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(72) Inventors:

- **WAKITA, Satoshi**
Tokyo 100-8310 (JP)
- **IKEUCHI, Yuichiro**
Tokyo 100-8310 (JP)
- **MIYAKE, Fumiyasu**
Tokyo 102-0073 (JP)

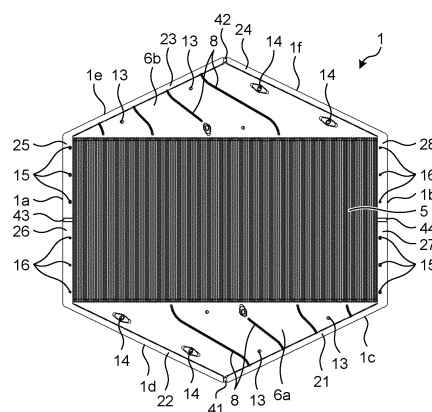
(71) Applicant: **MITSUBISHI ELECTRIC
CORPORATION**
Chiyoda-ku
Tokyo 100-8310 (JP)

(74) Representative: **Witte, Weller & Partner**
Patentanwälte mbB
Postfach 10 54 62
70047 Stuttgart (DE)

(54) **HEAT EXCHANGE ELEMENT**

(57) A heat exchange element is a heat exchange element formed by stacking a plurality of heat transfer plates (1). The heat transfer plate (1) includes: a heat exchanger (5) that allows air passing through one side in a stacking direction of a plurality of the heat transfer plates (1) and air passing through another side in the stacking direction to pass through in directions facing to each other to cause heat exchange; a header (6a, 6b) provided on one side and another side with the heat exchanger (5) interposed therebetween when viewed along the stacking direction; and a joining edge (25 to 28) provided along a side of the heat exchanger (5) not in contact with the header (6a, 6b). Joining edges (25 to 28) of a plurality of the stacked heat transfer plates (1) are in contact with each other and joined by ultrasonic welding, and the joining edge (25 to 28) is formed with a first convex portion (16) that protrudes along the stacking direction and a concave portion (15) into which the first convex portion (16) of an adjacent heat transfer plate is fitted.

FIG.4



Description

Field

[0001] The present disclosure relates to a heat exchange element of a counterflow type formed by stacking heat transfer plates.

[0002] As the heat exchange element of a counterflow type, there is a heat exchange element in which heat transfer plates formed by resin sheets are stacked. For example, Patent Literature 1 discloses a heat exchange element formed in a hexagonal column by stacking heat transfer plates having a hexagonal shape. In the heat exchange element of a hexagonal column, a part of a side surface serves as an inlet/outlet port for air for heat exchange. In addition, among edge portions of the heat transfer plates, edge portions other than edge portions facing the side surfaces serving as the inlet/outlet ports for air are joined between the heat transfer plates to be stacked, and leakage of air from the heat exchange element is prevented. The joining of the edge portions is performed by thermal welding or bonding using epoxy.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Patent Application Laid-open No. 2004-293862

Summary of Invention

Problem to be solved by the Invention

[0004] In recent years, there is a case where ultrasonic welding is used as a method for joining between heat transfer plates. By using ultrasonic welding, it is possible to shorten a time for joining between the heat transfer plates. In ultrasonic welding, ultrasonic vibration is transmitted to an edge portion through a tool sandwiching the edge portion. In the joining between the heat transfer plates using ultrasonic welding, there is a problem that a position of the heat transfer plate is deviated due to the ultrasonic vibration.

[0005] The present disclosure has been made in view of the above, and an object of the present invention is to provide a heat exchange element capable of accurately and easily positioning between heat transfer plates without positional deviation, even when the heat transfer plates constituting the heat exchange element are fixed with each other by ultrasonic welding.

Means to Solve the Problem

[0006] To solve the above problems and achieve the object a heat exchange element according to the present disclosure is formed by stacking a plurality of heat transfer plates. Each of the heat transfer plates includes: a

heat exchanger adapted to allow air passing through one side in a stacking direction of a plurality of the heat transfer plates and air passing through another side in the stacking direction to pass through in directions facing each other to cause heat exchange; a header provided on one side and another side with the heat exchanger interposed therebetween when viewed along the stacking direction; and a joining edge provided along a side of the heat exchanger that is not in contact with the header. The joining edge of a plurality of the stacked heat transfer plates are in contact with each other and joined by ultrasonic welding, and the joining edge is formed with a first convex portion that protrudes along the stacking direction and a concave portion into which the first convex portion of an adjacent heat transfer plate among the heat transfer plates is fitted.

Effects of the Invention

[0007] According to the present disclosure, it is possible to obtain a heat exchange element capable of accurately and easily positioning between heat transfer plates without positional deviation, even when the heat transfer plates constituting the heat exchange element are fixed with each other by ultrasonic welding.

Brief Description of Drawings

[0008]

FIG. 1 is a perspective view of a heat exchange element according to a first embodiment.

FIG. 2 is an exploded perspective view of the heat exchange element according to the first embodiment.

FIG. 3 is a perspective view in which a part of the heat exchange element according to the first embodiment is extracted.

FIG. 4 is a plan view of a first heat transfer plate according to the first embodiment.

FIG. 5 is a plan view of a second heat transfer plate in the first embodiment.

FIG. 6 is a partially enlarged cross-sectional view in which a protrusion and a base portion in the heat exchange element according to the first embodiment are enlarged.

FIG. 7 is a partially enlarged perspective cross-sectional view in which the protrusion and the base portion in the heat exchange element according to the first embodiment are enlarged.

FIG. 8 is a plan view of the base according to the first embodiment.

FIG. 9 is a partially enlarged cross-sectional view in which a cone cover and a cone portion in the heat exchange element according to the first embodiment are enlarged.

FIG. 10 is a partially enlarged perspective cross-sectional view in which the cone cover and the cone

portion in the heat exchange element according to the first embodiment are enlarged.

FIG. 11 is a view illustrating a schematic configuration of a manufacturing device for the heat exchange element according to the first embodiment.

FIG. 12 is a perspective cross-sectional view illustrating a state in which a guide pin illustrated in FIG. 11 is fitted into the protrusion.

FIG. 13 is a view illustrating a manufacturing process for the heat exchange element according to the first embodiment.

FIG. 14 is a view illustrating a manufacturing process for the heat exchange element according to the first embodiment.

FIG. 15 is a view illustrating a manufacturing process for the heat exchange element according to the first embodiment.

FIG. 16 is a view illustrating a manufacturing process for the heat exchange element according to the first embodiment.

Description of Embodiments

[0009] Hereinafter, a heat exchange element according to an embodiment will be described in detail with reference to the drawings.

First Embodiment.

[0010] FIG. 1 is a perspective view of a heat exchange element according to a first embodiment. FIG. 2 is an exploded perspective view of the heat exchange element according to the first embodiment. FIG. 3 is a perspective view in which a part of the heat exchange element according to the first embodiment is extracted. In a heat exchange element 50, a first heat transfer plate 1 and a second heat transfer plate 2 each having a hexagonal shape are alternately stacked to form a hexagonal column as a whole. Note that, in the following description, a stacking direction of the first heat transfer plate 1 and the second heat transfer plate 2 is simply referred to as a stacking direction. In addition, a description will be given assuming that a vertical direction on the page of FIG. 1 is a vertical direction in the heat exchange element 50.

[0011] In the heat exchange element 50, one of six side surfaces having a rectangular shape is a first inflow surface 61 serving as an inflow port of air into the heat exchange element 50. A side surface facing a direction opposite to the first inflow surface 61 is a first outflow surface 71 from which air having flowed in from the first inflow surface 61 flows out. An air passage 3 connecting the first inflow surface 61 and the first outflow surface 71 is formed inside the heat exchange element 50.

[0012] One side surface among two side surfaces adjacent to the first outflow surface 71 is a second inflow surface 62 serving as an inflow port of air into the heat exchange element 50. A side surface facing a direction opposite to the second inflow surface 62 is a second out-

flow surface 72 from which air having flowed in from the second inflow surface 62 flows out. The first inflow surface 61 and the second outflow surface 72 are adjacent to each other. An air passage 4 connecting the second inflow surface 62 and the second outflow surface 72 is formed inside the heat exchange element 50. The air passage 3 and the air passage 4 do not cross each other inside the heat exchange element 50.

[0013] The heat exchange element 50 is provided inside a ventilator, for example, and allows an exhaust air flow from inside to outside of a room to pass through the air passage 3, and allows a supply air flow from outside to inside of the room to pass through the air passage 4, so that the heat exchange element 50 can cause heat exchange between the supply air flow and the exhaust air flow.

[0014] FIG. 4 is a plan view of a first heat transfer plate according to the first embodiment. The first heat transfer plate 1 has a hexagonal shape in plan view. By stacking the first heat transfer plate 1 and the second heat transfer plate 2, the air passage 3 is formed on one surface side of the first heat transfer plate 1, and the air passage 4 is formed on another surface side of the first heat transfer plate 1. The first heat transfer plate 1 is provided with a heat exchanger 5 that causes heat exchange between air passing through the air passage 3 and air passing through the air passage 4. The heat exchanger 5 is formed by a rectangular region having, as short sides, sides 1a and 1b facing side surfaces on which the first inflow surface 61, the first outflow surface 71, the second inflow surface 62, and the second outflow surface 72 are not formed, among the side surfaces of the heat exchange element 50. Although a structure will not be described in detail, the heat exchanger 5 has a corrugated shape having a plurality of irregularities. In the heat exchanger 5, air passing through the air passage 3 and air passing through the air passage 4 pass in parallel and opposite directions to each other.

[0015] The first heat transfer plate 1 is provided with a first header 6a having a triangular shape in plan view. The first header 6a includes a side 1c facing the first inflow surface 61 and a side 1d facing the second outflow surface 72, in the heat exchange element 50.

[0016] The first heat transfer plate 1 is provided with a second header 6b having a triangular shape in plan view. The second header 6b includes a side 1e facing the first outflow surface 71 and a side 1f facing the second inflow surface 62, in the heat exchange element 50. The first header 6a and the second header 6b are provided on one side and another side with the heat exchanger 5 interposed therebetween. The sides 1a and 1b of the first heat transfer plate 1 are sides that are not in contact with the first header 6a and the second header 6b.

[0017] In the first header 6a and the second header 6b, ribs 8 are formed. The rib 8 formed in the first header 6a extends from the side 1c toward the heat exchanger 5. The rib 8 formed in the first header 6a extends substantially parallel to the side 1d, and allows air having

flowed in from the first inflow surface 61, that is, the side 1c side, to smoothly pass toward the heat exchanger 5.

[0018] The rib 8 formed in the second header 6b extends from the side 1e toward the heat exchanger 5. The rib 8 formed in the second header 6b extends substantially parallel to the side 1f, and allows air from the heat exchanger 5 to smoothly pass toward the side 1e.

[0019] On an outer edge of the first header 6a, a belt-shaped flat portion 21 is provided, which is a belt-shaped flat region extending along the side 1c. On an outer edge of the first header 6a, a belt-shaped flat portion 22 is provided, which is a belt-shaped flat region extending along the side 1d. In the first heat transfer plate 1, a step 41 along the stacking direction is provided between the belt-shaped flat portion 21 and the belt-shaped flat portion 22, in order to allow inflow of air from the side 1c and prevent inflow of air from the side 1d. More specifically, the belt-shaped flat portion 21 is formed at a position below a region where the rib 8 is formed, and the belt-shaped flat portion 22 is formed at a position above the belt-shaped flat portion 21. Note that the belt-shaped flat portion 21 and the region where the rib 8 is formed may be formed on one surface.

[0020] On an outer edge of the second header 6b, a belt-shaped flat portion 23 is provided, which is a belt-shaped flat region extending along the side 1e. On an outer edge of the second header 6b, a belt-shaped flat portion 24 is provided, which is a belt-shaped flat region extending along the side 1f. In the first heat transfer plate 1, a step 42 along the stacking direction is provided between the belt-shaped flat portion 23 and the belt-shaped flat portion 24, in order to allow outflow of air from the side 1e and prevent outflow of air from the side 1f. More specifically, the belt-shaped flat portion 23 is formed at a position below a region where the rib 8 is formed, and the belt-shaped flat portion 24 is formed at a position above the belt-shaped flat portion 23. Note that the belt-shaped flat portion 23 and the region where the rib 8 is formed may be formed on one flat surface.

[0021] On an outer edge of the heat exchanger 5, belt-shaped flat portions 25 and 26 are provided, which are belt-shaped flat regions extending along the side 1a. The belt-shaped flat portion 25 and the belt-shaped flat portion 26 are formed provided with a step 43 at an intermediate portion in between in a direction along the side 1a. The belt-shaped flat portion 26 is formed above the belt-shaped flat portion 25.

[0022] On an outer edge of the heat exchanger 5, belt-shaped flat portions 27 and 28 are provided, which are belt-shaped flat regions extending along the side 1b. The belt-shaped flat portion 27 and the belt-shaped flat portion 28 are formed provided with a step 44 at an intermediate portion in between in a direction along the side 1b. The belt-shaped flat portion 28 is formed above the belt-shaped flat portion 27. The first heat transfer plate 1 has a point symmetrical shape centered on a center position of the hexagonal shape in plan view.

[0023] FIG. 5 is a plan view of a second heat transfer

plate according to the first embodiment. The second heat transfer plate 2 has a hexagonal shape in plan view. Configurations similar to those of the first heat transfer plate 1 are denoted by identical reference numerals, and a detailed description thereof will be omitted. The second heat transfer plate 2 is in a mirror image relationship with the first heat transfer plate 1.

[0024] By stacking the first heat transfer plate 1 and the second heat transfer plate 2, the air passage 4 is formed on one surface side of the second heat transfer plate 2, and the air passage 3 is formed on another surface side of the second heat transfer plate 2. The second heat transfer plate 2 is provided with the heat exchanger 5 that causes heat exchange between air passing through the air passage 3 and air passing through the air passage 4. In the second heat transfer plate 2, the heat exchanger 5 is formed by a rectangular region having, as short sides, sides 2a and 2b facing side surfaces on which the first inflow surface 61, the first outflow surface 71, the second inflow surface 62, and the second outflow surface 72 are not formed, among the side surfaces of the heat exchange element 50.

[0025] The second heat transfer plate 2 is provided with a third header 6c having a triangular shape in plan view. The third header 6c includes a side 2c facing the first inflow surface 61 and a side 2d facing the second outflow surface 72, in the heat exchange element 50.

[0026] The second heat transfer plate 2 is provided with a fourth header 6d having a triangular shape in plan view. The fourth header 6d includes a side 2e facing the first outflow surface 71 and a side 2f facing the second inflow surface 62, in the heat exchange element 50. The third header 6c and the fourth header 6d are provided on one side and another side with the heat exchanger 5 interposed therebetween. The sides 2a and 2b of the second heat transfer plate 2 are sides not in contact with the third header 6c and the fourth header 6d.

[0027] In the third header 6c and the fourth header 6d, the ribs 8 are formed. The rib 8 formed in the third header 6c extends from the side 2d toward the heat exchanger 5. The rib 8 formed in the third header 6c extends substantially parallel to the side 2c, and allows air from the heat exchanger 5 to smoothly pass toward the side 2d.

[0028] The rib 8 formed in the fourth header 6d extends from the side 2f toward the heat exchanger 5. The rib 8 formed in the fourth header 6d extends substantially parallel to the side 2e, and allows air having flowed in from the second inflow surface 62, that is, the side 2f side, to smoothly pass toward the heat exchanger 5.

[0029] On an outer edge of the third header 6c, a belt-shaped flat portion 31 is provided, which is a belt-shaped flat region extending along the side 2c. On an outer edge of the third header 6c, a belt-shaped flat portion 32 is provided, which is a belt-shaped flat region extending along the side 2d. In the second heat transfer plate 2, a step 51 along the stacking direction is provided between the belt-shaped flat portion 31 and the belt-shaped flat portion 32, in order to allow outflow of air from the side

2d and prevent outflow of air from the side 2c. More specifically, the belt-shaped flat portion 32 is formed at a position below the region where the rib 8 is formed, and the belt-shaped flat portion 31 is formed at a position above the belt-shaped flat portion 32. Note that the belt-shaped flat portion 32 and the region where the rib 8 is formed may be formed on one flat surface.

[0030] On an outer edge of the fourth header 6d, a belt-shaped flat portion 33 is provided, which is a belt-shaped flat region extending along the side 2e. On an outer edge of the fourth header 6d, a belt-shaped flat portion 34 is provided, which is a belt-shaped flat region extending along the side 2f. In the second heat transfer plate 2, a step 52 along the stacking direction is provided between the belt-shaped flat portion 33 and the belt-shaped flat portion 34, in order to allow inflow of air from the side 2f and prevent inflow of air from the side 2e. More specifically, the belt-shaped flat portion 34 is formed at a position below the region where the rib 8 is formed, and the belt-shaped flat portion 33 is formed at a position above the belt-shaped flat portion 34. Note that the belt-shaped flat portion 34 and the region where the rib 8 is formed may be formed on one flat surface.

[0031] On an outer edge of the heat exchanger 5, belt-shaped flat portions 35 and 36 are provided, which are belt-shaped flat regions extending along the side 2a. The belt-shaped flat portion 35 and the belt-shaped flat portion 36 are formed provided with a step 53 at an intermediate portion in between in a direction along the side 2a. The belt-shaped flat portion 35 is formed above the belt-shaped flat portion 36.

[0032] On an outer edge of the heat exchanger 5, belt-shaped flat portions 37 and 38 are provided, which are belt-shaped flat regions extending along the side 2b. The belt-shaped flat portion 37 and the belt-shaped flat portion 38 are formed provided with a step 54 at an intermediate portion in between in a direction along the side 2b. The belt-shaped flat portion 37 is formed above the belt-shaped flat portion 38. The second heat transfer plate 2 has a point symmetrical shape centered on a center position of the hexagonal shape in plan view.

[0033] Next, a protrusion 13, a base 14, a cone cover 15, and a cone 16 formed on the first heat transfer plate 1 and the second heat transfer plate 2 will be described.

[0034] The protrusion 13 and the base 14 are formed on the headers 6a, 6b, 6c, and 6d. FIG. 6 is a partially enlarged cross-sectional view in which a protrusion and a base portion in the heat exchange element according to the first embodiment are enlarged. FIG. 7 is a partially enlarged perspective cross-sectional view in which the protrusion and the base portion in the heat exchange element according to the first embodiment are enlarged. FIG. 8 is a plan view of the base according to the first embodiment.

[0035] The protrusion 13 is formed so as to protrude downward. The protrusion 13 is a second convex portion. A back surface of the protrusion 13 is a recess. Returning to FIGS. 4 and 5, a plurality of protrusions 13 are formed

along the sides 1c, 1e, 2d, and 2f serving as inlet/outlet ports for air. The plurality of protrusions 13 are formed for each of the sides 1c, 1e, 2d, and 2f. The protrusions 13 are formed at positions where lengths of the sides 1c, 1e, 2d, and 2f are divided at equal intervals. A ratio of a height of the protrusion 13 to a diameter at a root of the protrusion 13 is 1 or less. With this ratio, when the heat transfer plates 1 and 2 are formed by vacuum molding, it is possible to prevent a material from becoming too thin and forming a hole.

[0036] As illustrated in FIGS. 6 and 7, the base 14 is formed so as to protrude upward. A cross-sectional shape of the base 14 is trapezoidal shape. A flat region is provided at a top portion of the base 14, and a recess 14a recessed downward is formed in the flat region. As illustrated in FIG. 8, a planar shape of the base 14 is a rhombus shape. The recess 14a has an elongated hole shape whose longitudinal direction is a direction toward a center of the heat transfer plates 1 and 2 in plan view. A width along a short direction of the recess 14a is a width in which the protrusion 13 is fitted.

[0037] The base 14 is provided such that a longer diagonal line among two diagonal lines of the rhombus is parallel to the sides 1d, 1f, 2c, and 2e with which the base 14 is along. That is, it suffices that the base 14 is provided such that the longer diagonal line among the two diagonal lines of the rhombus is along an air flow direction. The base 14 is provided as close as possible to the belt-shaped flat portions 22, 24, 31, and 33, at a position away to such an extent that the base 14 does not overlap with the belt-shaped flat portions 22, 24, 31, and 33 with a gap provided in between, on a straight line substantially parallel to the air flow direction. Note that, in the present embodiment, it can also be said that the base 14 is disposed on a straight line substantially parallel to the belt-shaped flat portions 22, 24, 31, and 33.

[0038] The protrusion 13 and the base 14 are formed at positions overlapping with each other in plan view when the first heat transfer plate 1 and the second heat transfer plate 2 are stacked. As illustrated in FIGS. 6 and 7, when the heat transfer plates 1 and 2 are stacked, a region serving as a flat surface of a top portion of the base 14 abuts on the heat transfer plates 1 and 2 stacked above. Further, the protrusion 13 is fitted into the recess 14a of the base 14. The protrusion 13 is fitted into the recess 14a and thus is not exposed to the air passages 3 and 4. Note that the protrusion 13 may protrude upward, and the base 14 may protrude downward.

[0039] As illustrated in FIGS. 4 and 5, the cone cover 15 is formed on the belt-shaped flat portions 25, 27, 36, and 38 of the heat transfer plates 1 and 2. A plurality of cone covers 15 are formed for each of the belt-shaped flat portions 25, 27, 36, and 38. The cone covers 15 are formed at positions where lengths of the belt-shaped flat portions 25, 27, 36, and 38 are divided at equal intervals. The cone covers 15 are formed at positions closer to the heat exchanger 5 than a center in a width direction of each of the belt-shaped flat portions 25, 27, 36, and 38.

[0040] FIG. 9 is a partially enlarged cross-sectional view in which a cone cover and a cone portion in the heat exchange element according to the first embodiment are enlarged. FIG. 10 is a partially enlarged perspective cross-sectional view in which the cone cover and the cone portion in the heat exchange element according to the first embodiment are enlarged. The cone cover 15 is a concave portion recessed upward from below. The cone cover 15 protrudes on a back surface side of the concave portion. The cone cover 15 is formed in a conical shape whose tip end has a flat shape. A ratio of a height of the cone cover 15 to a gap distance between the heat exchanger 5 and the cone cover 15 is 1 or less. With this ratio, when the heat transfer plates 1 and 2 are formed by vacuum molding, it is possible to prevent a material from becoming too thin and forming a hole. The concave portion of the cone cover 15 has an elongated hole shape extending in a length direction of each of the belt-shaped flat portions 25, 27, 36, and 38.

[0041] As illustrated in FIGS. 4 and 5, the cone 16 is formed on the belt-shaped flat portions 26, 28, 35, and 37 of the heat transfer plates 1 and 2. A plurality of cones 16 are formed for each of the belt-shaped flat portions 26, 28, 35, and 37. The cones 16 are formed at positions where lengths of the belt-shaped flat portions 26, 28, 35, and 37 are divided at equal intervals. The cones 16 are formed at positions closer to the heat exchanger 5 than a center in a width direction of each of the belt-shaped flat portions 26, 28, 35, and 37. A ratio of a height of the cone 16 to a gap distance between the heat exchanger 5 and the cone 16 is 1 or less. With this ratio, when the heat transfer plates 1 and 2 are formed by vacuum molding, it is possible to prevent a material from becoming too thin and forming a hole.

[0042] As illustrated in FIGS. 9 and 10, the cone 16 is a first convex portion protruding upward. The cone 16 is formed in a conical shape whose tip end has a curved surface.

[0043] When the heat transfer plates 1 and 2 are stacked, the belt-shaped flat portion 21 abuts on the belt-shaped flat portion 31 below. The belt-shaped flat portion 22 abuts on the belt-shaped flat portion 32 above. The belt-shaped flat portion 23 abuts on the belt-shaped flat portion 33 below. The belt-shaped flat portion 24 abuts on the belt-shaped flat portion 34 above. The belt-shaped flat portion 25 abuts on the belt-shaped flat portion 35 below. The belt-shaped flat portion 26 abuts on the belt-shaped flat portion 36 above. The belt-shaped flat portion 27 abuts on the belt-shaped flat portion 37 below. The belt-shaped flat portion 28 abuts on the belt-shaped flat portion 38 above. As will be described in detail later, the abutting belt-shaped flat portions 21, 22, 23, 24, 25, 26, 27, 28, 31, 32, 33, 34, 35, 36, 37, and 38 serve as joining edge joined by ultrasonic welding.

[0044] The cone cover 15 and the cone 16 are formed at positions overlapping with each other in plan view when the heat transfer plates 1 and 2 are stacked. As illustrated in FIGS. 9 and 10, when the heat transfer

plates 1 and 2 are stacked, the cone 16 fits into the concave portion of the cone cover 15. Note that the concave portion of the cone cover 15 may be recessed downward, and the cone 16 may be protruded downward.

[0045] Next, a manufacturing process for the heat exchange element will be described. FIG. 11 is a view illustrating a schematic configuration of a manufacturing device for the heat exchange element according to the first embodiment. The manufacturing device includes a receiving base 17 on which the heat transfer plates 1 and 2 are placed. The receiving base 17 has a function of holding the heat transfer plates 1 and 2 by a method such as suction, and is provided with a hole (not illustrated) for positioning at a location identical to a position of the protrusion 13. Furthermore, on an upper side of the manufacturing device, a guide pin 18 and a guide pin 19 are included at locations identical to positions of the protrusion 13. FIG. 12 is a perspective cross-sectional view illustrating a state in which a guide pin illustrated in FIG. 11 is fitted into the protrusion. The guide pin 18 is movable up and down, and a tip end thereof is inserted into a recess on a back surface of the protrusion 13 as illustrated in FIG. 12 when the guide pin 18 moves downward. This similarly applies to the guide pin 19.

[0046] In the manufacturing process for the heat exchange element 50, stacking and fixing of the first heat transfer plate 1 and the second heat transfer plate 2 are repeated. FIGS. 13 to 16 are views illustrating a manufacturing process for the heat exchange element according to the first embodiment.

[0047] In the manufacturing process of the heat exchange element 50, as illustrated in FIG. 13, first, the first heat transfer plate 1, which is the first piece of stacking, is placed on the receiving base 17. At this time, the protrusion 13 is aligned with the hole of the receiving base 17, so that the protrusion 13 is fitted into the hole of the receiving base 17 to perform positioning.

[0048] Next, as illustrated in FIG. 14, a tip end of the guide pin 18 is fitted into the concave portion on the back surface of the protrusion 13 of the second heat transfer plate 2 to be stacked next, and then, as illustrated in FIG. 15, the second heat transfer plate 2 is stacked. By doing in this manner, the abutting belt-shaped flat portions 22, 24, 26, 28, 32, 34, 36, and 38 are fixed with one another by ultrasonic welding in a state where both the heat transfer plates 1 and 2 of the upper layer and the lower layer are positioned by the manufacturing device. Next, as illustrated in FIG. 16, stacking is performed while positioning is performed using the guide pins 19 with respect to the first heat transfer plates 1 to be stacked next. In this manner, the first heat transfer plate 1 and the second heat transfer plate 2 are stacked up to any height by alternately repeatedly stacking and fixing. As can be seen from the description of the manufacturing process, the guide pin 18 is used for positioning the second heat transfer plate 2, and the guide pin 19 is used for positioning the first heat transfer plate 1.

[0049] Further, the tip ends of the guide pins 18 and

19 are fitted into the concave portions on the back surfaces of the protrusions 13, and the heat transfer plates 1 and 2 on the upper layer are pressed against the heat transfer plates 1 and 2 below. Therefore, frictional resistance is generated between the flat portion of the base 14 in which the protrusion 13 is fitted and the region of the headers 6a, 6b, 6c, and 6d that abuts on the flat portion of the base 14. As a result, reliability of ultrasonic welding is improved, and a yield is improved.

[0050] According to the heat exchange element 50 described above, the protrusion 13, the base 14, the cone cover 15, and the cone 16 formed on the heat transfer plates 1 and 2 are less likely to cause positional deviation in a stacked state. Therefore, even by ultrasonic welding that applies vibration to the heat transfer plates 1 and 2, positional deviation is less likely to occur in the heat transfer plates 1 and 2. In addition, since the protrusion 13 is fitted into the recess 14a of the base 14 and the cone 16 is fitted into the cone cover 15 only by stacking the heat transfer plates 1 and 2, positioning can be performed accurately and easily. In addition, if the protrusion 13 is tightly fitted into the recess 14a of the base 14 and the cone 16 is tightly fitted into the cone cover 15, it is possible to further reduce occurrence of positional deviation. In addition, the heat transfer plates 1 and 2 contract toward a center thereof after molding. Since the recess 14a has an elongated hole shape whose longitudinal direction is a direction toward a center of the heat transfer plates 1 and 2 in plan view, the protrusion 13 is easily fitted into the recess 14a even when the position of the base 14 is deviated due to contraction toward the center of the heat transfer plates 1 and 2. In addition, by the protrusions 13 abutting on the recesses 14a, the heat transfer plates 1 and 2 are prevented from being deviated from each other in a direction different from the direction toward the center of the heat transfer plates 1 and 2, so that positioning accuracy is also improved.

[0051] Further, the protrusion 13 and the base 14 are at positions close to the belt-shaped flat portions 22, 24, 31, and 33 even in the regions of the headers 6a, 6b, 6c, and 6d, and the cone cover 15 and the cone 16 are also at the belt-shaped flat portions 25, 26, 27, 28, 35, 36, 37, and 38. Therefore, even when a force for deviating the heat transfer plates 1 and 2 acts by ultrasonic welding, a bending stress generated in the heat transfer plates 1 and 2 remains in a short distance range, so that it is possible to make the heat transfer plates less likely to be bent.

[0052] In addition, since the plurality of protrusions 13, the plurality of bases 14, the plurality of cone covers 15, and the plurality of cones 16 are formed for each of the belt-shaped flat portions 21, 22, 23, 24, 25, 26, 27, 28, 31, 32, 33, 34, 35, 36, 37, and 38, positional deviation is further less likely to occur.

[0053] Further, since the protrusion 13 has a tapered shape, the cone cover 15 has a conical shape, and the cone 16 has a conical shape, it is easy to perform centering when the heat transfer plates 1 and 2 are positioned with each other or the heat transfer plate and the manu-

facturing device are positioned with each other, and the heat transfer plates 1 and 2 can be easily positioned with each other.

[0054] In addition, by performing ultrasonic welding in a state where accurate positioning is made, a range to be welded is less likely to reach other ranges, or a portion having a welding defect is less likely to occur. Accordingly, clogging due to excessive welding and leakage of air from the heat exchange element 50 can be prevented.

[0055] In addition, since the base 14 is provided such that the longer diagonal line among the two diagonal lines of the rhombus is along the air flow direction, and the top portion of the base 14 abuts on the adjacent heat transfer plate 1 or 2, the base 14 is less likely to obstruct an air flow. In addition, by providing a gap between the base 14 and the belt-shaped flat portions 22, 24, 31, and 33, it is possible to reduce disturbance of a wind flow around the base 14 and the sides 1d, 1f, 2c, and 2e and to suppress occurrence of a pressure loss, as compared with a case where no gap is provided. Further, by disposing the bases 14 linearly in the air flow direction, it is possible to similarly reduce disturbance of the flow and suppress occurrence of a pressure loss. In addition, by disposing the base 14 as close as possible to the sides 1d, 1f, 2c, and 2e with the gap interposed therebetween, a distance between the welding point and the base 14 becomes as short as possible, and the positioning can be more effectively performed at the time of welding.

[0056] Further, since the base 14 is provided on the headers 6a, 6b, 6c, and 6d, a width of the belt-shaped flat portions 21, 22, 23, 24, 31, 32, 33, and 34 can be narrowed as compared with a case where the base 14 is provided on the belt-shaped flat portions 21, 22, 23, 24, 31, 32, 33, and 34. If the heat transfer plates 1 and 2 have equal sizes, the headers 6a, 6b, 6c, and 6d can be widened as the widths of the belt-shaped flat portions 21, 22, 23, 24, 31, 32, 33, and 34 are narrower. Although the base 14 is to be provided in the flow path, by widening the headers 6a, 6b, 6c, and 6d, a pressure loss of the heat exchange element 50 can be reduced as compared with a case where the base 14 is provided in the belt-shaped flat portions 21, 22, 23, 24, 31, 32, 33, and 34.

[0057] The configuration described in the above embodiment is an example of the contents of the present disclosure. The configuration of the embodiment can be combined with another known technique. A part of the configuration of the embodiment can be omitted or changed without departing from the gist of the present disclosure.

Reference Signs List

[0058] 1 first heat transfer plate; 1a, 1b, 1c, 1d, 1e, 1f side; 2 second heat transfer plate; 2a, 2b, 2c, 2d, 2e, 2f side; 3, 4 air passage; 5 heat exchanger; 6a first header; 6b second header; 6c third header; 6d fourth header; 8 rib; 13 protrusion; 14 base; 14a recess; 15 cone cover; 16 cone; 17 receiving base; 18, 19 guide pin; 21, 22, 23,

24, 25, 26, 27, 28, 31, 32, 33, 34, 35, 36, 37, 38 belt-shaped flat portion; 41, 42, 43, 44, 51, 52, 53, 54 step; 50 heat exchange element; 61 first inflow surface; 62 second inflow surface; 71 first outflow surface; 72 second outflow surface.

Claims

1. A heat exchange element formed by stacking a plurality of heat transfer plates, wherein

each of the heat transfer plates includes:

a heat exchanger adapted to allow air passing through one side in a stacking direction of a plurality of the heat transfer plates and air passing through another side in the stacking direction to pass through in directions facing each other to cause heat exchange;

a header provided on one side and another side with the heat exchanger interposed therebetween when viewed along the stacking direction; and

a joining edge provided along a side of the heat exchanger that is not in contact with the header, wherein

the joining edge of a plurality of the stacked heat transfer plates are in contact with each other and joined by ultrasonic welding, and

the joining edge is formed with a first convex portion that protrudes along the stacking direction and a concave portion into which the first convex portion of an adjacent heat transfer plate among the heat transfer plates is fitted.

2. The heat exchange element according to claim 1, wherein

the header is formed with a base protruding along the stacking direction and having a recess formed at a top portion thereof, and a second convex portion to fit into the recess of an adjacent heat transfer plate among the heat transfer plates.

3. The heat exchange element according to claim 2, wherein

a flat region is provided at a top portion of the base, and the flat region abuts on an adjacent heat transfer plate among the heat transfer plates.

4. The heat exchange element according to claim 2 or 3, wherein

each of the heat transfer plates has a hexagonal shape as viewed along the stacking direction, the first convex portion and the base are provid-

ed along any side of the hexagonal shape, and a plurality of the first convex portions and a plurality of the bases are formed for a side along which the first convex portions and the bases are formed.

5. The heat exchange element according to claim 4, wherein

a plurality of the first convex portions and a plurality of the bases are provided at positions where a length of a side along which the first convex portions and the base are formed is divided at equal intervals.

6. The heat exchange element according to any one of claims 2 to 5, wherein

the base has a rhombus shape when viewed along the stacking direction, and is formed such that a longer diagonal line among two diagonal lines is formed along a flow direction of air passing through the header.

7. The heat exchange element according to any one of claims 1 to 6, wherein

a ratio of a height of the first convex portion to a diameter at a root of the first convex portion is 1 or less.

FIG.1

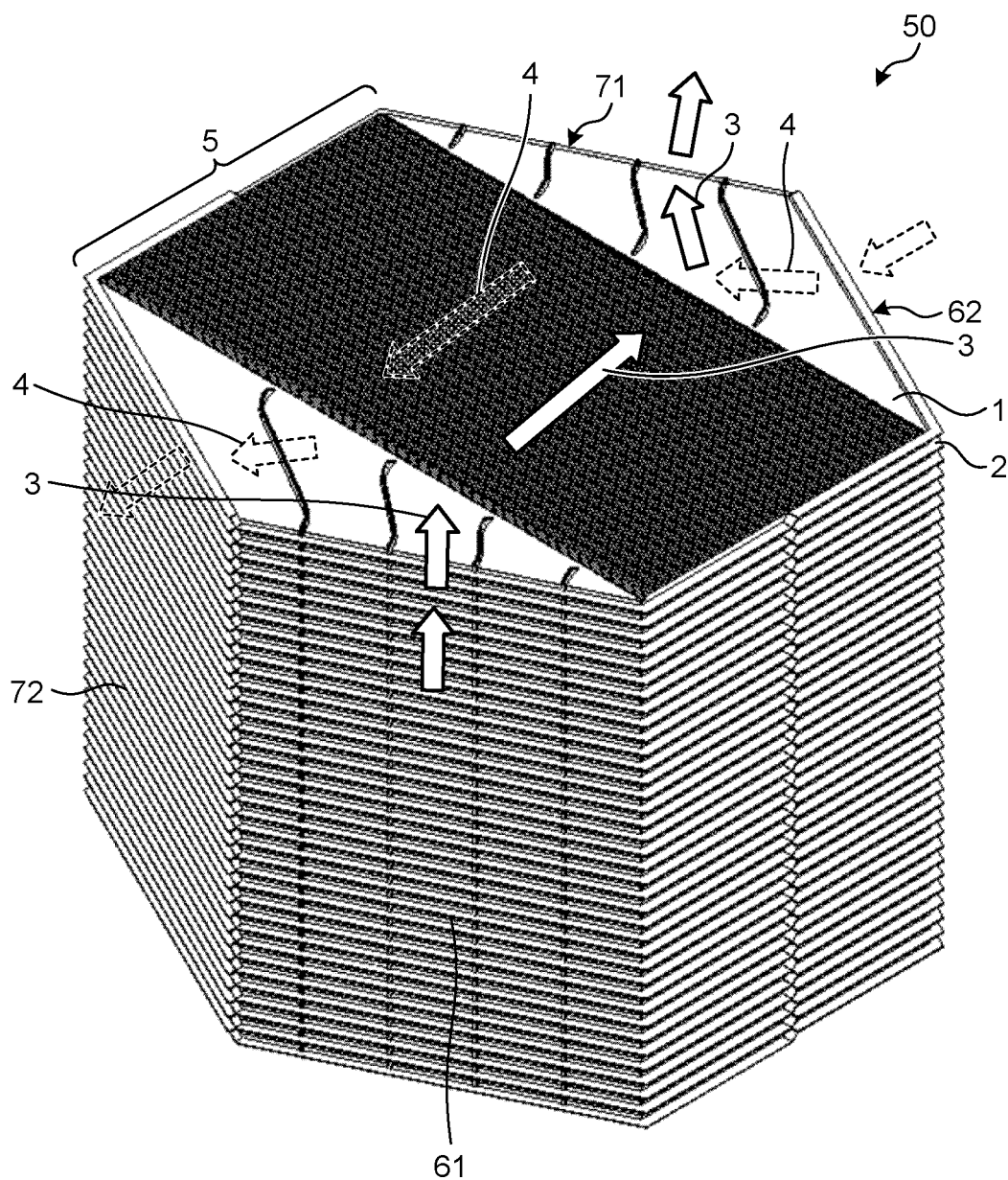


FIG.2

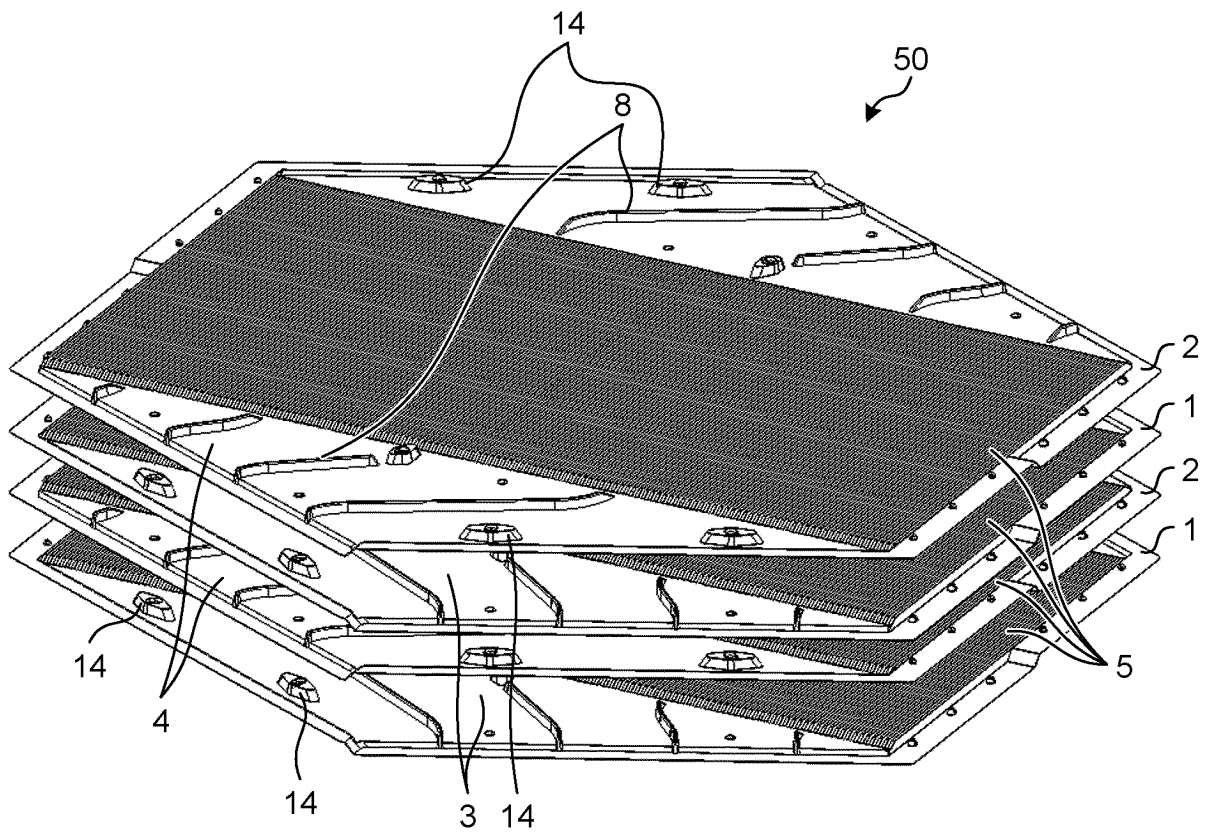


FIG.3

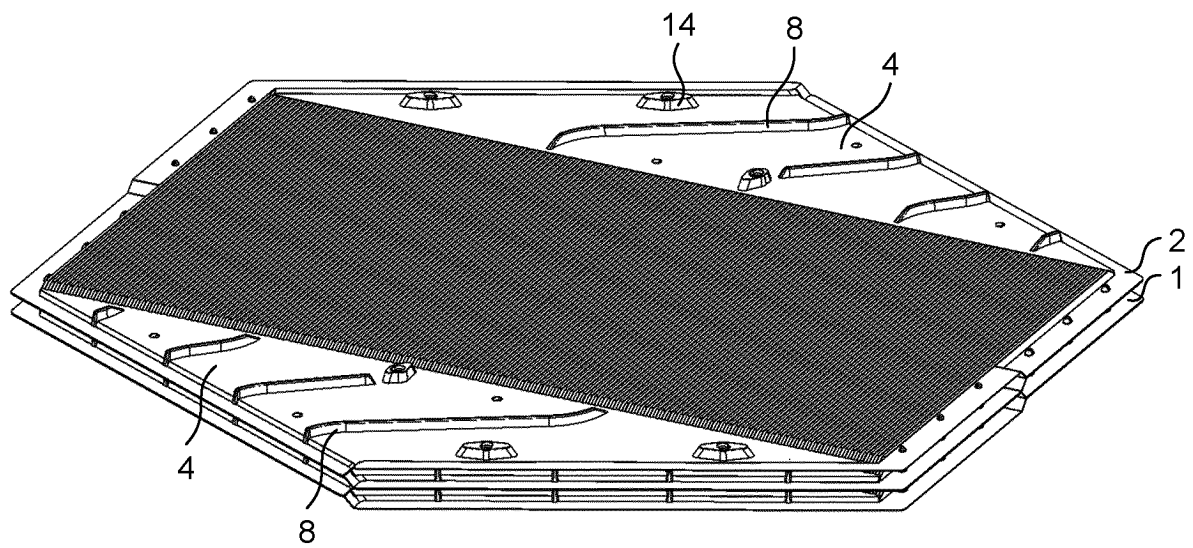


FIG.4

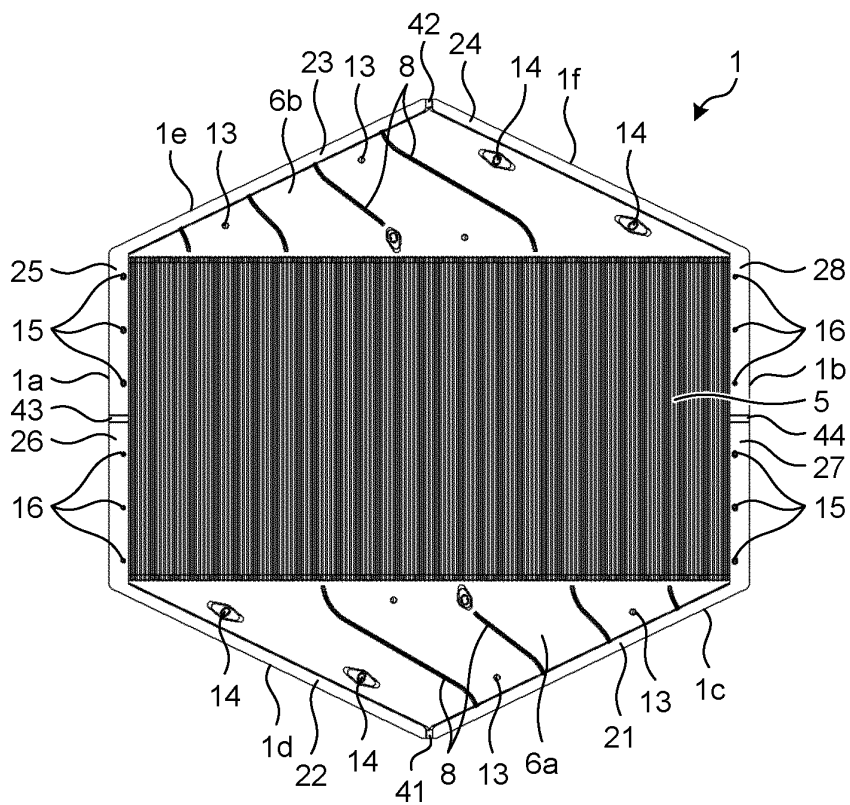


FIG.5

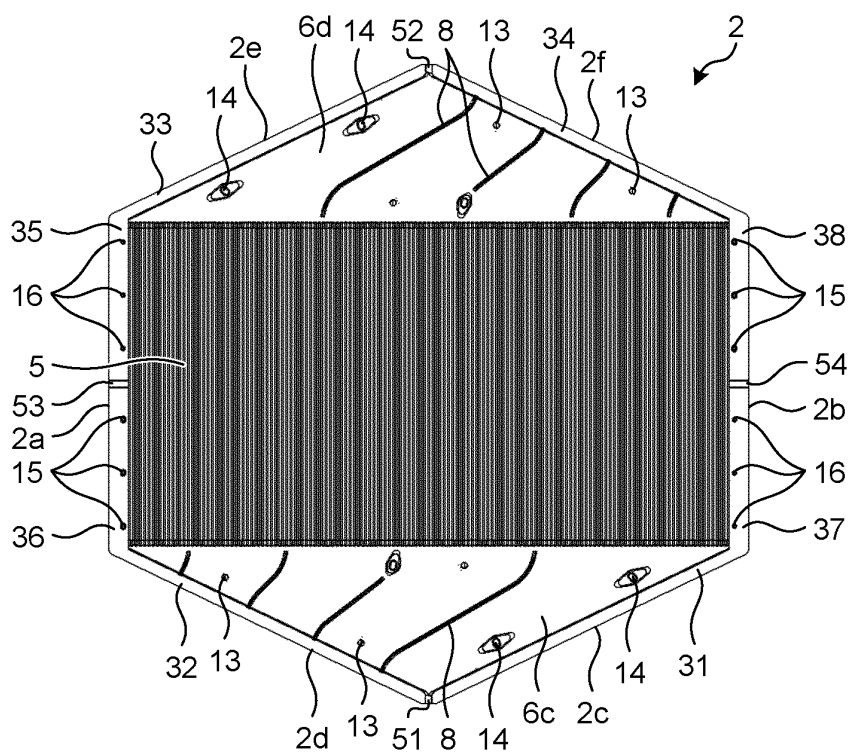


FIG.6

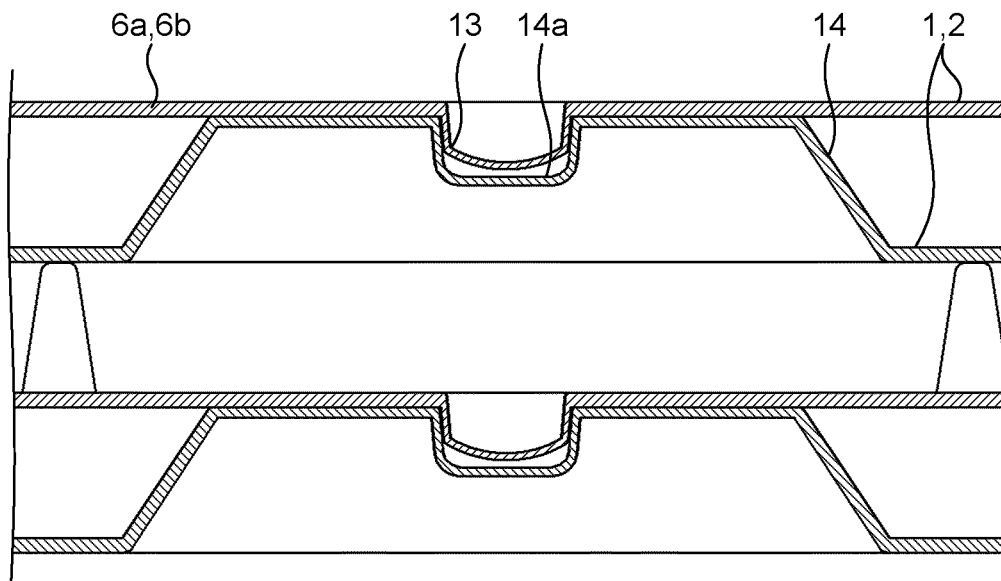


FIG.7

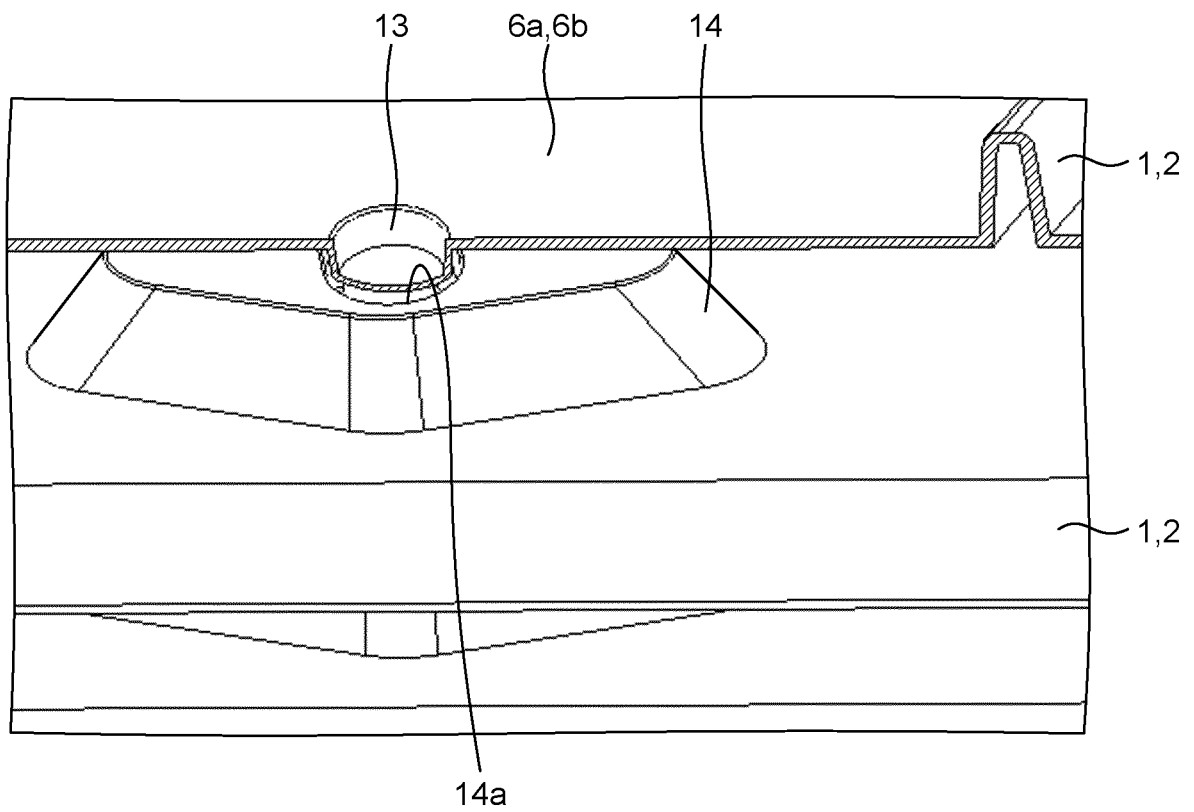


FIG.8

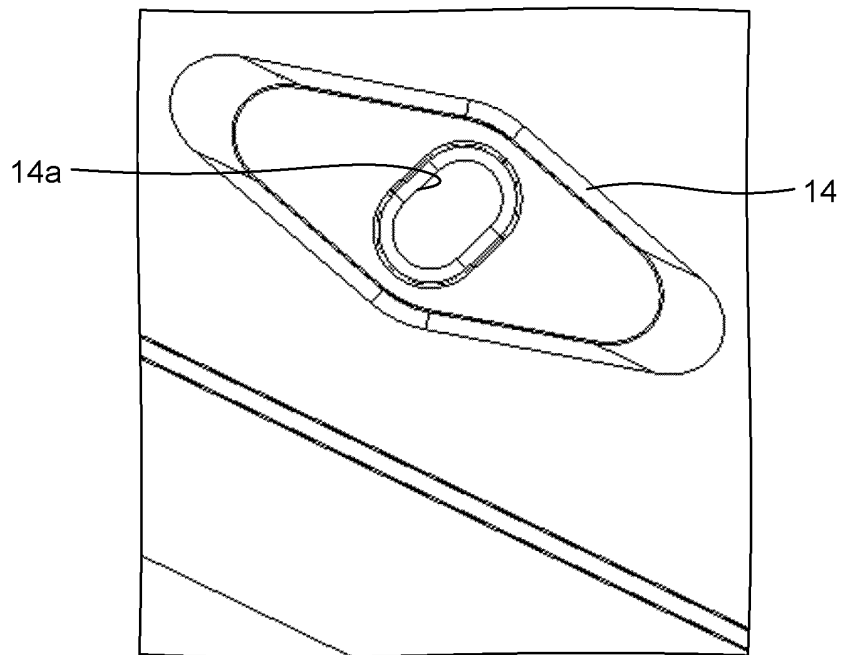


FIG.9

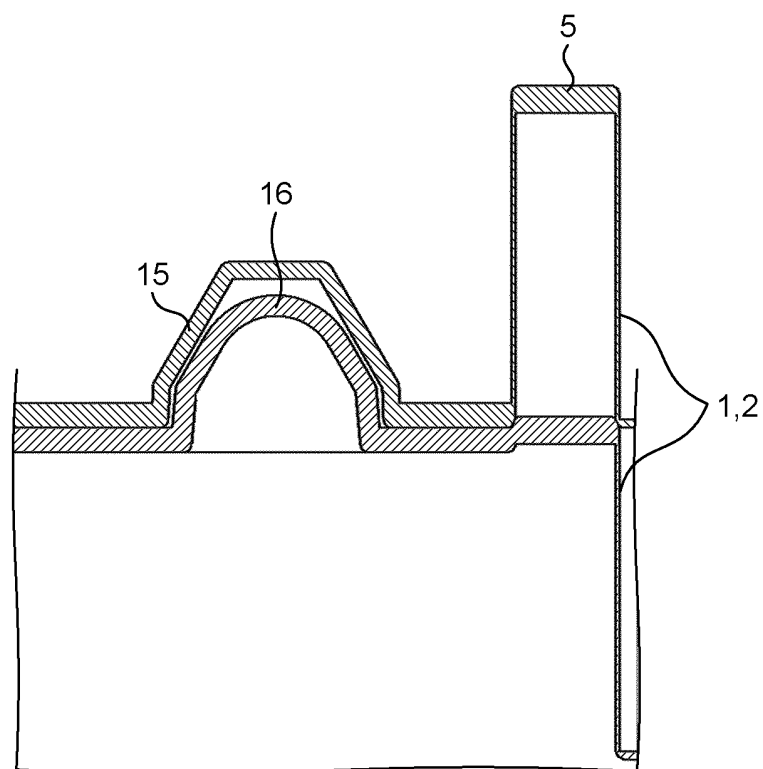


FIG.10

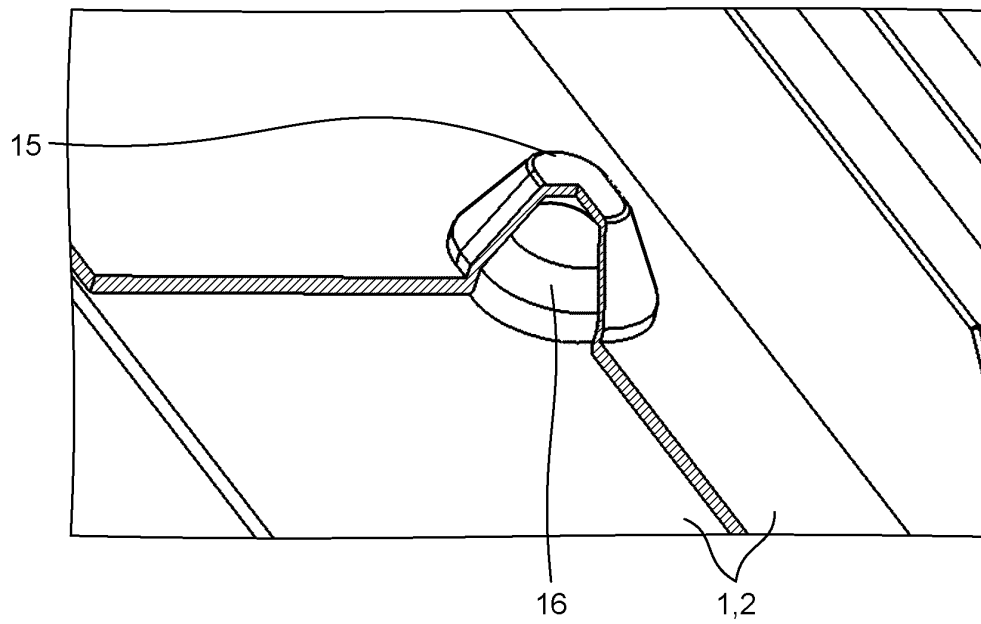


FIG.11

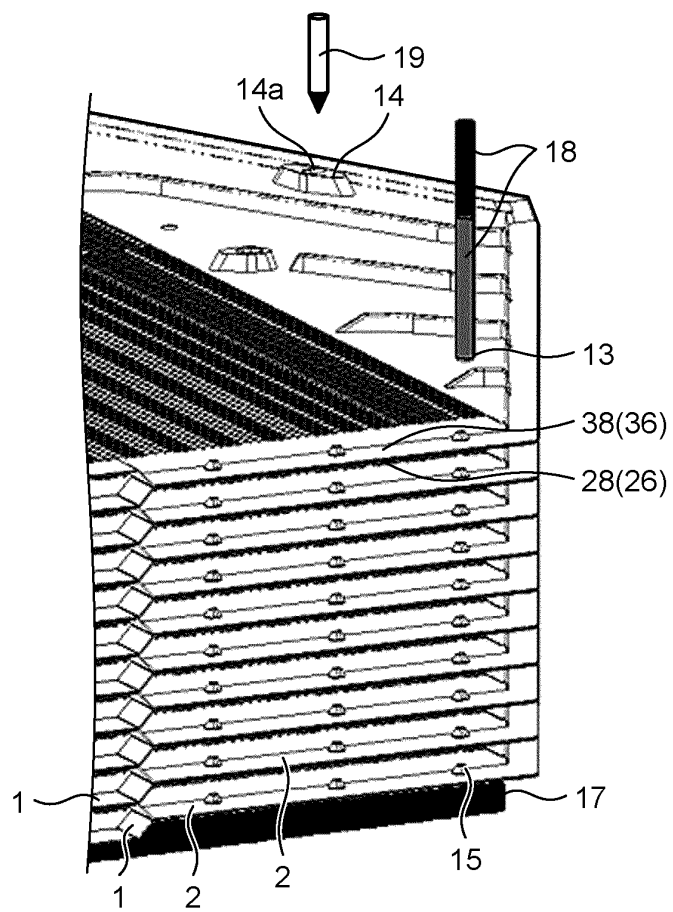


FIG.12

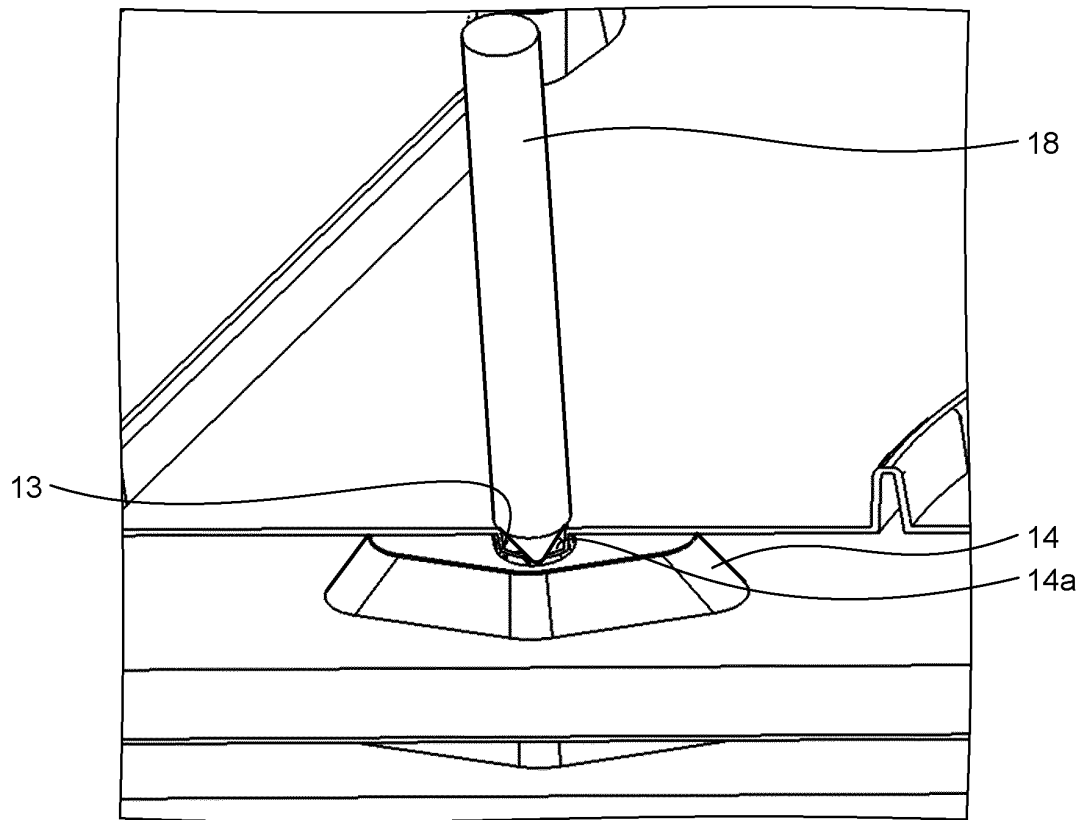


FIG.13

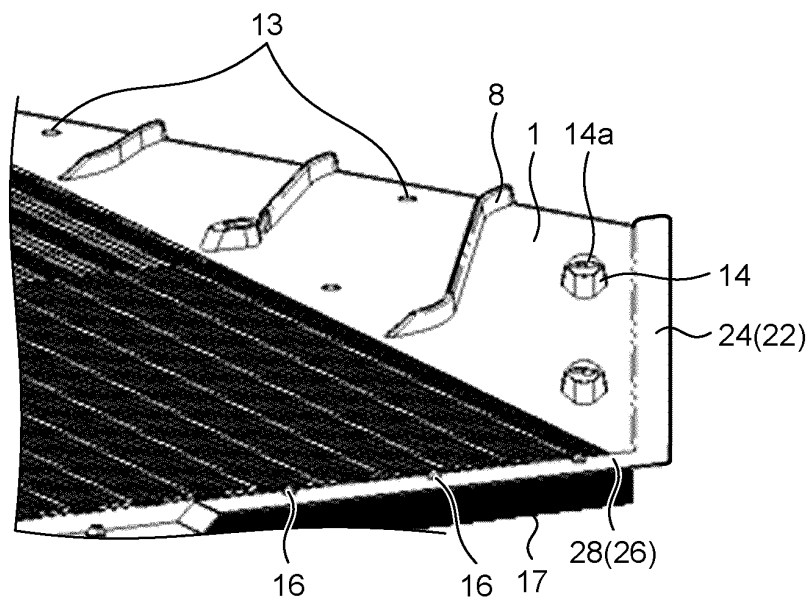


FIG.14

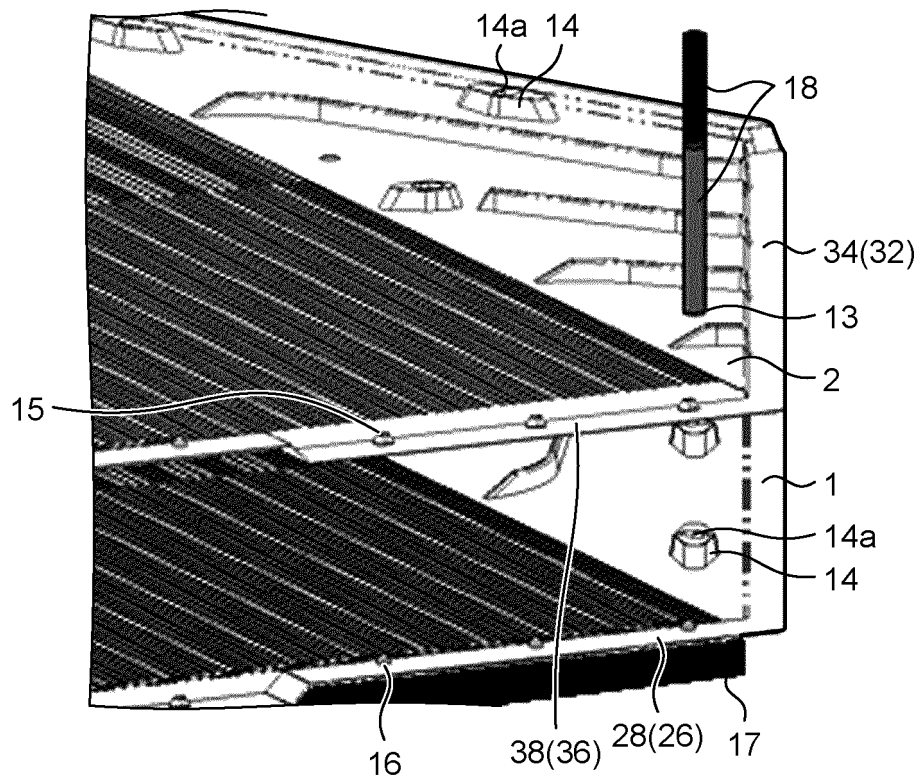


FIG.15

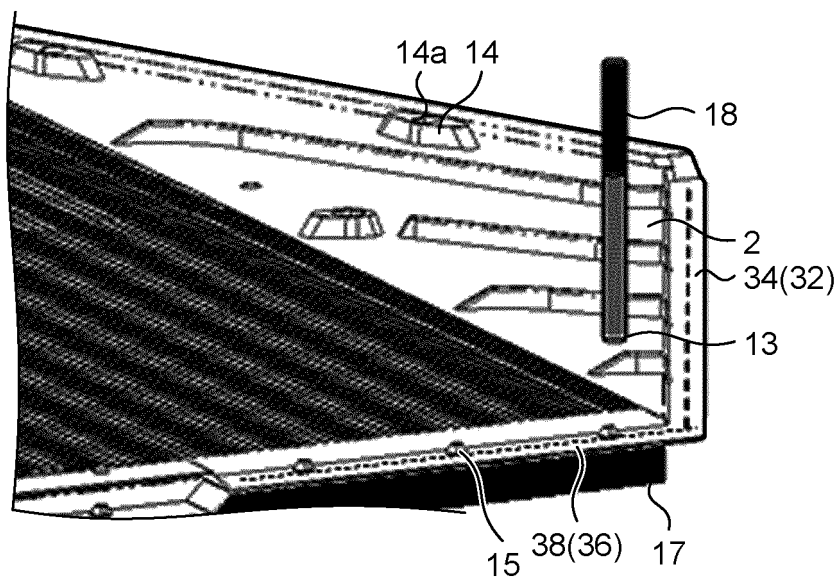
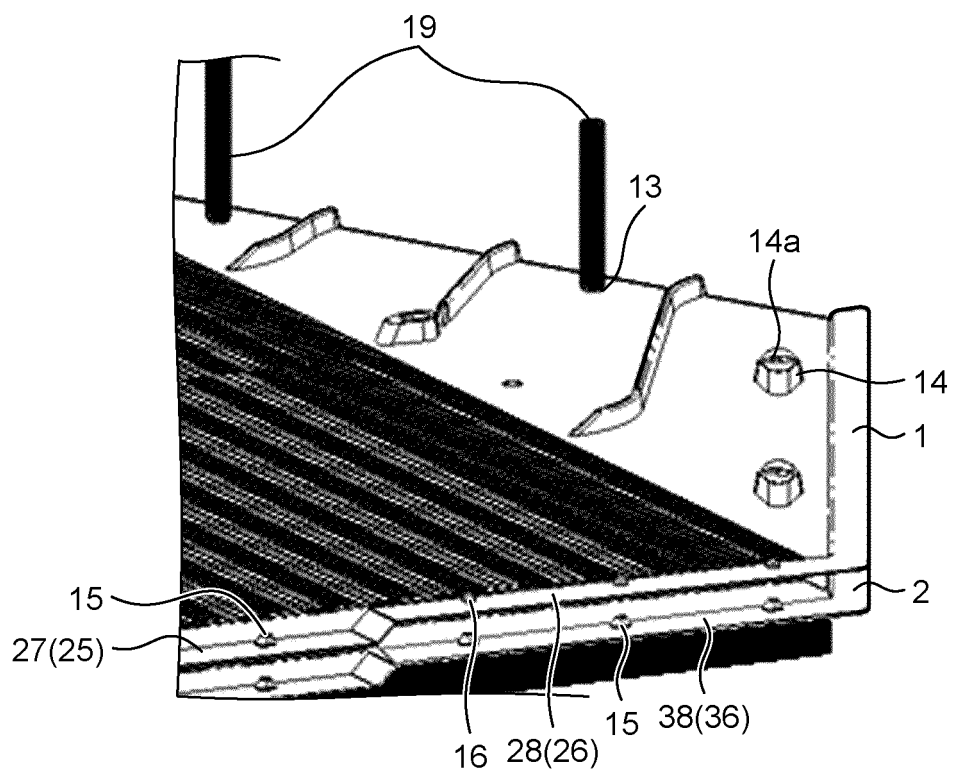


FIG.16



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2021/026095

A. CLASSIFICATION OF SUBJECT MATTER

F28F 3/08(2006.01)i

FI: F28F3/08 301Z

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)

F28F3/08

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2021

Registered utility model specifications of Japan 1996-2021

Published registered utility model applications of Japan 1994-2021

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 2004-293862 A (MATSUSHITA ELECTRIC IND CO LTD) 21 October 2004 (2004-10-21) paragraphs [0077]- [0094], fig. 1-3	1-7
A	JP 2004-3824 A (MATSUSHITA ECOLOGY SYS CO) 08 January 2004 (2004-01-08) paragraphs [0074]-[0083], fig. 1-3	1-7
A	JP 2008-107071 A (MATSUSHITA ELECTRIC IND CO LTD) 08 May 2008 (2008-05-08) paragraph [0083]	1-7
A	JP 2007-285691 A (MATSUSHITA ELECTRIC IND CO LTD) 01 November 2007 (2007-11-01) fig. 1-2	1-7



Further documents are listed in the continuation of Box C.



See patent family annex.

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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
06 August 2021 (06.08.2021)Date of mailing of the international search report
24 August 2021 (24.08.2021)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application no.

PCT/JP2021/026095

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JP 2004-293862 A	21 Oct. 2004	(Family: none)	
JP 2004-3824 A	08 Jan. 2004	(Family: none)	
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REFERENCES CITED IN THE DESCRIPTION

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- JP 2004293862 A [0003]