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(54) HEAT EXCHANGER AND HEAT PUMP DEVICE

WÄRMETAUSCHER UND WÄRMEPUMPVORRICHTUNG

ÉCHANGEUR DE CHALEUR ET DISPOSITIF DE POMPE À CHALEUR

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Description

Technical Field

[0001] The present invention relates to heat exchangers, and heat pump devices.

Background Art

[0002] A stacking type header having a header tank, in which a plate serving as a bare member and a plate serving as a clad member are stacked and brazed together, has been known (see, for example, Patent Literature 1). In the stacking type header disclosed in Patent Literature 1, projections (positioning portions 32) are provided in communication holes (communication holes 31) provided in the bare member (intermediate plate 14) in a header tank (a header tank 2) to project inward from the side surfaces of the communication holes. By reducing the sectional area of the communication holes from the contact boundary surface between the bare member and the clad member (inner plate 13) toward the ends of flat tubes (heat exchange tubes 8) by the provision of the projections, positioning of the ends of the flat tubes is achieved, and entrance of the brazing material into the tubes is prevented.

[0003] Furthermore, there is a known stacking type header having a header tank, in which a tank portion formed of a bare member and a plate portion formed of a clad member are stacked (for example, see Patent Literature 2). In the stacking type header disclosed in Patent Literature 2, a pair of inclined portions (tube-positioning portion 29) are formed in the tank portion 25 to narrow in the width direction from the contact boundary surface between the tank portion 25 formed of the bare member and the plate portion 27 formed of the clad member toward an end of a flat tube (tube 2). By bringing the end of the flat tube into contact with the inclined portions, positioning of the end of the flat tube is achieved.

[0004] JP2005188787A discloses a header tank for a heat exchanger to reduce the cost and dimension of a high pressure-resisting header tank used in the heat exchanger. WO2012/018125A1 discloses a method for fusion-bonding heat transfer tubes for a heat exchanger, and a heat exchanger.

Citation List

Patent Literature

[0005]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2008-249241 (pages 5 to 8 and Figs. 2 to 7)

Patent Literature 2: Japanese Unexamined Patent Application Publication No. 2006-17442 (pages 5, 6, and Fig. 2)

Summary of Invention

Technical Problem

[0006] In the stacking type header disclosed in Patent Literature 1, because the sectional area of the communication holes decreases from the contact boundary surface between the bare member and the clad member toward the flat tubes, there has been a problem in that molten brazing material flows below the flat tubes, and it is difficult to form fillets on upper parts of the flat tubes.

[0007] In the stacking type header disclosed in Patent Literature 2, because a shape that is tapered only in the width direction from the contact boundary surface between the bare member and the clad member toward the end of the flat tube is employed, there has been a problem in that fillets cannot be formed over the entire area in the circumferential direction of the flat tubes, leading to low joining strength. In addition, there is a problem in that the amount of brazing material filled is small.

[0008] Furthermore, in the stacking type header disclosed in Patent Literature 2, because the end of the flat tube and the inclined portions are in contact with each other at points, there has been a problem in that fillets cannot be formed at the contact boundary surfaces between the flat tube and the tank portion.

[0009] The present invention has been made in view of the above-described problems, and an object thereof is to provide a stacking type header having stacked heat-medium flow paths, in which the joining strength between the plates and the flat tubes has been improved by forming fillets at intended joint portions.

[0010] Another object of the present invention is to obtain a heat exchanger having such a stacking type header.

[0011] Another object of the present invention is to obtain a heat pump device having such a heat exchanger.

Solution to Problem

[0012] A heat exchanger of the present invention as set forth in claim 1 is provided. Advantageous Effects of Invention

[0013] In the heat exchanger of the present invention, because the spaces formed at positions surrounded by the flat tubes, the bare member, and the clad member each include the first space formed in the vicinity of the contact boundary surface between the flat tube and the clad member, the second space smaller than, at least, the first space and formed in the vicinity of the contact boundary surface between the bare member and the clad member, and the third space smaller than, at least, the first space and formed in the vicinity of the contact boundary surface between the bare member and the flat tube, the spaces can be configured to increase in size from the contact boundary surfaces between the bare member and the clad member toward the flat tube. Thus, it is possible to form fillets at the intended joint portions, increasing the joining strength of the flat tubes, the clad member, and the bare member.

Brief Description of Drawings

[0014]

[Fig. 1] Fig. 1 shows the configuration of a heat exchanger to which a stacking type header according to Embodiment 1 of the present invention is applied.
[Fig. 2] Fig. 2 is a partially exploded schematic perspective view showing the stacking type header according to Embodiment 1 of the present invention.
[Fig. 3] Fig. 3 is a schematic sectional view showing the sectional configuration of a flat tube to be joined to the stacking type header according to Embodiment 1 of the present invention.
[Fig. 4] Fig. 4 is a schematic diagram for explaining the relationship between the flat tube and the bare member in the stacking type header according to Embodiment 1 of the present invention.
[Fig. 5] Fig. 5 includes enlarged schematic configuration diagrams showing the flat tube, the clad member, and the bare member of the stacking type header according to a first example which does not form part of this invention.
[Fig. 6] Fig. 6 is a partially exploded enlarged schematic perspective view showing the stacking type header according the first example which does not form part of this invention.
[Fig. 7] Fig. 7 includes schematic sectional configuration diagrams taken along line A-A in Fig. 6, showing states before and after the flat tubes are inserted into the stacking type header.
[Fig. 8] Fig. 8 includes schematic diagrams showing an example method for joining a conventional stacking type header and flat tubes.
[Fig. 9] Fig. 9 includes schematic diagrams showing an example method for joining a stacking type header and the flat tubes according to the first example which does not form part of this invention.
[Fig. 10(a)] Fig. 10(a) includes enlarged schematic configuration diagrams showing a flat tube, a clad member, and a bare member of a stacking type header according to an embodiment of the present invention in a connected state.
[Fig. 10(b)] Fig. 10(b) shows a similar configuration as Fig. 10(a) according to another embodiment of this invention.
[Fig. 11] Fig. 11 is a schematic circuit diagram showing the configuration of a heat pump device according to an embodiment of the present invention. Description of Embodiments

[0015] Embodiments of the present invention will be described below based on the drawings.

[0016] The configuration, operation, and other related information described below are merely examples, and the present invention is not limited to such configuration, operation and other information. In the drawings, the same or similar components are denoted by the same reference signs or are not denoted by reference signs. Furthermore, detailed structures are illustrated in simplified forms or are not illustrated. In addition, overlapping or similar explanations will be given in simplified forms or omitted.

Example 1

[0017] First, a heat exchanger 1 to which a stacking type header 10 according to Example 1 is applied will be described.

<Configuration of Heat Exchanger 1>

[0018] The configuration of the heat exchanger 1 will be described below.

[0019] Fig. 1 shows the configuration of the heat exchanger 1 to which the stacking type header 10 is applied. Note that, in Fig. 1, the flow direction of refrigerant is indicated with arrows filled in black.

[0020] As shown in Fig. 1, the heat exchanger 1 includes the stacking type header 10, a header 3, a plurality of flat tubes 20, and a plurality of fins 5. The header 3 may be either a stacking type header similar to the stacking type header 10 or a header of another type.

[0021] Heat-medium flow paths 10a are formed inside the stacking type header 10. A refrigerant pipe (not shown) is connected to the inflow side of the heat-medium flow paths 10a. The plurality of flat tubes 20 are connected to the outflow side of the heat-medium flow paths 10a. Merging flow paths 3a are formed inside the header 3. The plurality of flat tubes 20 are connected to the inflow side of the merging flow paths 3a. A refrigerant pipe (not shown) is connected to the outflow side of the merging flow paths 3a.

[0022] The flat tubes 20 have a plurality of flow paths formed therein. The flat tubes 20 are made of, for example, aluminum. The flat tubes 20 are joined to the plurality of fins 5. The fins 5 are made of, for example, aluminum. The flat tubes 20 and the fins 5 are preferably joined together by brazing. Although Fig. 1 shows a configuration in which eight flat tubes 20 are provided, the present invention is not limited to such a configuration.

<Flow of Refrigerant in Heat Exchanger 1>

[0023] The flow of refrigerant in the heat exchanger 1 will be described below.

[0024] The refrigerant flowing through the refrigerant pipe flows in the stacking type header 10, is divided into the heat-medium flow paths 10a, and flows out into the plurality of flat tubes 20. In the plurality of flat tubes 20, the refrigerant exchanges heat with, for example, air supplied by a fan. Note that the refrigerant flowing through the plurality of flat tubes 20 flows into the merging flow paths 3a in the header 3, is merged, and flows out into the refrigerant pipe. Note that the refrigerant may be flowed in the opposite direction.

<Configuration of Stacking Type Header 10>

[0025] Next, the configuration of the stacking type header 10 will be described.

[0026] Fig. 2 is a partially exploded schematic perspective view showing the stacking type header 10. Fig. 3 is a schematic sectional view showing the sectional configuration of the flat tube 20 to be joined to the stacking type header 10.

[0027] As shown in Fig. 2, the stacking type header 10 includes a clad member 11 and a bare member 12. As described below, the bare member 12 is provided with openings 12A, into which the flat tubes 20 are inserted, and stoppers 12B, with which the ends 20A of the flat tubes 20 come into contact. The ends 20A of the flat tubes 20 inserted into the openings 12A in the bare member 12 are configured to be butted against the stoppers 12B. The number of the clad members 11 is at least one, and the clad member 11 is provided at a side of the bare member 12 from which the flat tubes 20 are inserted. The ends 20A of the flat tubes 20 mean the ends of the flat tubes 20 at the bare member 12 side and include the ends and the outer circumferential surfaces of the ends.

[0028] Although Fig. 2 shows, as an example, the stacking type header 10 in which one clad member 11 and one bare member 12 are stacked, the present invention is not limited thereto. For example, besides the structure of the stacking type header 10 shown in Fig. 2, a plurality of bare members and clad members, provided only with openings, may be stacked, and the bare member 12 as shown in Fig. 2 may be provided at a desired position for positioning.

[0029] The bare member 12 is made of, for example, aluminum. The bare member 12 is not coated with brazing material. The openings 12A are through-holes extending between the front and rear surfaces of the bare member 12. When the bare member 12 and the clad member 11 are stacked, the openings 12A function as parts of the heat-medium flow paths 10a.

[0030] The clad member 11 is made of, for example, aluminum and is thinner than the bare member 12. The clad member 11 is coated with brazing material over, at least, the front and rear surfaces. The clad member 11 is provided with openings 11A. The openings 11A are through-holes extending between the front and rear surfaces of the clad member 11. When the bare member 12 and the clad member 11 are stacked, the openings 11A function as parts of the heat-medium flow paths 10a.

[0031] Refrigerant pipes (not shown) are connected to the bare member 12. For example, a mouthpiece or another related component may be provided on the surface of the bare member 12 from which the refrigerant flows in so that the refrigerant pipes are connected to the bare member 12 via the mouthpiece or the other related component. Alternatively, the inner circumferential surfaces of the openings 12A in the bare member 12 may be shaped to fit onto the outer circumferential surfaces of the refrigerant pipes so that the refrigerant pipes can be directly connected to the openings 12A without using a mouthpiece or another related component.

[0032] As shown in Fig. 3, the flat tubes 20 each have a tube height 21 (hereinbelow, referred to as "H21"), a tube width 22 (hereinbelow, referred to as "L22"), and a tube thickness 23 (hereinbelow, referred to as "t23"). The flat tube 20 is provided with at least one partition 20B inside the tube and, thus, has a multi-hole structure.

[0033] Fig. 4 is a schematic diagram for explaining the relationship between the flat tube 20 and the bare member 12 in the stacking type header 10. Fig. 5 includes enlarged schematic configuration diagrams showing the flat tube 20, the clad member 11, and the bare member 12 of the stacking type header 10 in a connected state. The stacking type header 10 will be described in more detail based on Figs. 4 and 5. Fig. 5 shows two configuration examples of a space 30.

[0034] As shown in Figs. 4 and 5, the bare member 12 is provided with the openings 12A, into which the flat tubes 20 are inserted, and the stoppers 12B.

[0035] The openings 12A are formed to have a hole height 24 (hereinbelow, referred to as "H24") and a hole width 25 (hereinbelow, referred to as "L25") at the side from which the flat tubes 20 are inserted.

[0036] Furthermore, the openings 12A are formed to have a hole height 26 (hereinbelow, referred to as "H26") and a hole width 27 (hereinbelow, referred to as "L27") at the stopper side, which is opposite from the side from which the flat tubes 20 are inserted.

[0037] That is, the openings 12A are formed to be reduced in diameter from the insertion side toward the stopper side, as L25 > L22 > L27, and H24 > H21 > H26. In this way, the insertion positions of the flat tubes 20 are determined inside the bare member 12. The spaces 30 may have either a chamfered shape, as shown in Fig. 5 (a), in which wall surfaces are flat, or a rounded shape, as shown in Fig. 5 (b), in which the wall surfaces are curved (i.e., curved to protrude toward the central axes of the openings 12A).

[0038] Furthermore, the stoppers 12B are formed on the stopper-side circumferences of the openings 12A by making portions of the bare member 12 protrude toward the central axes of the openings 12A. By forming the stoppers 12B, as shown in Figs. 5 (a) and 5 (b), the ends 20A of the flat tubes 20 make surface contact with the inner parts of the bare member 12, and the positions of the flat tubes 20 are determined.

[0039] When the flat tubes 20 are joined to the stacking type header 10, the spaces 30 are formed inside the bare member 12, at positions surrounded by the flat tubes 20, the clad member 11, and the bare member 12. These spaces 30 communicate with the openings 12A (the side from which the flat tubes 20 are inserted and the stopper side, which is opposite from the side from which the flat tubes 20 are inserted). The spaces 30 each include a first space 30a, a second space 30b, and a third space 30c.

[0040] The first space 30a is formed in the vicinity of the contact boundary surface between the flat tube 20 and the clad member 11 and functions as a buffer space.

[0041] The second space 30b is formed in the vicinity of the contact boundary surface between the bare member 12 and the clad member 11 and is smaller than, at least, the first space 30a. The second space 30b is formed to increase in size from the contact boundary surface between the bare member 12 and the clad member 11 toward the flat tube 20.

[0042] The third space 30c is formed in the vicinity of the contact boundary surface between the bare member 12 and the flat tube 20 and is smaller than, at least, the first space 30a. The third space 30c is formed to increase in size from the contact boundary surface between the bare member 12 and the flat tube 20 toward the clad member 11.

[0043] The lengths of boundary surfaces among the first space 30a, the second space 30b, and the third space 30c may be appropriately changed depending on the type and material of the brazing material.

[0044] Fig. 6 is a partially exploded enlarged schematic perspective view showing the stacking type header 10. Fig. 7 includes schematic sectional configuration diagrams taken along line A-A in Fig. 6, showing states before and after the flat tubes 20 are inserted into the stacking type header 10. Insertion of the flat tubes 20 into the stacking type header 10 will be described based on Figs. 6 and 7. Note that Fig. 7 (a) shows the state before the flat tubes 20 are inserted into the stacking type header 10, and Fig. 7 (b) shows the state after the flat tubes 20 are inserted into the stacking type header 10.

[0045] When the flat tubes 20 are joined to the stacking type header 10, the flat tubes 20 are inserted into the openings 11A in the clad member 11 and the openings 12A in the bare member 12, and the positions of the ends 20A of the flat tubes 20 are determined by the stoppers 12B provided in the bare member 12. When the flat tubes 20 are inserted, the spaces 30 are formed by the flat tubes 20, the clad member 11, and the bare member 12. Then, the flat tubes 20 are brazed to the stacking type header 10.

[0046] During brazing, the brazing material applied to the clad member 11 flows in narrower spaces, namely, the second spaces 30b and the third spaces 30c, due to the capillary action, forming fillets 31 over the entire area in the circumferential direction of the spaces 30. Although not shown, the fillets 31 are also formed in the vicinity of the contact boundary surfaces between the flat tubes 20 and the clad member 11 in the first spaces 30a, by allowing the brazing material to flow therein.

[0047] The wall-surface hole size of the openings 12A in the bare member 12 at the stopper side, at which the insertion positions of the flat tubes 20 are determined, are set to satisfy the relationships $H21 \geq H26 \geq (H21 - 2 \times t23)$ and $L22 \geq L27 \geq (L22 - 2 \times t23)$. Thus, the ends 20A of the flat tubes 20 do not project from the wall surface of the bare member 12.

[0048] Furthermore, the wall-surface hole size of the openings 12A in the bare member 12, at the side from which the flat tubes 20 are inserted, are set to satisfy the relationships $H21 \leq H24$ and $L22 \leq L25$. Thus, the openings 12A in the bare member 12 may be formed in a rounded shape or a chamfered shape from the insertion side to the stopper side (see Figs. 5 (a) and 5 (b)). In other words, the inner wall surfaces of the openings 12A in the bare member 12 may be formed in a rounded shape or a chamfered shape from the insertion side to the stopper side.

[0049] As a result, in the second spaces 30b and the third spaces 30c, it is possible to reduce (shorten) the thicknesses (the distances between the individual members) of the portions where the capillary action occurs and to increase the lengths of the portions where the capillary action occurs. In other words, in the second spaces 30b and the third spaces 30c, by adjusting the distances and lengths of the members defining these spaces, the capillary action is made more likely to occur.

[0050] Hence, by forming the spaces 30 to increase in size from the third spaces 30c toward the first spaces 30a, a shape that allows the fillets 31 to be more easily formed at the intended joining portions can be obtained.

<Method for Joining Stacking Type Header 10 and Flat Tubes 20>

[0051] An example method for joining the stacking type header 10 and the flat tubes 20 will be described below, together with the behavior of the brazing material. First, an example method for joining the conventional stacking type header and the flat tubes will be described.

[0052] Fig. 8 includes schematic diagrams showing an example method for joining a conventional stacking type header 49 and flat tubes 40. Fig. 8 shows an example in which the sectional area of the openings, formed from a contact boundary surface between a clad member 41 and a bare member 42 toward ends of the flat tubes 40, is not reduced. Fig. 8 also shows the behavior of brazing material 45. In Fig. 8, the gravity direction is shown by a solid arrow. In Fig. 8 (a), intended joint portions, where fillets are intended to be formed, are shown by dashed line circles.

[0053] The flat tubes 40 are inserted into openings 41A in the clad member 41 and openings 42A in the bare member 42. In this state, the flat tubes 40, the clad member 41, and the bare member 42 are heated (Fig. 8 (a)). As a result, the brazing material 45 coating the clad member 41 reaches or exceeds the melting point temperature, melting and flowing into spaces 46 (Fig. 8 (b)).

[0054] The brazing material 45 tends to flow to lower parts of the spaces 46 due to the influence of the gravity, and, before the fillets are formed on upper parts of the flat tubes 40, a large amount of brazing material 45 accumulates below the flat tubes 40 (Fig. 8 (c)). As a result, a large amount of brazing material 45 accumulates only in the spaces 46 below the flat tubes 40, and a large amount of brazing material 45 does not accumulate in the spaces 46 above the flat tubes 40 (Fig. 8 (d)). In other words, it is impossible to guide an appropriate amount of brazing material 45 to all the intended joint portions, where the fillets are intended to be formed.

[0055] When heating of the flat tubes 40, the clad member 41, and the bare member 42 is completed and the brazing material 45 is cooled, the flat tubes 40, the clad member 41, and the bare member 42 are joined together. However, in the stacking type header 49, an appropriate amount of brazing material 45 is not distributed to all the intended joint portions, where the fillets are intended to be formed. Thus, the bonding strength of the flat tubes 40, the clad member 41, and the bare member 42 is low.

[0056] Next, an example method for joining the stacking type header 10 and the flat tubes 20 will be described.

[0057] Fig. 9 includes schematic diagrams showing an example method for joining the stacking type header 10 and the flat tubes 20. Fig. 9 shows an example in which the sectional area of the openings 12A, formed from the contact boundary surface between the clad member 11 and the bare member 12 toward the end of the flat tubes 20, is reduced, as described above. Fig. 9 also shows the behavior of the brazing material. In Fig. 9, the gravity direction is shown by a solid arrow. In Fig. 9 (a), intended joint portions, where fillets are intended to be formed, are shown by dashed line circles.

[0058] The flat tubes 20 are inserted into the openings 11A in the clad member 11 and the openings 12A in the bare member 12. In this state, the flat tubes 20, the clad member 11, and the bare member 12 are heated (Fig. 9 (a)). As a result, the brazing material 15 coating the clad member 11 reaches or exceeds the melting point temperature, melting and flowing into the spaces 30.

[0059] When the flat tubes 20, the clad member 11, and the bare member 12 are heated, fluid is preferably supplied from the inside of the flat tubes 20 toward the ends 20A of the flat tubes 20. The temperature of the fluid is preferably higher than the melting point of the brazing material 15, and, in such a case, inhibiting of melting of the brazing material 15 is controlled. Furthermore, a preferred fluid is air, and, in such a case, general-purpose equipment can be used, and thus, the process can be simplified.

[0060] The molten brazing material 15 gathers at the contact boundary surfaces between the clad member 11 and the bare member 12 in the second spaces 30b due to the influence of the capillary action (Fig. 9 (b)).

[0061] When the amount of the brazing material 15 flowing in increases, and the influence of the gravity becomes larger than the influence of the capillary action, the brazing material 15 gathers at the inner parts of the spaces 30 along the wall surfaces of the spaces 30. The brazing material 15 flowing in the third spaces 30c along the wall surfaces inside the spaces 30 gathers at the contact boundary surfaces between the bare member 12 and the flat tubes 20 inside the third spaces 30c due to the capillary action, similarly to the second spaces 30b (Fig. 9 (c)).

[0062] If the brazing material 15 further flows in after the fillets 31 are formed at the intended joint portions, the brazing material 15 flows into the first spaces 30a, gathers in the vicinity of the contact boundary surfaces between the clad member 11 and the flat tubes 20, preventing the brazing material 15 from flowing in from the ends 20A of the flat tubes 20 (Fig. 9 (d)).

<Flow of Refrigerant in Stacking Type Header 10>

[0063] Next, the operation of the stacking type header 10 will be described based on an example.

[0064] The stacking type header 10 includes the heat-medium flow paths 10a, through which heat medium flows, formed by stacking the clad member 11 and the bare member 12 in multiple layers. Thus, the heat medium flowing in the stacking type header 10 is divided into the plurality of heat-medium flow paths 10a by the effect of the stacking type header 10 and flows into or out to each of the flat tubes 20.

<Advantage of Stacking Type Header 10>

[0065] An advantage of the stacking type header 10 will be described.

[0066] The stacking type header 10 is configured so that the spaces 30 defined by the flat tubes 20, the clad member 11, and the bare member 12 increase in size from the contact boundary surfaces between the clad member 11 and the bare member 12 toward the flat tubes 20. With this configuration, in the stacking type header 10, it is possible to allow the brazing material 15 to preferentially flow into the intended joint portions. By allowing the brazing material 15 to preferentially flow into the intended joint portions, the fillets 31 can be easily formed at the intended joint portions.

[0067] In addition, by allowing the brazing material 15 to preferentially flow into the intended joint portions, the joining strength can be increased compared with the conventional headers for the same amount of the brazing material 15 used. Furthermore, because the fillets 31 are formed by allowing the brazing material 15 to preferentially flow into the intended joint portions, the amount of the brazing material 15 used can be reduced.

[0068] By setting the size of the holes in the bare member 12 at the stopper side to satisfy the relationships $H21 \geq H26 \geq (H21 - 2 \times t23)$ and $L22 \geq L27 \geq (L22 - 2 \times t23)$ and by setting the size of the holes at the insertion side to satisfy the relationships $H21 \leq H24$ and $L22 \leq L25$, it is possible to form the fillets 31 at all the intended joint portions located in the circumferential direction of the flat tubes 20. By forming the fillets 31 over the entire area in the circumferential direction of the flat tubes 20, the joining strength can be increased.

[0069] By bringing the ends 20A of the flat tubes 20 and the stoppers 12B of the bare member 12 into surface contact, the brazing material 15 can be prevented from flowing into the flat tubes 20.

[0070] In addition, by setting the size of the holes in the bare member 12 at the stopper side to satisfy the relationships H21 $\geq$ H26 $\geq$ (H21 -2 $\times$ t23) and L22 $\geq$ L27 $\geq$ (L22 -2 $\times$ t23), and by bringing the ends 20A of the flat tubes 20 and the stoppers 12B of the bare member 12 into surface contact, not only flowing in of the brazing material 15 can be prevented, but also the resistance occurring when the heat medium flows in or out can be reduced. Moreover, the ends 20A of the flat tubes 20 can be easily positioned.

[0071] By determining the insertion positions of the flat tubes 20 with the stoppers 12B, the heat exchanger 1 can be manufactured without providing an excessive insertion allowance. Thus, the proportion of the heat exchanging part in a heat exchanger can be increased compared with a heat exchanger of the same size. In addition, by eliminating the need to provide an excessive insertion allowance, the size of the heat exchanger can be reduced when an equivalent heat exchange capacity is to be obtained.

[0072] By reducing the thicknesses and increasing the lengths of the second spaces 30b, located close to the contact boundary surfaces between the clad member 11 and the bare member 12, and the third spaces 30c, located close to the contact boundary surfaces between the flat tubes 20 and the bare member 12, the influence of the capillary action can be increased. Thus, the areas in the second spaces 30b and the third spaces 30c where the fillets 31 are formed can be increased. By increasing these areas in the second spaces 30b and the third spaces 30c where the fillets 31 are formed, the joining strength at the contact boundary surfaces can be increased.

Embodiment 1

[0073] Fig. 10 includes enlarged schematic configuration diagrams showing the flat tube 20, the clad member 11, and the bare member 12 of a stacking type header 10A according to Embodiment 1 of the present invention in a connected state. The stacking type header 10A will be described based on Fig. 10. Fig. 10 shows two configuration examples of the spaces 30. In Embodiment 1, the difference from Example 1 will be mainly described, and the components the same as or similar to those in Example 1 will be denoted by the same reference signs, and the descriptions thereof will be omitted or given in a simplified form.

[0074] Although the stacking type header 10A has basically the same configuration as the stacking type header 10 according to Example 1, it differs from the stacking type header 10 according to Example 1 in that the shape of the openings 12A in the bare member 12 into which the flat tubes 20 are inserted, at portions from the insertion side to the stoppers, namely, the configuration of the spaces 30, is step-shaped.

[0075] As has been described in Example 1, the openings 12A are formed to be reduced in diameter, as L25 > L22 > L27, and H24 > H21 > H26, from the insertion side to the stopper side. With this configuration, the insertion positions of the flat tubes 20 are determined in the bare member 12. As shown in Fig. 10, the spaces 30 are shaped so that the second spaces 30b and the third spaces 30c can ensure certain capacities.

[0076] For example, as shown in Fig. 10 (a), a multiple-step shape in which, while the second spaces 30b and the third spaces 30c are reserved, the wall surfaces of the spaces 30 connecting the second spaces 30b and the third spaces 30c are formed in the shape of steps may be employed.

[0077] Alternatively, as shown in Fig. 10 (b), a step shape in which, while the second spaces 30b and the third spaces 30c are reserved, the wall surfaces of the spaces 30 connecting the second spaces 30b and the third spaces 30c are formed in a flat surface may be employed. Note that the wall surfaces of the spaces 30 connecting the second spaces 30b and the third spaces 30c do not need to be exactly flat, but may be partially curved. In addition, the wall surfaces of the spaces 30 connecting the second spaces 30b and the third spaces 30c may be formed as curved surfaces.

<Advantage of Stacking Type Header 10A>

[0078] Advantages of the stacking type header 10A will be described. The stacking type header 10A provides the following advantages, in addition to the same advantages as those provided by the stacking type header 10 according to Example 1.

[0079] By making the portions from the openings to the stoppers in the openings 12A in the bare member 12, into which the flat tubes 20 are inserted, have a step shape, manufacturing is relatively easy, compared with a case where chamfering is performed or curved surfaces are formed.

[0080] Furthermore, in the stacking type header 10A, the thicknesses and lengths of the second spaces 30b and the third spaces 30c can be easily set to desired values. Hence, manufacturing of the stacking type headers 10A is easy, and thus, the manufacturing costs can be reduced. Furthermore, by making it easy to set the thicknesses and lengths of the second spaces 30b and the third spaces 30c to desired values, the stacking type headers 10A can be more uniformly manufactured during manufacturing. By making it possible to manufacture stacking type headers 10A having a uniform quality, the reliability of the commercial products can be increased.

[0081] Furthermore, in manufacturing of the stacking type header 10A using a mold made by cutting and casting, by making the spaces 30 have a simple step shape, mold manufacturing can be easily performed. Hence, manufacturing of the stacking type headers 10A is easy, and thus, the manufacturing costs can be reduced.

Embodiment 2

[0082] Fig. 11 is a schematic circuit diagram showing the configuration of a heat pump device 51 according to Embodiment 2 of the present invention. The heat pump device 51 will be described based on Fig. 11. This heat pump device 51 has a heat exchanger to which the stacking type header according to Embodiment 1 is applied and is used as, for example, a refrigerator, a freezer, a vending machine, an air-conditioning apparatus, a freezing apparatus, or a hot-water dispenser. In Embodiment 2, a case where the stacking type header 10 according to Embodiment 1 is used will be described as an example.

<Use Mode of Heat Exchanger>

[0083] A case where the heat pump device 51 is an air-conditioning apparatus that is configured to be able to switch between a cooling operation and a heating operation will be described below. In Fig. 11, the flow direction of the refrigerant during the cooling operation is indicated by a solid arrow, and the flow direction of the refrigerant during the heating operation is indicated by a dashed-line arrow.

[0084] As shown in Fig. 11, the heat pump device 51 includes a compressor 52, a four-way valve 53, a heat-source-side heat exchanger 54, an expansion device 55, a load-side heat exchanger 56, a heat-source-side fan 57, a load-side fan 58, and a controller 59. The compressor 52, the four-way valve 53, the heat-source-side heat exchanger 54, the expansion device 55, and the load-side heat exchanger 56 are connected by a refrigerant pipe, forming a refrigerant circuit.

[0085] For example, the compressor 52, the four-way valve 53, the expansion device 55, the heat-source-side fan 57, the load-side fan 58, various sensors, and other related components are connected to the controller 59. When the controller 59 switches the flow path of the four-way valve 53, the cooling operation and the heating operation are switched. The heat-source-side heat exchanger 54 serves as a condenser during the cooling operation and serves as an evaporator during the heating operation. The load-side heat exchanger 56 serves as an evaporator during the cooling operation and serves as a condenser during the heating operation.

[0086] The flow of the refrigerant during the cooling operation will be described.

[0087] The high-pressure, high-temperature gaseous refrigerant discharged from the compressor 52 flows into the heat-source-side heat exchanger 54 via the four-way valve 53, is condensed by heat exchange with the outdoor air supplied by the heat-source-side fan 57, is transformed into high-pressure liquid refrigerant, and then flows out of the heat-source-side heat exchanger 54. The high-pressure liquid refrigerant flowing out of the heat-source-side heat exchanger 54 flows into the expansion device 55 and is transformed into low-pressure two-phase gas-liquid refrigerant. The low-pressure two-phase gas-liquid state refrigerant flowing out of the expansion device 55 flows into the load-side heat exchanger 56, is evaporated by heat exchange with the indoor air supplied by the load-side fan 58, is transformed into low-pressure gaseous refrigerant, and then flows out of the load-side heat exchanger 56. The low-pressure gaseous refrigerant flowing out of the load-side heat exchanger 56 is sucked into the compressor 52 via the four-way valve 53, is condensed by heat exchange with the indoor air supplied by the load-side fan 58, is transformed into high-pressure liquid refrigerant, and then flows out of the load-side heat exchanger 56. The high-pressure liquid refrigerant flowing out of the load-side heat exchanger 56 flows into the expansion device 55, and is transformed into low-pressure two-phase gas-liquid refrigerant. The low-pressure two-phase gas-liquid refrigerant flowing out of the expansion device 55 flows into the heat-source-side heat exchanger 54, is evaporated by heat exchange with the outdoor air supplied by the heat-source-side fan 57, is transformed into low-pressure gaseous refrigerant, and then flows out of the heat-source-side heat exchanger 54. The low-pressure gaseous refrigerant flowing out of the heat-source-side heat exchanger 54 is sucked into the compressor 52 via the four-way valve 53.

[0088] The heat exchanger 1 to which the stacking type header 10 according to Embodiment 1 is applied is used as, at least, one of the heat-source-side the heat exchanger 54 and the load-side heat exchanger 56. When the heat exchanger 1 serves as the evaporator, the heat exchanger 1 is connected so that the refrigerant flows in from the stacking type header 10 and the refrigerant flows out of the header 3. In other words, when the heat exchanger 1 serves as the evaporator, the two-phase gas-liquid refrigerant flows into the stacking type header 10 from the refrigerant pipe, and the gaseous refrigerant flows into the header 3 from the flat tubes 20. When the heat exchanger 1 serves as the condenser, the gaseous refrigerant flows into the header 3 from the refrigerant pipe, and the liquid refrigerant flows into the stacking type header 10 from the flat tubes 20.

[0089] Because the stacking type header 10 divides the refrigerant by a plurality of branch flow paths, even when two-phase gas-liquid refrigerant flows therein, it is possible to equalize the flow rate and quality of the refrigerant flowing in the plurality of flat tubes 20. In other words, the stacking type header 10 is suitable for the heat pump device 51.

<Effect of Heat Exchanger 1>

[0090] In the stacking type header 10, the bare member 12 has a larger thickness than the clad member 11, and the flat tubes 20 are joined in such a state that their ends 20a are positioned by the stoppers 12B. Hence, the molten brazing material does not flow into the flat tubes 20, eliminating an increase in the pressure loss of the refrigerant.

[0091] Furthermore, in the stacking type header 10, by determining the insertion positions of the flat tubes 20 with the stoppers 12B, the heat exchanger 1 can be manufactured without providing an excessive insertion allowance, and thus, the proportion of the heat exchanging part in the heat exchanger can be increased compared with a heat exchanger of the same size. In addition, by eliminating the need to provide an excessive insertion allowance, the size of the heat exchanger can be reduced when an equivalent heat exchange capability is to be obtained.

[0092] Although Embodiments 1 to 2 have been described above, the present invention is not limited by the descriptions of these embodiments. For example, it is possible to combine the embodiments entirely or partially, or to combine modifications thereof.

Reference Signs List

[0093] 1 heat exchanger, 3 header, 3a merging flow path, 5 fin, 10 stacking type header, 10A stacking type header, 10a heat-medium flow path, 11 clad member, 11A opening, 12 bare member, 12A opening, 12B stopper, 15 brazing material, 20 flat tube, 20A end, 20B partition, 20a end, 21 tube height, 22 tube width, 23 tube thickness, 24 hole height, 25 hole width, 26 hole height, 27 hole width, 30 space, 30a first space, 30b second space, 30c third space, 31 fillet, 40 flat tube, 41 clad member, 41A opening, 42 bare member, 42A opening, 45 brazing material, 46 space, 49 stacking type header, 51 heat pump device, 52 compressor, 53 four-way valve, 54 heat-source-side heat exchanger, 55 expansion device, 56 load-side heat exchanger, 57 heat-source-side fan, 58 load-side fan, 59 controller

Claims

1. A heat exchanger (1) comprising a stacking type header (10) and a flat tube (20), the stacking type header (10) comprising:

    a clad member (11) coated with brazing material and provided on a side from which the flat tube (20) is inserted; and
    a bare member (12) stacked on the clad member (11) and having an opening (12A) into which the flat tube (20) is inserted and a stopper (12B) with which an end (20A) of the flat tube (20) inserted into the opening (12A) is brought into contact,
    wherein the stopper (12B) is formed in the opening (12A), wherein, in a state in which the flat tube (20) is inserted into the opening (12A) in the bare member (12) and in which the end (20A) of the flat tube (20) is in contact with the stopper (12B), spaces (30) are formed at positions surrounded by the flat tube (20), the clad member (11), and the bare member (12), and
    wherein the spaces (30) each include a first space (30a) formed in a vicinity of a contact boundary surface between the flat tube (20) and the clad member (11), a second space (30b) smaller than the first space (30a) and formed in a vicinity of a contact boundary surface between the bare member (12) and the clad member (11) to be continuous with the first space (30a), and a third space (30c) smaller than the first space (30a) and formed in a vicinity of a contact boundary surface between the bare member (12) and the flat tube (20) to be continuous with the first space, **characterized in that**
    an inner wall surface of the opening (12A) in the bare member (12), extending from the side from which the flat tube (20) is inserted to a side of the stopper (12B), is formed in a step shape.

2. The heat exchanger (1) of claim 1,
wherein the second space (30b) is formed to increase in size from the contact boundary surface between the bare member (12) and the clad member (11) toward the flat tube (20).

3. The heat exchanger (1) of claim 1 or 2,
wherein the third space (30c) is formed to increase in size from the contact boundary surface between the bare member (12) and the flat tube (20) toward the bare member (12).

4. The heat exchanger (1) of any one of claims 1 to 3,
wherein the opening (12A) is formed to extend from a front surface to a rear surface of the bare member (12),
wherein a hole size of the opening (12A) at a side of the stopper (12B) is set to satisfy relationships in which
a tube height of the flat tube (20) ≥ a hole height of the opening (12A) at the side of the stopper (12B) ≥ (the tube height of the flat tube (20) - 2 × a tube thickness of the flat tube (20)), and
a tube width of the flat tube (20) ≥ a hole width of the opening (12A) at the side of the stopper (12B) ≥ (the tube width of the flat tube (20) - 2 × the tube thickness of the flat tube (20)).

5. The heat exchanger (1) of claim 4,
wherein a hole size at the side from which the flat tube (20) is inserted is set to satisfy relationships in which
the tube height of the flat tube (20) ≤ a hole height of the opening (12A) at the side from which the flat tube (20) is inserted, and
the tube width of the flat tube (20) ≤ a hole width of the opening (12A) at the side from which the flat tube (20) is inserted.

6. A heat pump device (51) comprising the heat ex-

changer (1) of any one of claims 1 to 5.

Patentansprüche

1. Wärmetauscher (1) umfassend eine Endkammer vom Stapeltyp (10) und ein Flachrohr (20), wobei die Endkammer vom Stapeltyp (10) Folgendes umfasst:

ein beschichtetes Element (11), das mit Lötmaterial beschichtet ist und auf einer Seite bereitgestellt ist, an der das Flachrohr (20) eingeführt wird; und
ein unbeschichtetes Element (12), das auf dem beschichteten Element (11) gestapelt ist und eine Öffnung (12A), in die das Flachrohr (20) eingeführt wird, sowie einen Anschlag (12B), mit dem ein Ende (20A) des in die Öffnung (12A) eingeführten Flachrohrs (20) in Berührung gebracht wird, aufweist,
wobei der Anschlag (12B) in der Öffnung (12A) ausgebildet ist;
wobei in einem Zustand, in dem das Flachrohr (20) in die Öffnung (12A) in das unbeschichtete Element (12) eingeführt ist und in dem das Ende (20A) des Flachrohrs (20) mit dem Anschlag (12B) in Berührung gebracht wurde, Bereiche (30) an Positionen gebildet werden, die von dem Flachrohr (20), dem beschichteten Element (11) und dem unbeschichteten Element (12) umgeben sind, und
wobei die Bereiche (30) jeweils einen ersten Bereich (30a), der in einer Umgebung einer Berührungsgrenzfläche zwischen dem Flachrohr (20) und dem beschichteten Element (11) ausgebildet ist, einen zweiten Bereich (30b), der kleiner als der erste Bereich (30a) ist und in einer Umgebung einer Berührungsgrenzfläche zwischen dem unbeschichteten Element (12) und dem beschichteten Element (11) im Anschluss an den ersten Bereich (30a) ausgebildet ist, und einen dritten Bereich (30c), der kleiner ist als der erste Bereich (30a) und in einer Umgebung einer Berührungsgrenzfläche zwischen dem unbeschichteten Bereich (12) und dem Flachrohr (20) im Anschluss an den ersten Bereich ausgebildet ist, umfassen, **dadurch gekennzeichnet, dass**
eine Innenwandfläche der Öffnung (12A) in dem unbeschichteten Element (12), die sich von der Seite, an der das Flachrohr (20) eingeführt wird, zu einer Seite des Anschlags (12B) erstreckt, in Stufenform ausgebildet ist.

2. Wärmetauscher (1) nach Anspruch 1,
wobei der zweite Bereich (30b) so ausgebildet ist, dass seine Größe von der Berührungsgrenzfläche zwischen dem unbeschichteten Element (12) und dem beschichteten Element (11) in Richtung des Flachrohrs (20) zunimmt.

3. Wärmetauscher (1) nach Anspruch 1 oder 2,
wobei der dritte Bereich (30c) so ausgebildet ist, dass seine Größe von der Berührungsgrenzfläche zwischen dem unbeschichteten Element (12) und dem Flachrohr (20) in Richtung des unbeschichteten Elements (12) zunimmt.

4. Wärmetauscher (1) nach einem der Ansprüche 1 bis 3,
wobei die Öffnung (12A) so ausgebildet ist, dass sie sich von einer Vorderfläche zu einer Rückfläche des unbeschichteten Elements (12) erstreckt,
wobei eine Lochgröße der Öffnung (12A) an einer Seite des Anschlags (12B) so gewählt ist, dass Beziehungen erfüllt werden, in denen
eine Rohrhöhe des Flachrohrs (20) ≥ eine Lochhöhe der Öffnung (12A) an der Seite des Anschlags (12B) ≥ (die Rohrhöhe des Flachrohrs (20) - 2 x eine Rohrdicke des Flachrohrs (20)) und
eine Rohrbreite des Flachrohrs (20) ≥ eine Lochbreite der Öffnung (12A) an der Seite des Anschlags (12B) ≥ (die Rohrbreite des Flachrohrs (20) - 2 x eine Rohrdicke des Flachrohrs (20)).

5. Wärmetauscher (1) nach Anspruch 4,
wobei eine Lochgröße an der Seite, von der aus das Flachrohr (20) eingeführt wird, so gewählt ist, dass Beziehungen erfüllt werden, in denen
die Rohrhöhe des Flachrohrs (20) ≤ eine Lochhöhe der Öffnung (12A) an der Seite, an der das Flachrohr (20) eingeführt wird, und
die Rohrbreite des Flachrohrs (20) ≤ eine Lochbreite der Öffnung (12A) an der Seite, an der das Flachrohr (20) eingeführt wird.

6. Wärmepumpenvorrichtung (51) umfassend einen Wärmetauscher (1) nach einem der Ansprüche 1 bis 5.

Revendications

1. Echangeur de chaleur (1) comprenant un collecteur de type stratifié (10) et un tube plat (20), le collecteur de type stratifié (10) comprenant :

un élément de gaine (11) revêtu de matériau de brasage et prévu sur un côté à partir duquel le tube plat (20) est inséré; et
un élément brut (12) stratifié sur l'élément de gaine (11) et ayant une ouverture (12A) dans laquelle le tube plat (20) est inséré et une butée (12B) avec laquelle une extrémité (20A) du tube plat (20) inséré dans l'ouverture (12A) est mise en contact,

dans lequel la butée (12B) est formée dans l'ouverture (12A),
dans lequel, dans un état dans lequel le tube plat (20) est inséré dans l'ouverture (12A) dans l'élément brut (12) et dans lequel l'extrémité (20A) du tube plat (20) est en contact avec le bouchon (12B), des espaces (30) sont formés dans des positions entourées par le tube plat (20), l'élément de gaine (11) et l'élément brut (12), et
dans lequel les espaces (30) comprennent chacun un premier espace (30a) formé au voisinage d'une surface limite de contact entre le tube plat (20) et l'élément de gaine (11), un deuxième espace (30b) plus petit que le premier espace (30a) et formé au voisinage d'une surface limite de contact entre l'élément brut (12) et l'élément de gaine (11) pour être continu avec le premier espace (30a), et un troisième espace (30c) plus petit que le premier espace (30a) et formé au voisinage d'une surface limite de contact entre l'élément brut (12) et le tube plat (20) pour être continu avec le premier espace, **caractérisé en ce que**
une surface de paroi intérieure de l'ouverture (12A) dans l'élément brut (12), s'étendant du côté à partir duquel le tube plat (20) est inséré jusqu'à un côté de la butée (12B), est formée en forme de gradin.

2. Echangeur de chaleur (1) selon la revendication 1, dans lequel le deuxième espace (30b) est formé pour augmenter en taille depuis la surface de limite de contact entre l'élément brut (12) et l'élément de gaine (11) vers le tube plat (20).

3. Echangeur de chaleur (1) selon la revendication 1 ou 2,
dans lequel le troisième espace (30c) est formé pour augmenter en taille à partir de la surface limite de contact entre l'élément brut (12) et le tube plat (20) vers l'élément brut (12).

4. Echangeur de chaleur (1) selon l'une quelconque des revendications 1 à 3,
dans lequel l'ouverture (12A) est formée pour s'étendre d'une surface avant à une surface arrière de l'élément brut (12),
dans lequel une taille de trou de l'ouverture (12A) sur un côté de la butée (12B) est réglée pour satisfaire des relations dans lesquelles
une hauteur de tube du tube plat (20) ≥ une hauteur de trou de l'ouverture (12A) du côté de la butée (12B) ≥ (la hauteur du tube du tube plat (20) - 2 x une épaisseur de tube du tube plat (20)), et
une largeur de tube du tube plat (20) ≥ une largeur de trou de l'ouverture (12A) du côté de la butée (12B) ≥ (la hauteur du tube du tube plat (20) - 2 x l'épaisseur de tube du tube plat (20)).

5. Echangeur de chaleur (1) selon la revendication 4, dans lequel une taille de trou du côté à partir duquel le tube plat (20) est inséré est réglée pour satisfaire de relations dans lesquelles
la hauteur du tube du tube plat (20) ≤ une hauteur de trou de l'ouverture (12A) du côté à partir duquel le tube plat (20) est inséré, et
la largeur du tube du tube plat (20) ≤ une largeur de trou de l'ouverture (12A) du côté à partir duquel le tube plat (20) est inséré.

6. Dispositif de pompe à chaleur (51) comprenant l'échangeur de chaleur (1) selon l'une quelconque des revendications 1 à 5.

FIG. 1

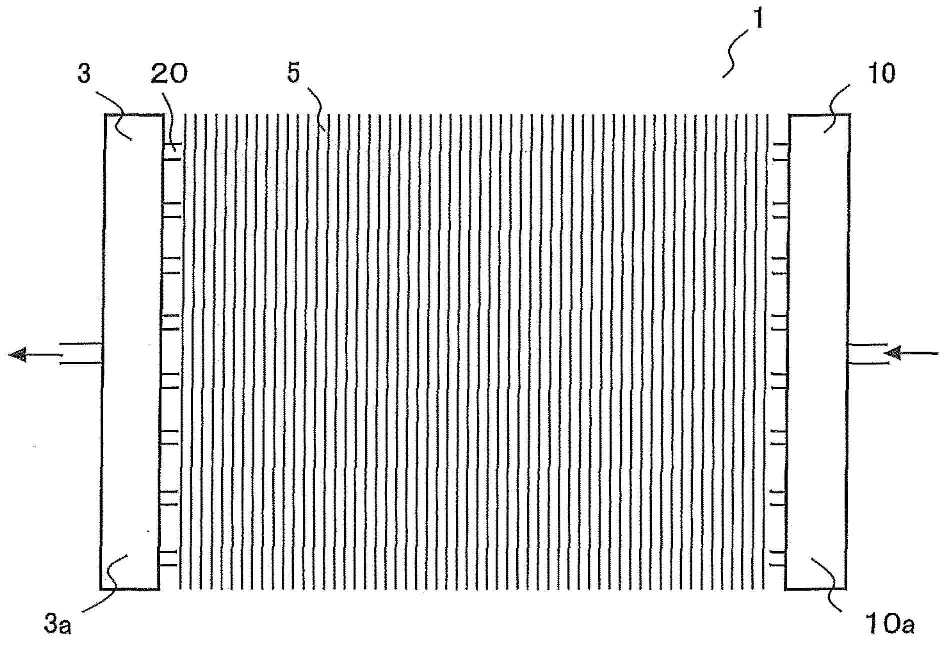


FIG. 2

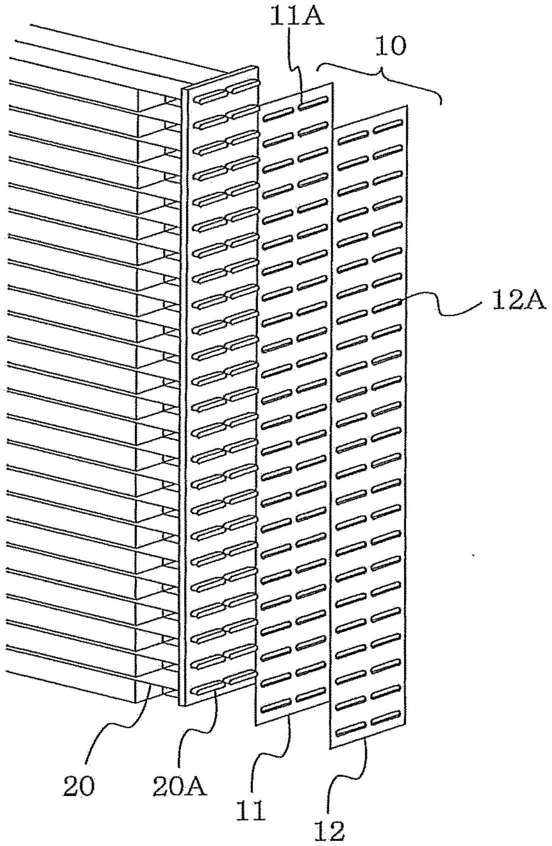


FIG. 3

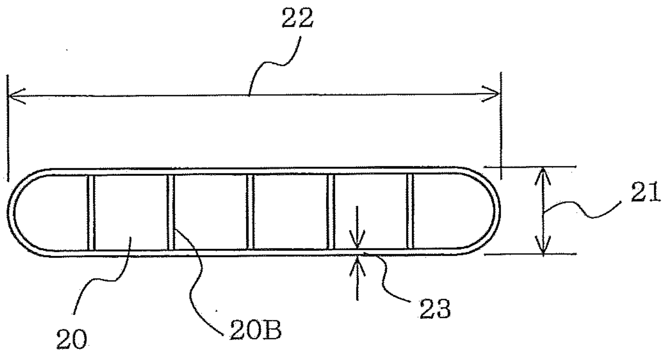


FIG. 4

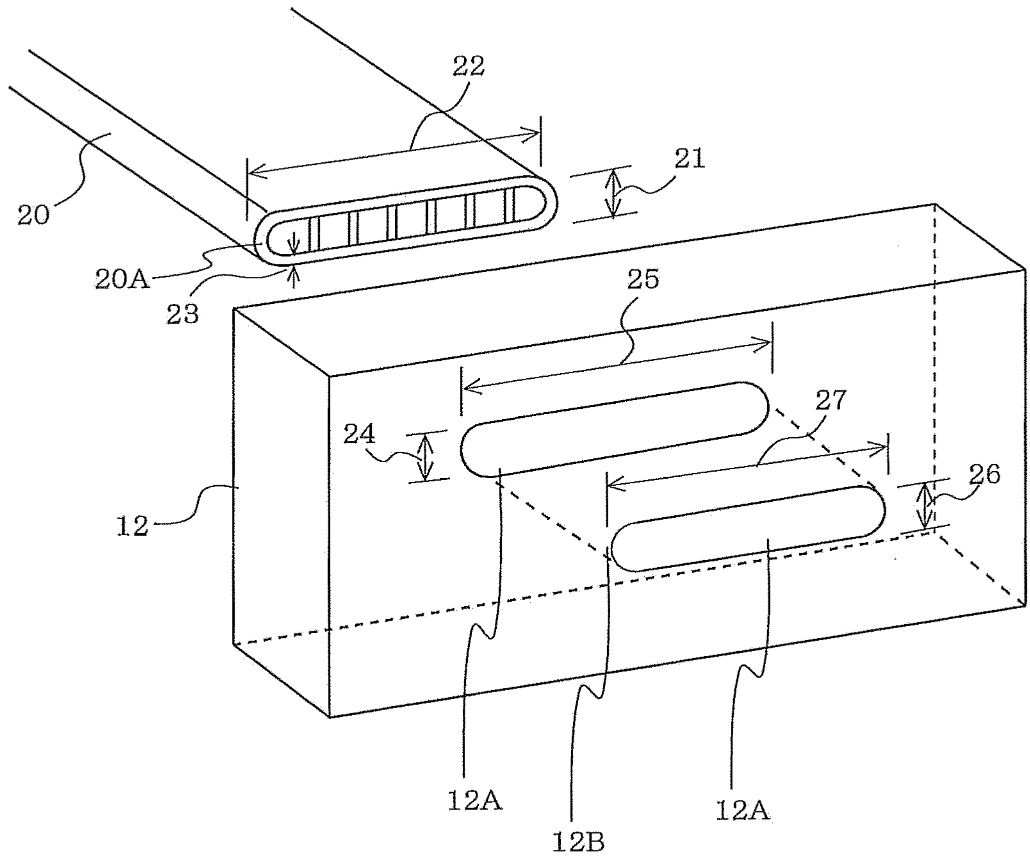
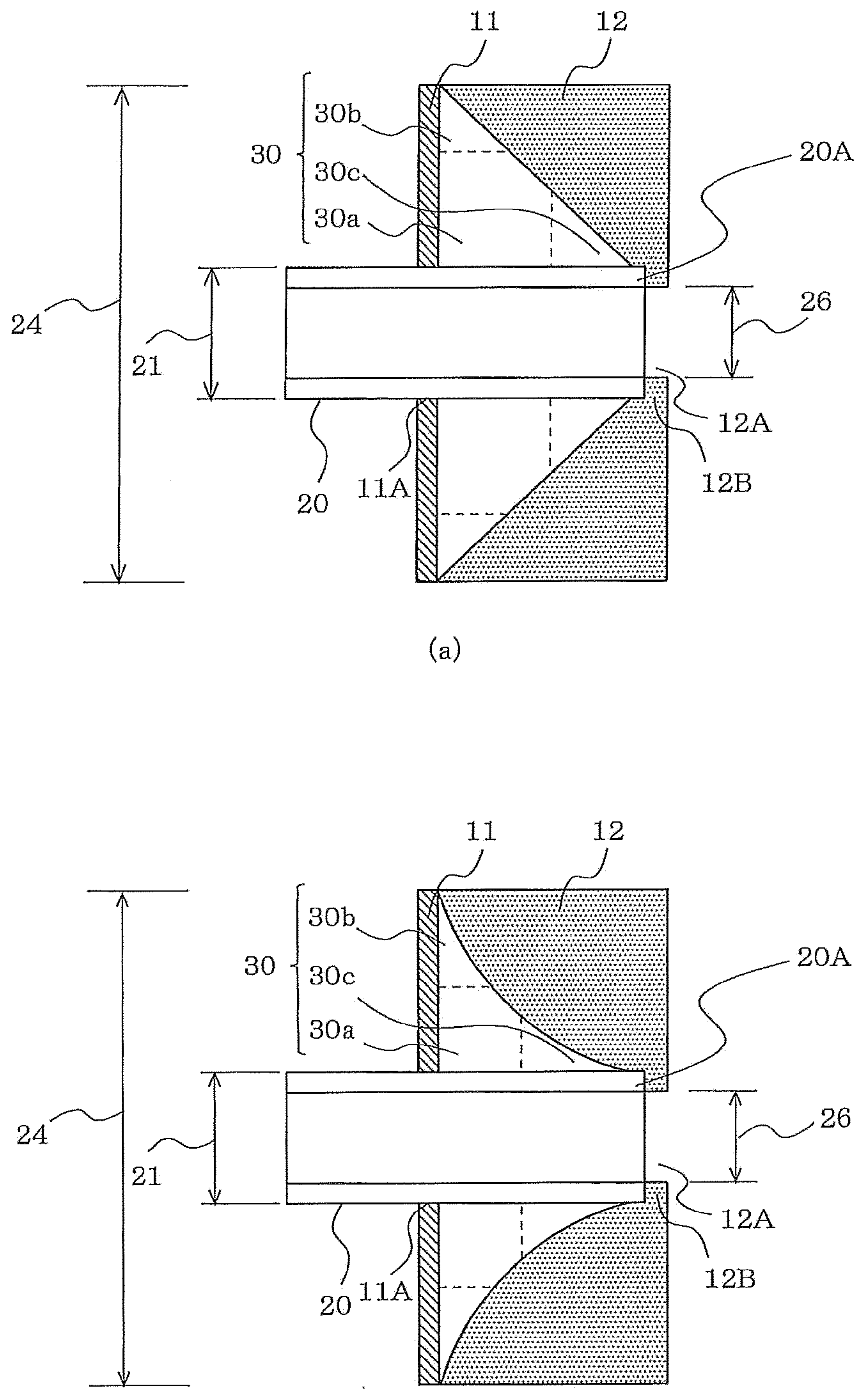


FIG. 5


11
12
30b
30
30c
30a
20A
24
21
26
12A
20
11A
12B
11
12
30b
30
30c
30a
20A
24
21
26
12A
20
11A
12B

(a)

(b)

FIG. 6

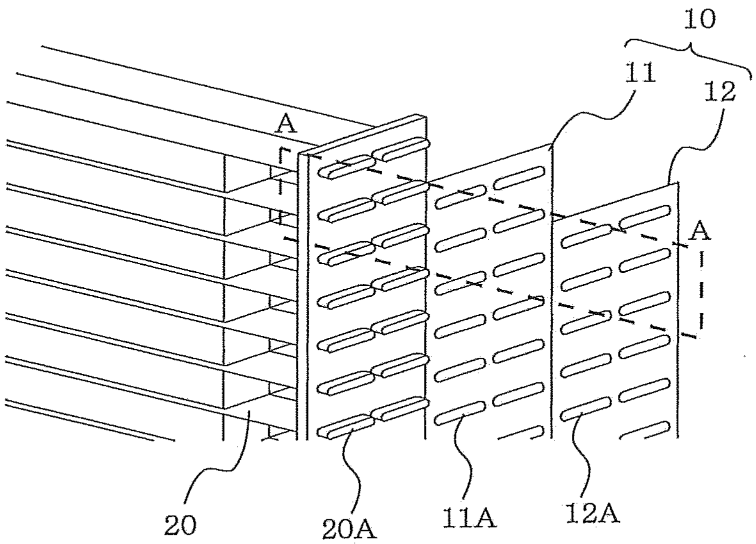
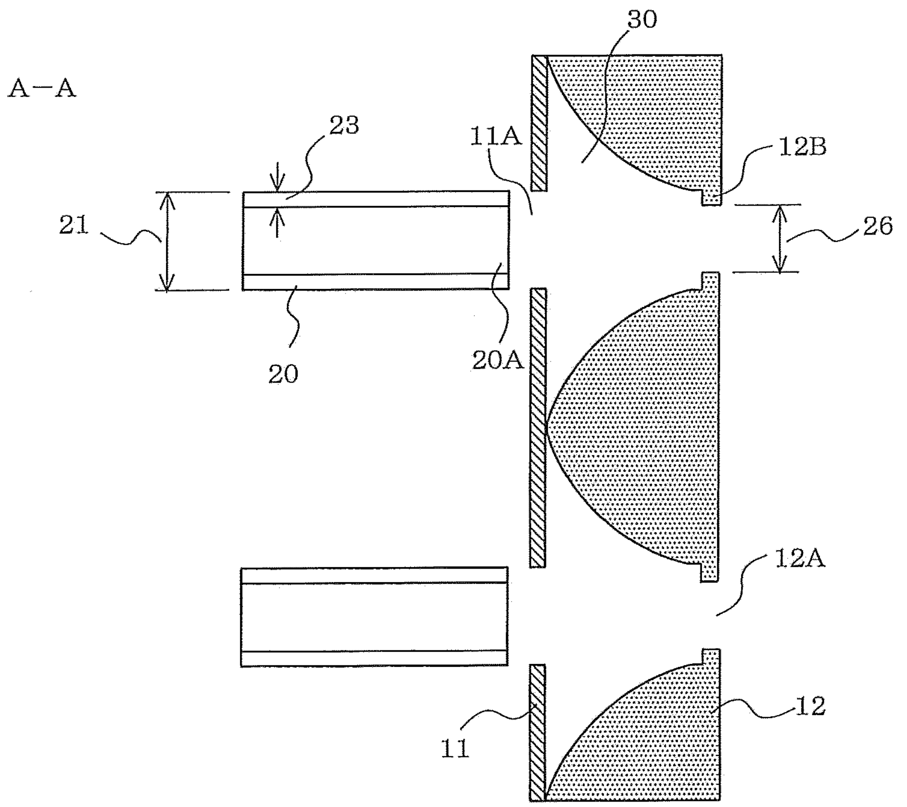
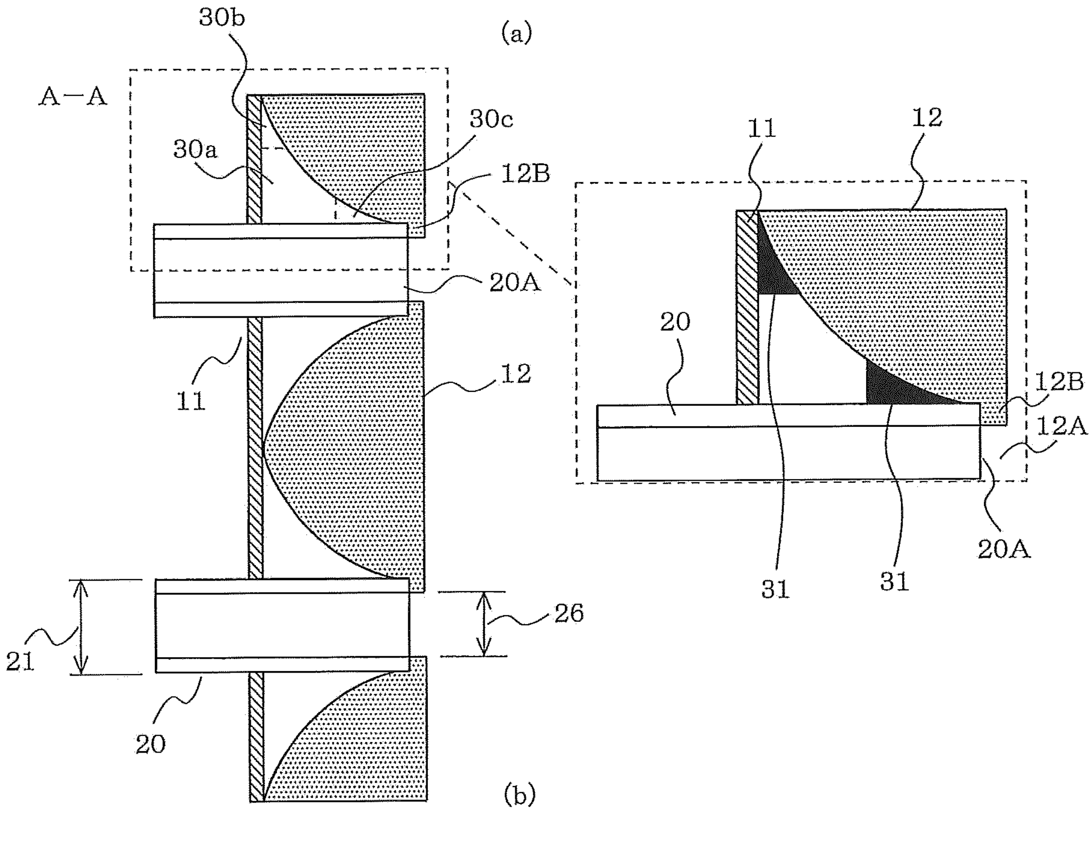


FIG. 7


A−A
30
23
11A
12B
21
26
20
20A
12A
11
12

(a)


30b
A−A
30c
30a
12B
11
12
20A
20
11
12
12B
12A
26
21
20
31
31
20A

(b)

FIG. 8

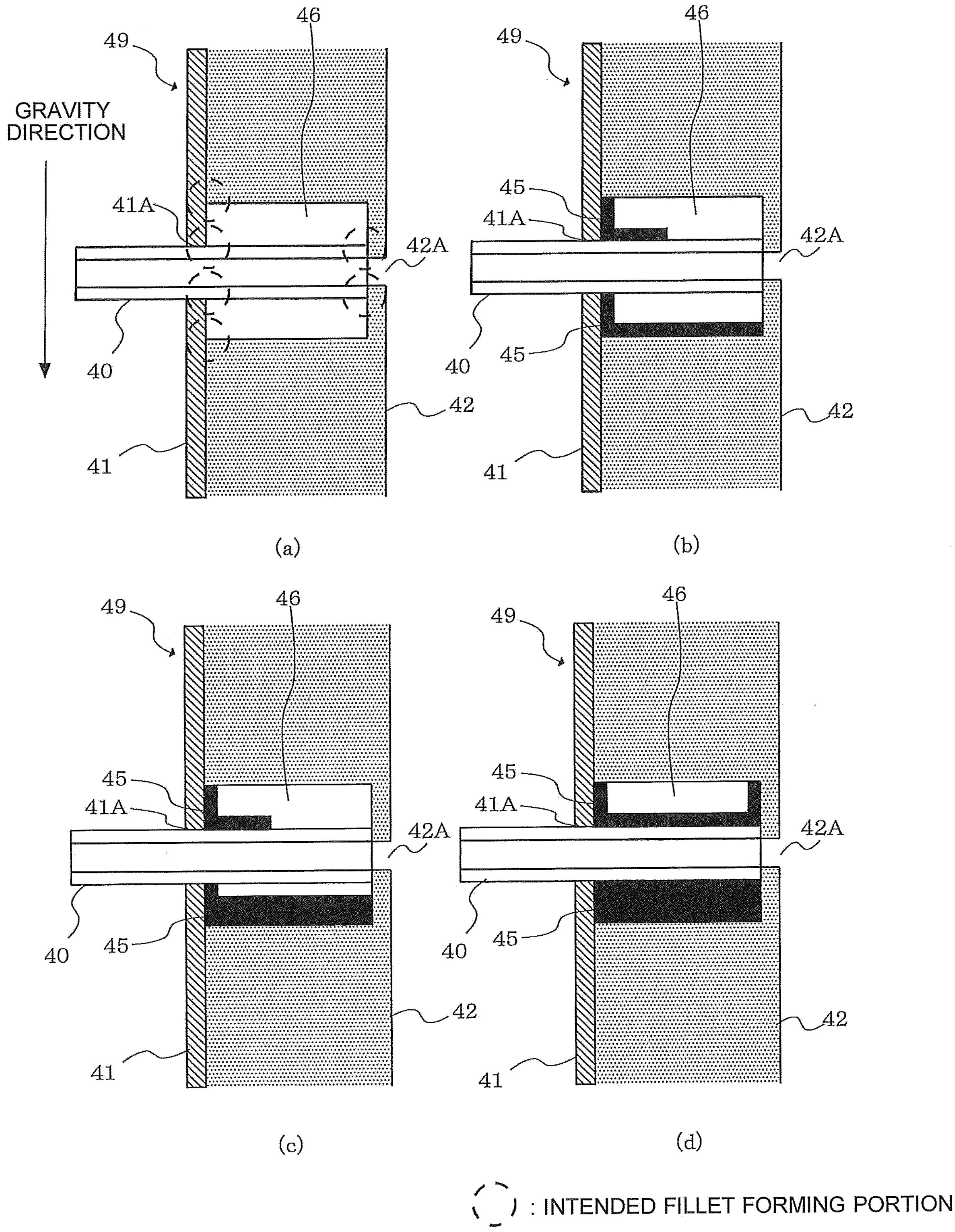

GRAVITY DIRECTION
49
46
41A
42A
40
42
41
45
(a)
(b)
(c)
(d)
: INTENDED FILLET FORMING PORTION

FIG. 9

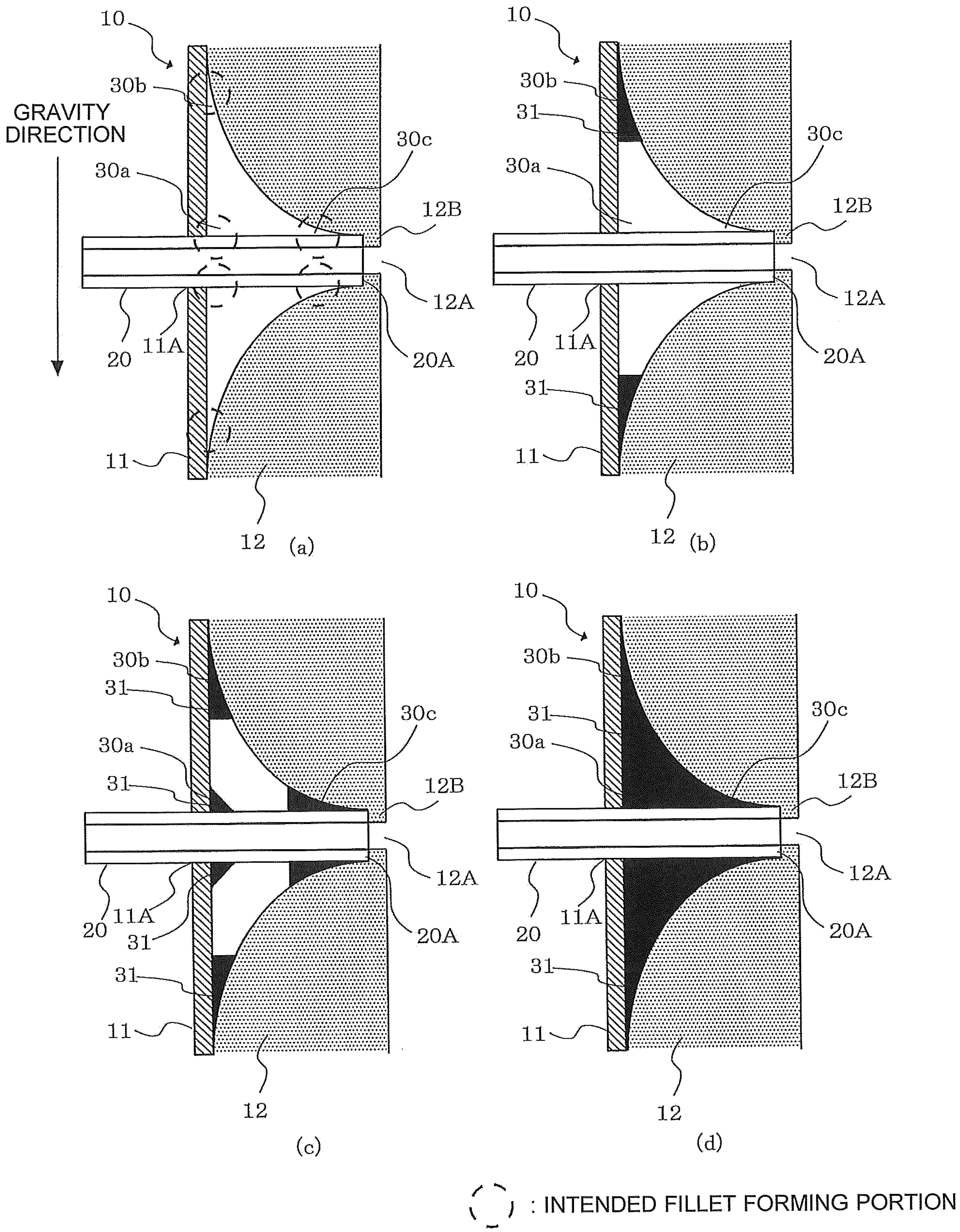
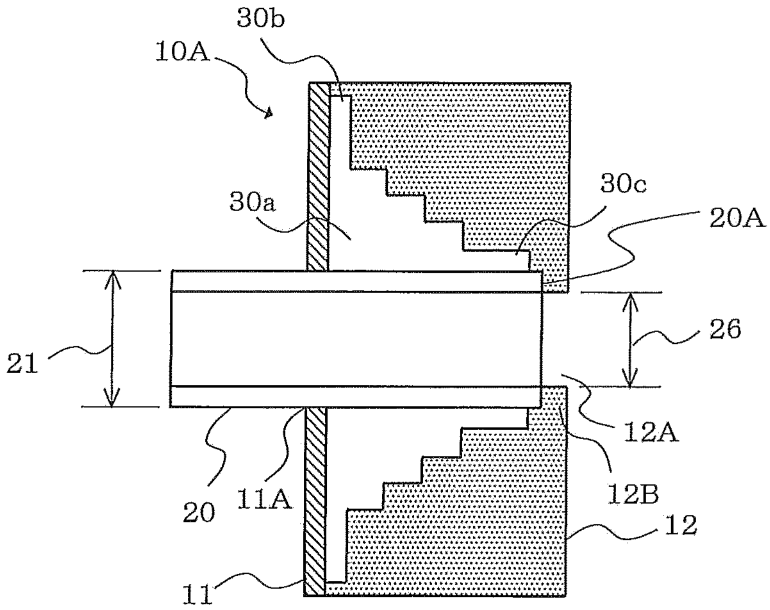
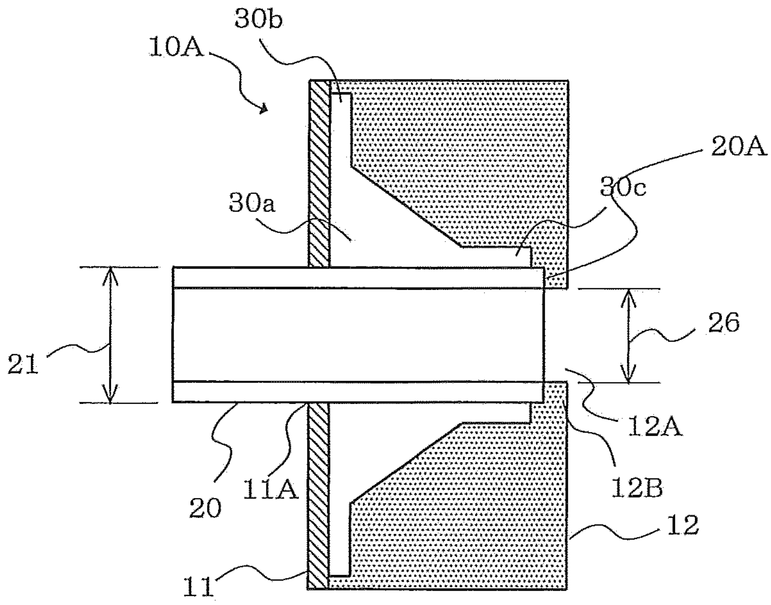

10
30b
GRAVITY DIRECTION
30a
30c
12B
12A
20
11A
20A
11
12
(a)
10
30b
31
30a
30c
12B
12A
20
11A
20A
31
11
12
(b)
10
30b
31
30a
31
30c
12B
12A
20
11A
31
20A
31
11
12
(c)
10
30b
31
30a
30c
12B
12A
20
11A
20A
31
11
12
(d)
: INTENDED FILLET FORMING PORTION

FIG. 10

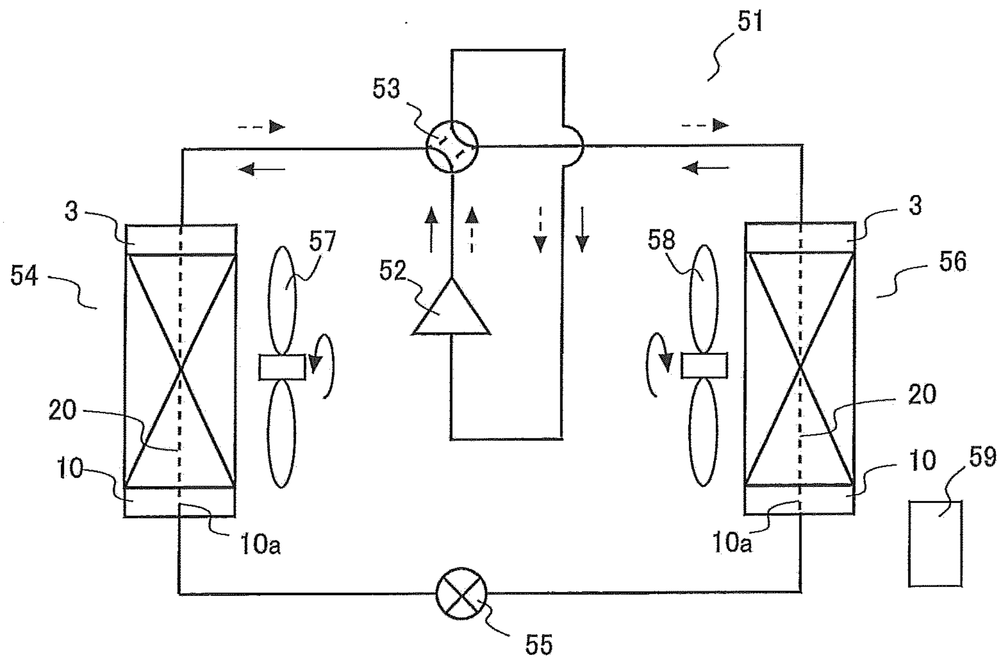

30b
10A
30a
30c
20A
21
26
12A
20
11A
12B
12
11

(a)


30b
10A
20A
30c
30a
21
26
12A
20
11A
12B
12
11

(b)

FIG. 11



REFERENCES CITED IN THE DESCRIPTION

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- WO 2012018125 A1 **[0004]**
- JP 2008249241 A **[0005]**
- JP 2006017442 A **[0005]**