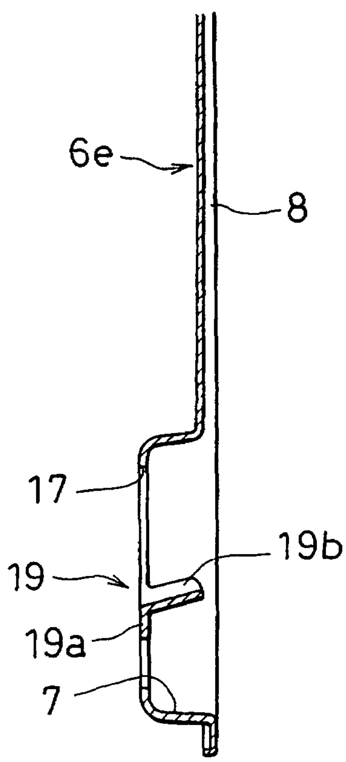


FIG. 27

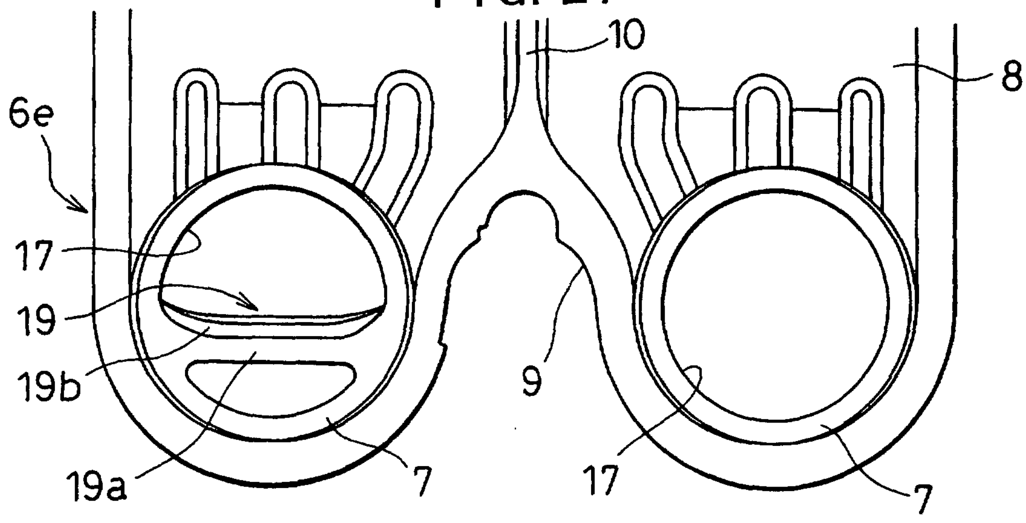


FIG. 28

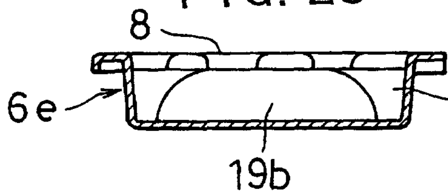


FIG. 29

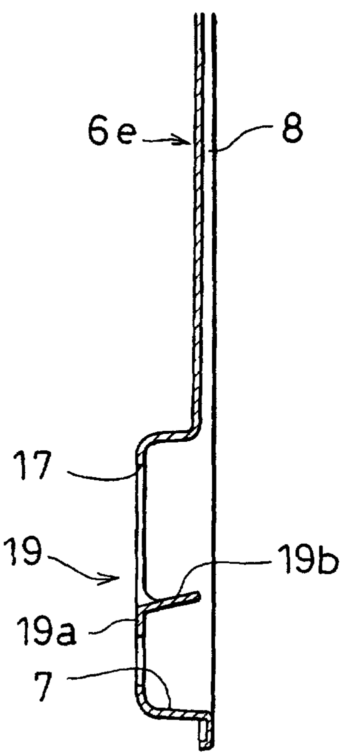


FIG. 30

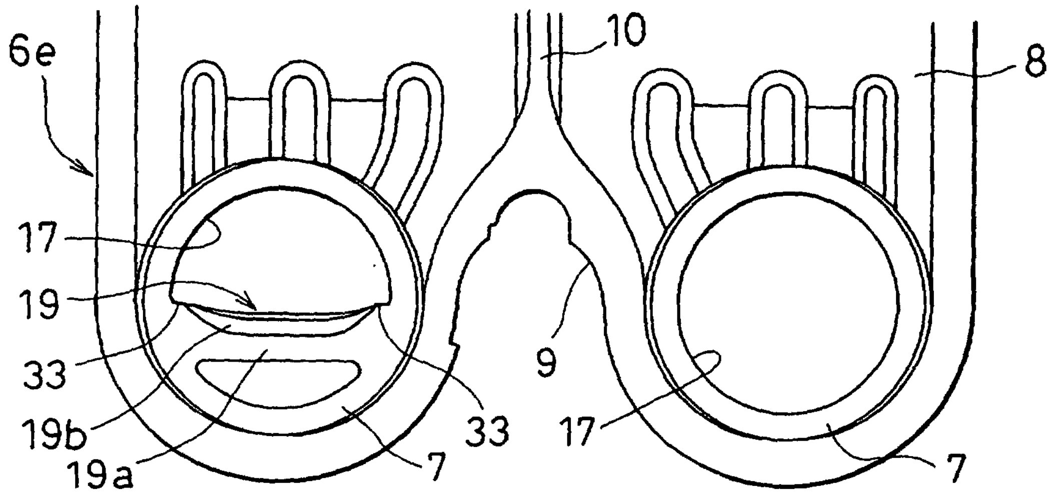


FIG. 31

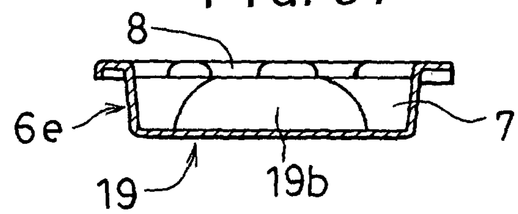


FIG. 32

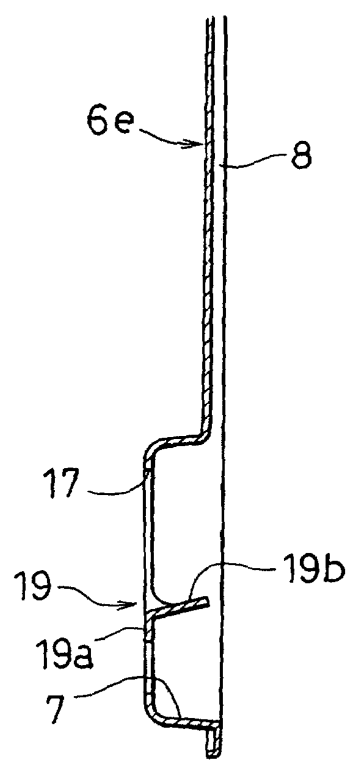


FIG. 33

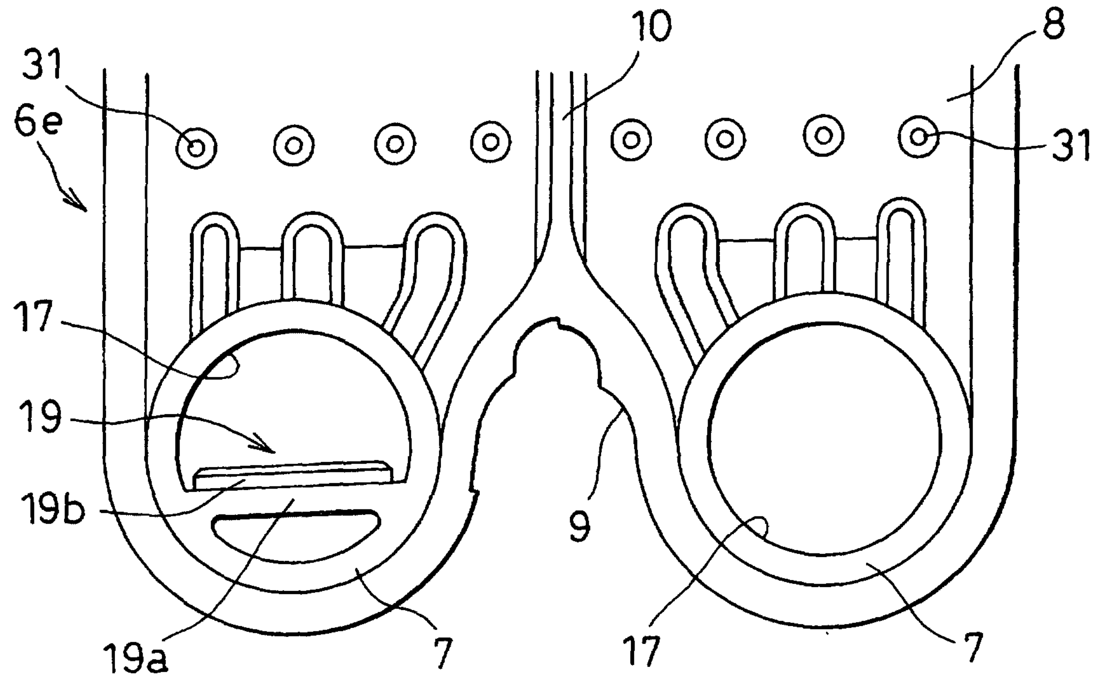


FIG. 34

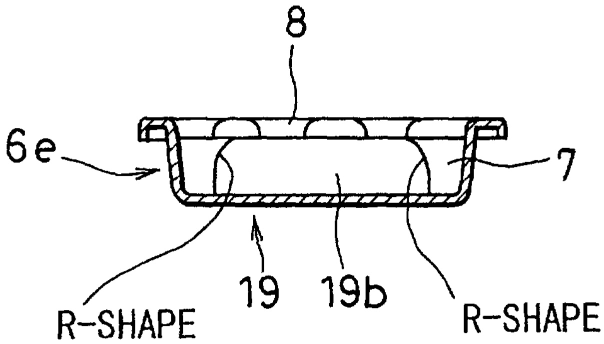


FIG. 35

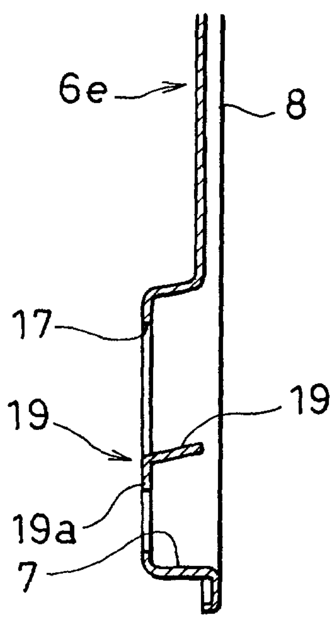


FIG. 36

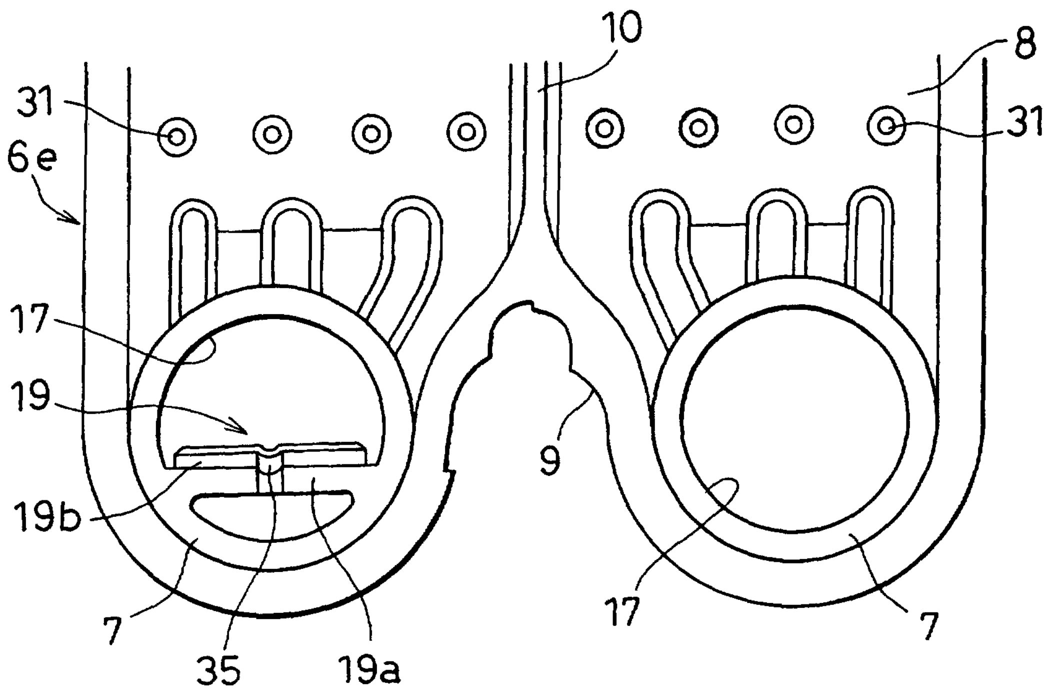


FIG. 37

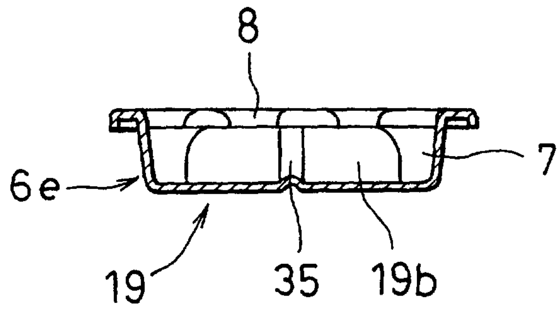


FIG. 38

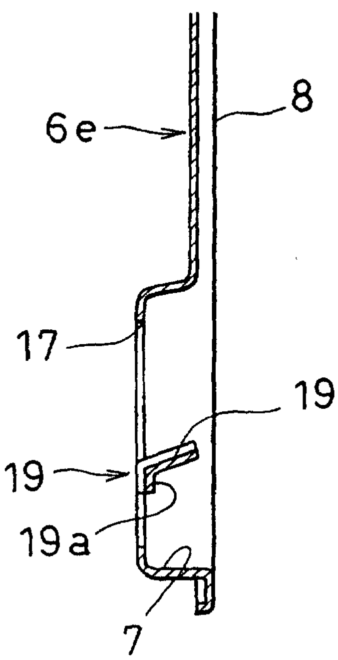


FIG. 39

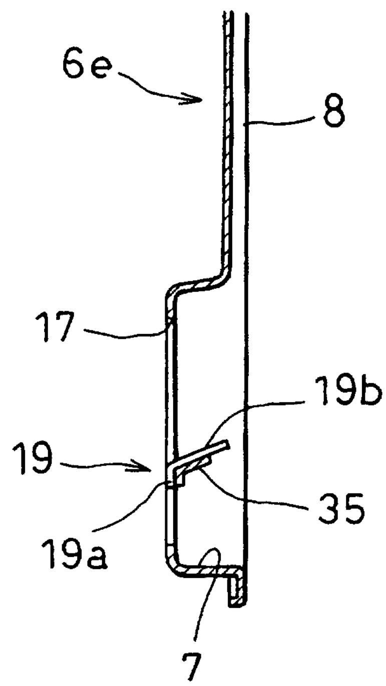


FIG. 40

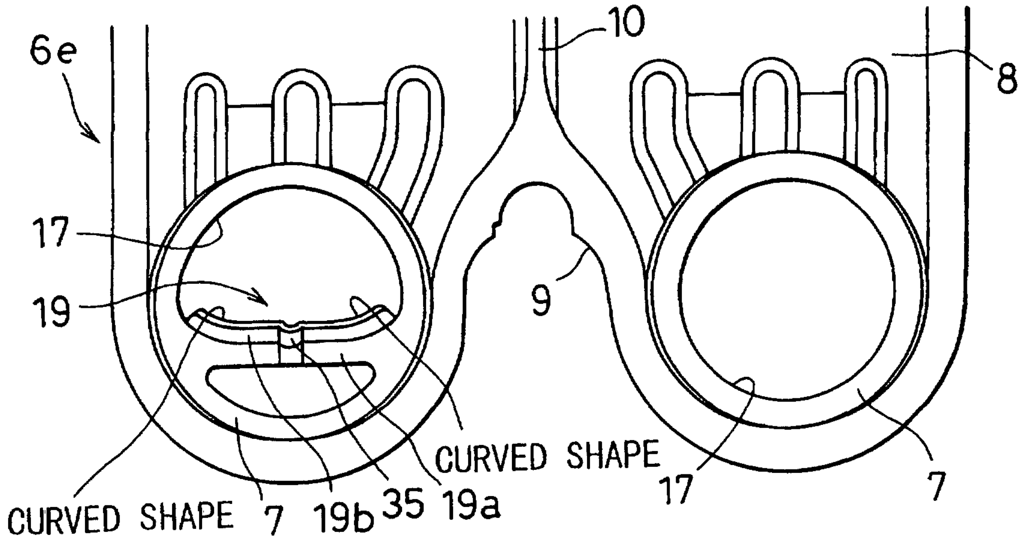


FIG. 41

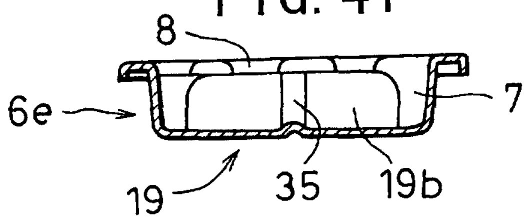


FIG. 42

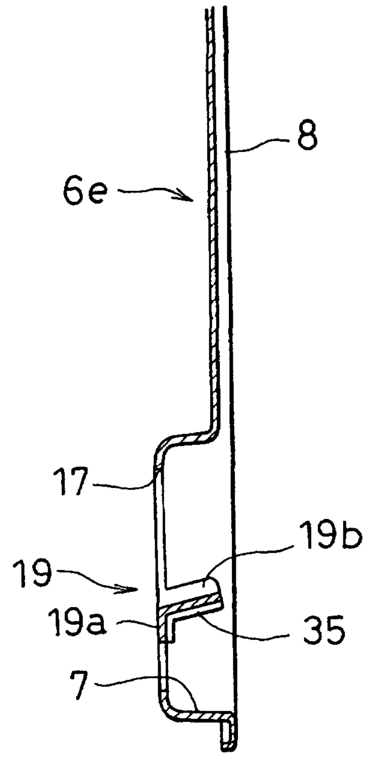


FIG. 43

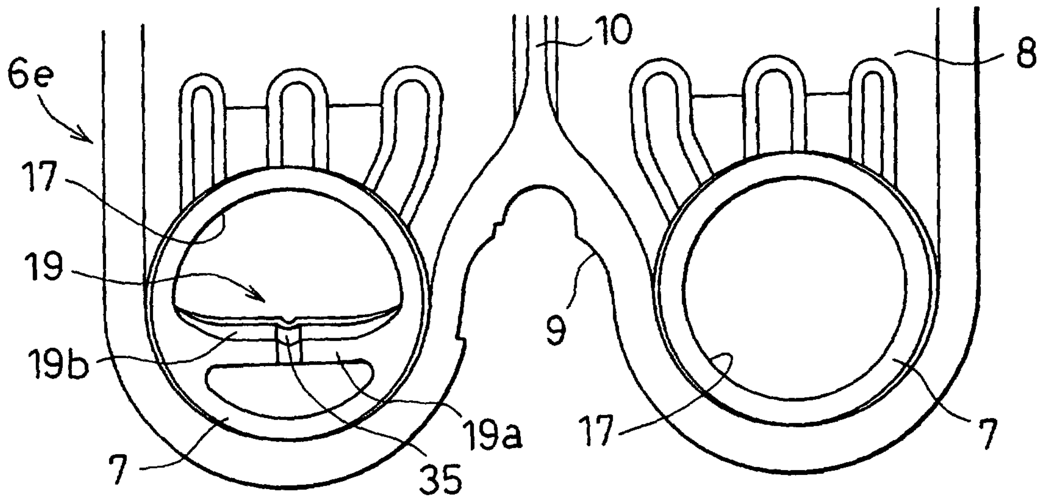


FIG. 44

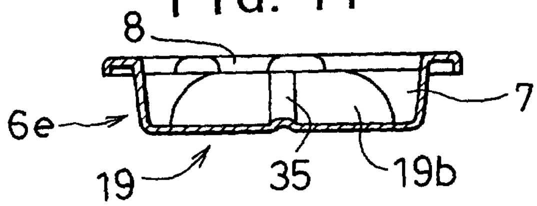


FIG. 45

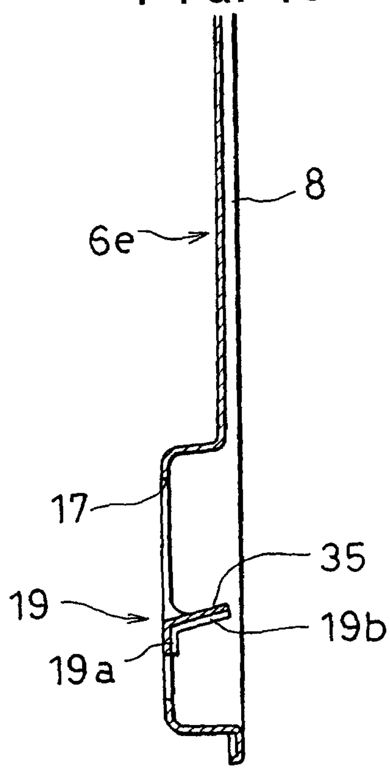


FIG. 46

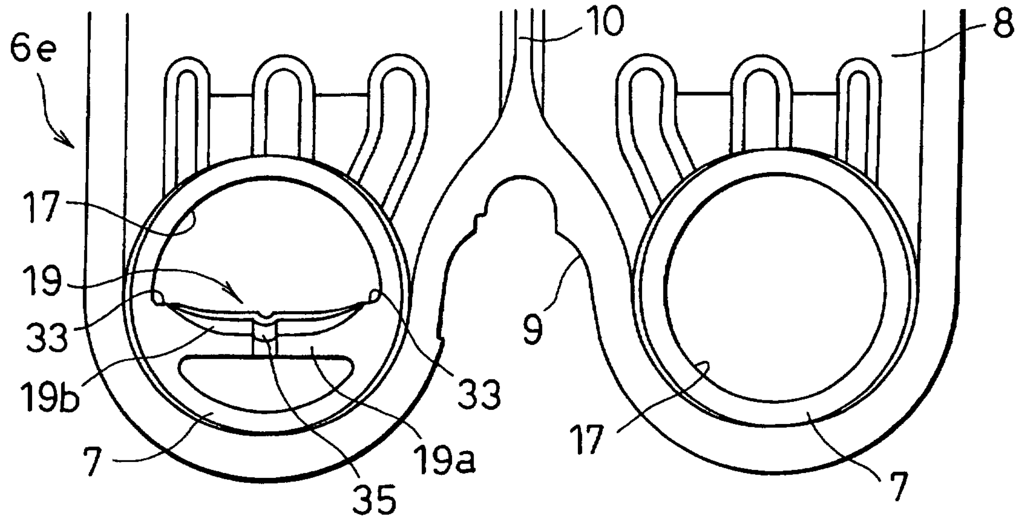


FIG. 47

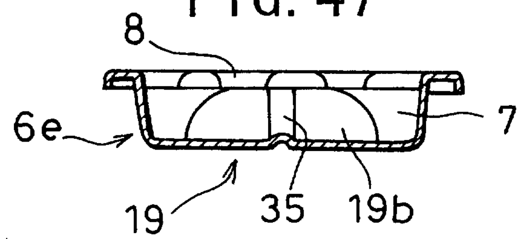


FIG. 48

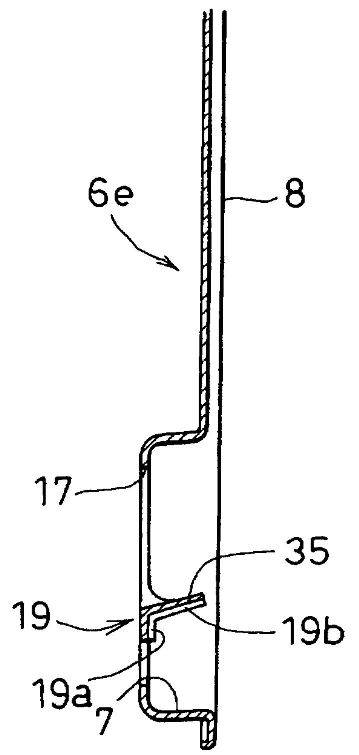


FIG. 49

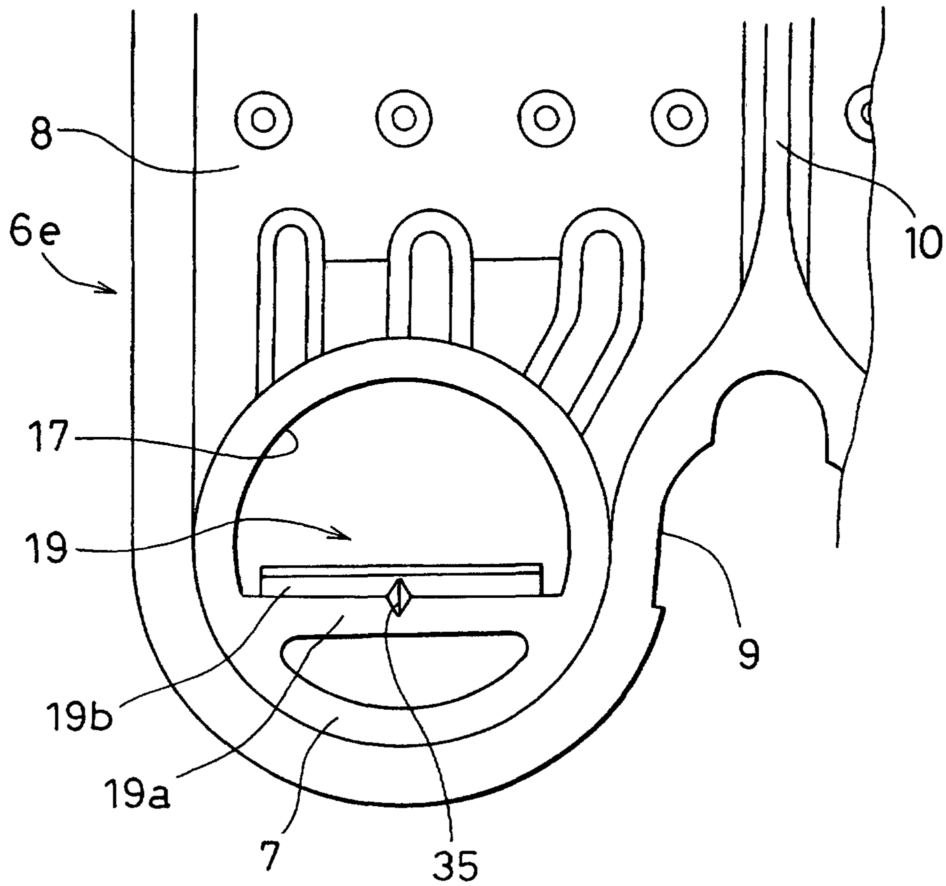


FIG. 50

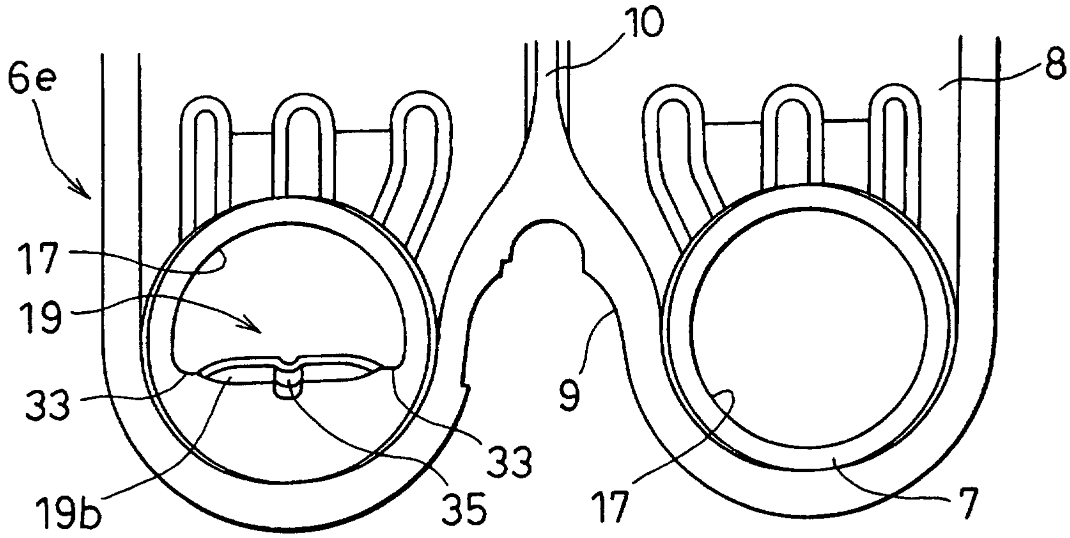


FIG. 51

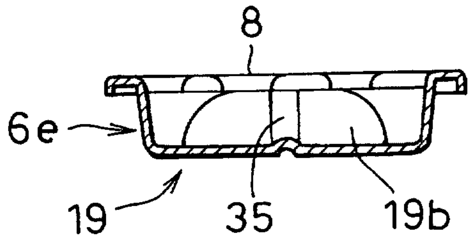


FIG. 52

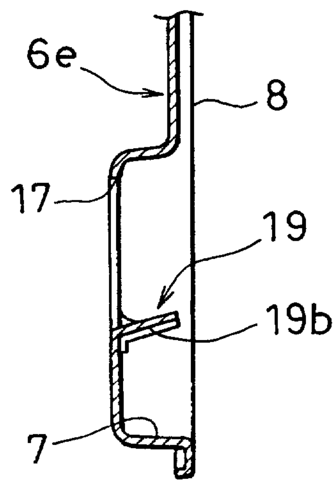


FIG. 53

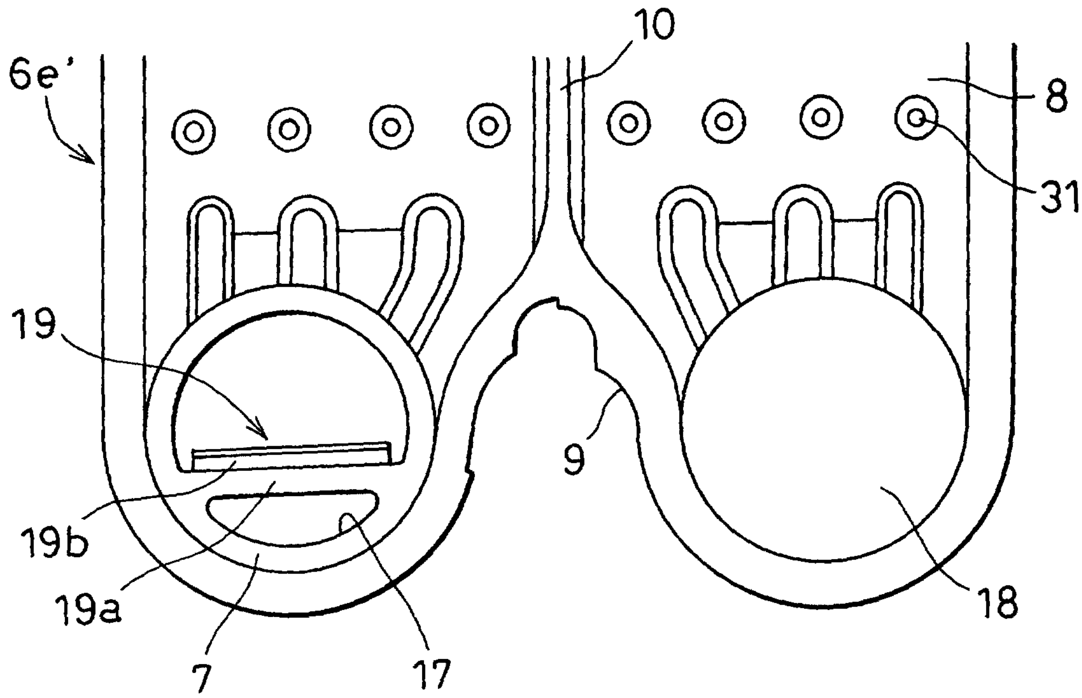


FIG. 54

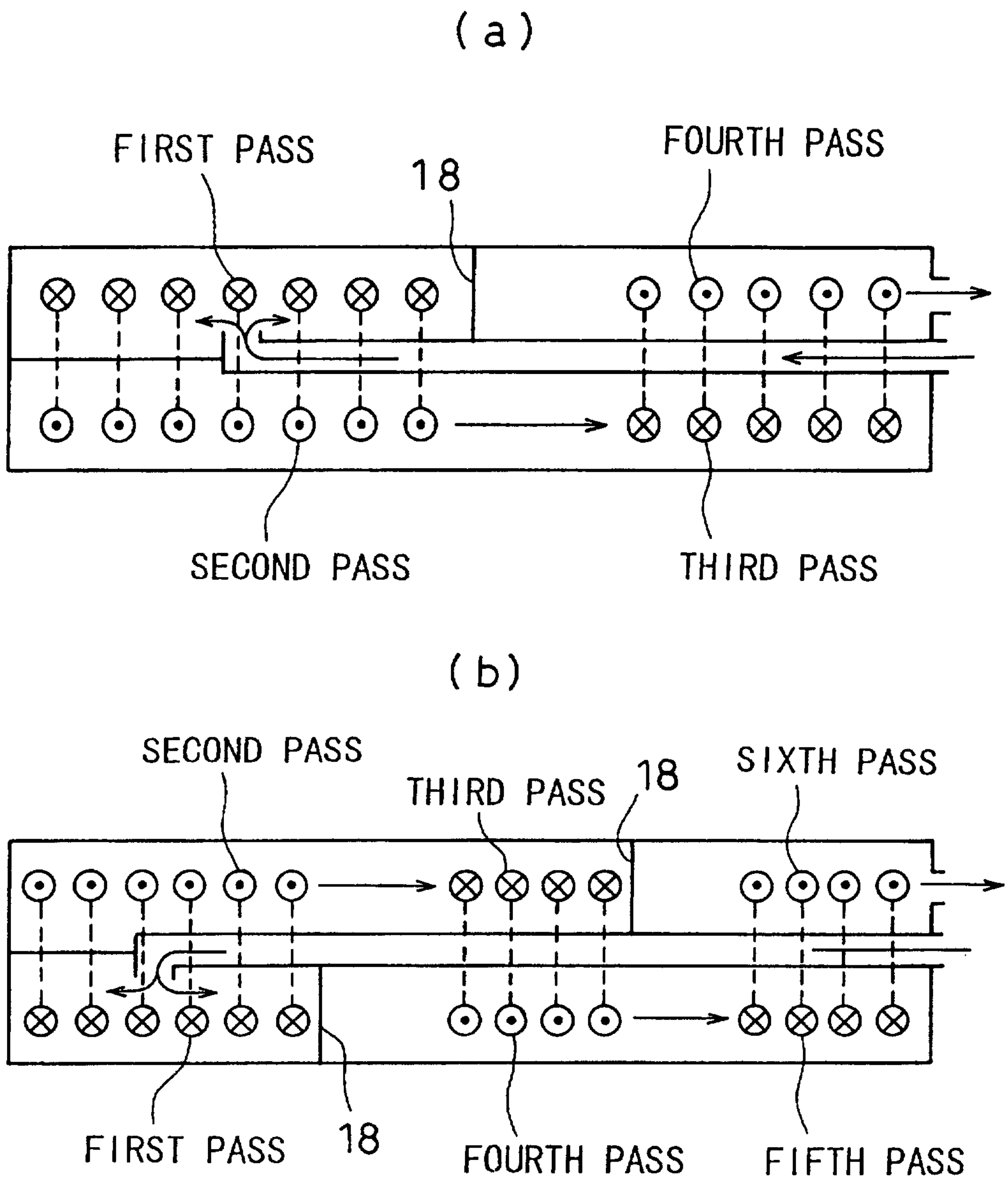
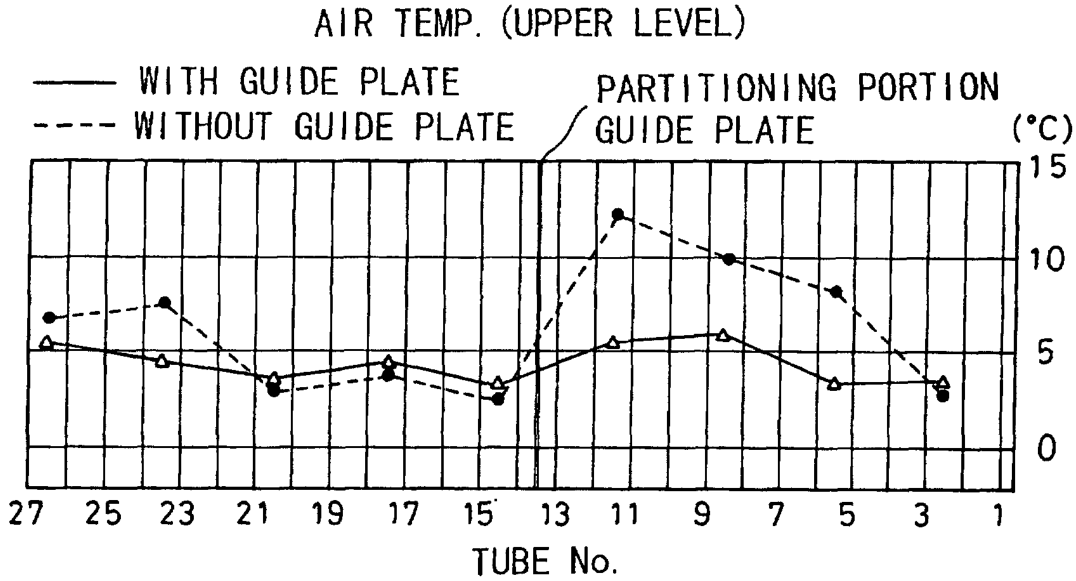
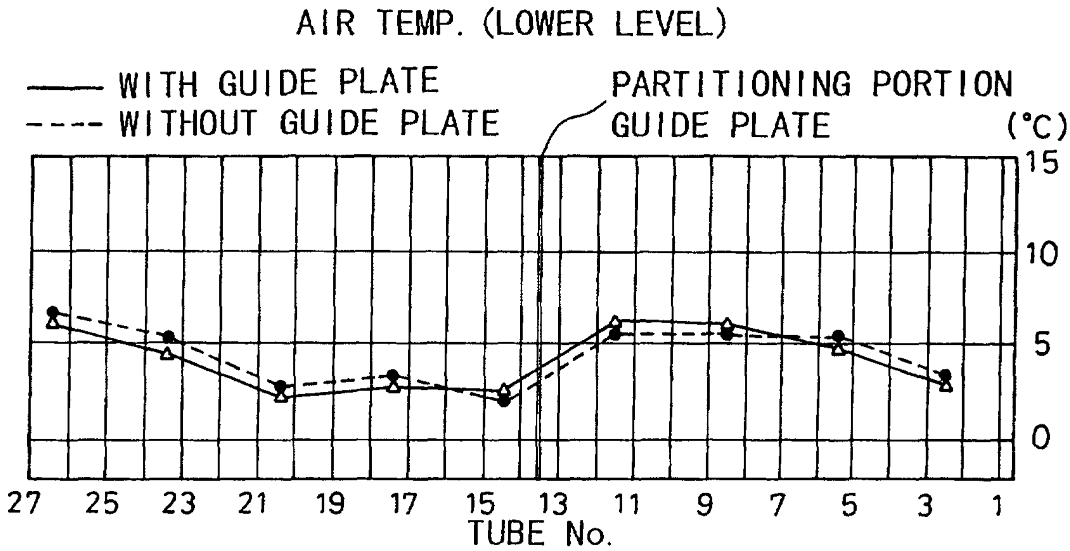

(a)
FIRST PASS
18
FOURTH PASS
SECOND PASS
THIRD PASS
(b)
SECOND PASS
THIRD PASS
18
SIXTH PASS
FIRST PASS
18
FOURTH PASS
FIFTH PASS

FIG. 55

(a)


AIR TEMP. (UPPER LEVEL)
WITH GUIDE PLATE
WITHOUT GUIDE PLATE
PARTITIONING PORTION
GUIDE PLATE
(°C)
15
10
5
0
27 25 23 21 19 17 15 13 11 9 7 5 3 1
TUBE No.

(b)


AIR TEMP. (LOWER LEVEL)
WITH GUIDE PLATE
WITHOUT GUIDE PLATE
PARTITIONING PORTION
GUIDE PLATE
(°C)
15
10
5
0
27 25 23 21 19 17 15 13 11 9 7 5 3 1
TUBE No.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP99/03685

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[6] F28D1/03, F28F9/02, F28F9/22

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[6] F28D1/03, F28F9/02, F28F9/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-1999
Kokai Jitsuyo Shinan Koho 1971-1999 Jitsuyo Shinan Toroku Koho 1996-1999

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.
A	JP, 8-285407, A (Zexel Corp.), 1 November, 1996 (01. 11. 96) & EP, 727625, A2 & CN, 1137636, A	1-32
A	JP, 8-178581, A (K.K. Nippon Climate Systems), 12 July, 1996 (12. 07. 96) (Family: none)	1-32
A	JP, 61-18394, U (Nippon Radiator K.K.), 3 February, 1986 (03. 02. 86) (Family: none)	1-32

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

* Special categories of cited documents:
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 September, 1999 (30. 09. 99)	12 October, 1999 (12. 10. 99)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)