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(54) PLATE-TYPE HEAT EXCHANGER

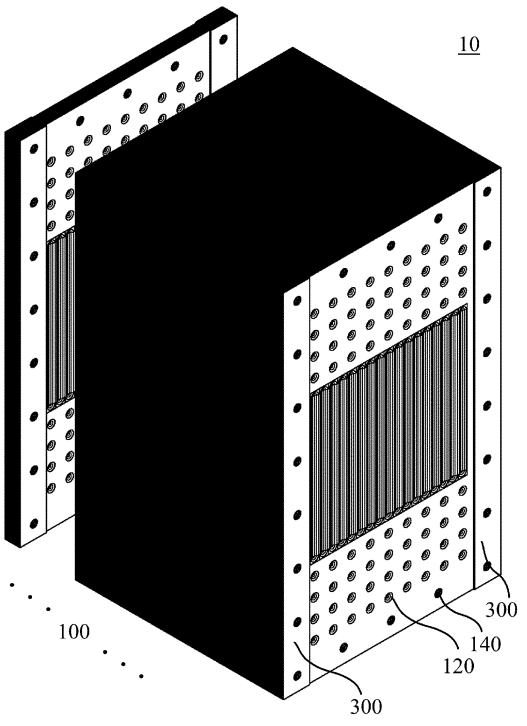
(57) [Object]

To provide a plate type heat exchanger which can maintain high heat transfer efficiency, can be cleaned easily and can be made compact in configuration by making an inlet and an outlet for at least one fluid large while allowing a heat transfer surface to maintain a large area.

[Solving means]

A plate type heat exchanger 10 includes: a large number of plates 100 formed by arranging plates each having concave and convex portions 120, 130 parallel to each other; and a large number of spacers 200, 300 sandwiched between the large number of plates 100, wherein the spacers 200, 300 include: the first spacers 200 where the first spacers 200 which are disposed on edges of a plate surface of the plate with a predetermined distance therebetween form a first flow passage in cooperation with the plate surface; and the second spacers 300 where the second spacers 300 which are disposed on edges of a plate surface of the plate with a predetermined distance therebetween form a second flow passage having an inlet and an outlet which differ in direction from the first flow passage in cooperation with the plate surface, and the first spacers 200 and the second spacers 300 are alternately arranged between the large number of plates 100.

[Fig.2]



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Description

Technical Field

[0001] The present invention relates to a plate type heat exchanger which performs heat exchange between fluids.

Background Art

[0002] As heat exchangers which perform heat exchange between fluids, there have been known a tube type heat exchanger and a plate type heat exchanger, and these heat exchangers are applicable to many fluids. The tube type heat exchanger is of a type where heat exchange is performed between fluids which flow inside and outside tubes. In the tube type heat exchanger, a high pressure fluid is made to flow in the inside of the tubes and a low pressure fluid is made to flow outside the tubes and hence, the fluid can be used in the form of the high pressure fluid. However, a heat transfer area is limited to surfaces of the tubes and hence, the number of tubes is large whereby a volume and a weight of the tube type heat exchanger become large.

[0003] On the other hand, the plate type heat exchanger is of a type where heat exchange is performed by making fluids flow along both surfaces of a planar plate respectively. Although the plate type heat exchanger can be made light-weighted and compact, the plate type heat exchanger possesses a limited resistance against pressure and hence, the development of a large-sized heat exchanger is difficult. Further, an inlet and an outlet of the plate type heat exchanger are formed on a stacked plate surface (heat transfer surface) in general. Accordingly, when areas for forming the inlet and the outlet are increased, a heat transfer area is decreased so that there exists a drawback that heat exchange ability is lowered.

[0004] Further, in the conventional plate heat exchanger, a pressure of fluid which acts on the plate surface is received by support plates on both sides so that there exists a drawback that it is inevitably necessary to increase a thickness of the support plate as an area of the plate is increased.

[0005] Still further, a fluid on a heating side or a cooling side is taken into this heat exchange system from the outside of the system and hence, there is a possibility that the fluid contains various kinds of contaminants. Such contaminants adhere to a heat transfer surface and becomes a factor which causes lowering of heat transfer performance. Accordingly, there has been a request for a structure where a heat transfer surface can be cleaned.

Citation List

Patent Literature

[0006]

PTL 1: Japanese Patent 3445387
PTL 2: JP-A-2015-49037

Summary of Invention

Technical Problem

[0007] The present invention has been made in view of the above-mentioned drawbacks, and it is an object of the present invention to provide a plate type heat exchanger which can maintain high heat transfer efficiency, can be cleaned easily and can be made compact in configuration by making an inlet and an outlet for at least one fluid large while allowing a heat transfer surface to maintain a large area.

Solution to Problem

[0008] To overcome the above-mentioned drawbacks, the inventors of the present invention have made extensive studies to develop a heat exchanger which allows a heat transfer surface to maintain a large area, enables an inlet and an outlet for at least one fluid to have a large area, enables open cleaning of at least one heat transfer surface, and can be manufactured by press working for realizing the reduction of a manufacturing cost. As a result of such extensive studies, the inventors have found that the above-mentioned drawbacks can be overcome by arranging different spacers alternately between a large number of press-formed plates on which concave and convex portions are formed by press working thus forming inlets and outlets and flow passages for fluids in two directions, and the inventors have completed the present invention.

[0009] That is, the present invention provides [1] a plate type heat exchanger which includes: a large number of plates formed by arranging plates each having concave and convex portions parallel to each other; and a large number of spacers sandwiched between the large number of plates, wherein the spacers include: first spacers where the first spacers which are disposed on edges of a plate surface of the plate with a predetermined distance therebetween form a first flow passage in cooperation with the plate surface; and second spacers where the second spacers which are disposed on edges of a plate surface of the plate with a predetermined distance therebetween form a second flow passage having an inlet and an outlet which differ in direction from an inlet and an outlet of the first flow passage in cooperation with the plate surface, and the first spacers and the second spacers are alternately arranged between the large number of plates.

[2] The present invention is also characterized in that, in the plate type heat exchanger having the configuration described in [1], the inlet and the outlet of the second flow passage are arranged orthogonal to an inlet and an outlet of the first flow passage.

[3] The present invention is also characterized in that, in the plate type heat exchanger having the configuration described in [2], the first spacer is formed of a pair of L-shaped spacers arranged at corners of the plate surface in an opposedly facing manner and the second spacer is formed of a pair of straight-line spacers arranged in an extending manner on both edges of the plate surface parallel to each other.

[4] The present invention is also characterized in that, in the plate type heat exchanger having the configuration described in any one of [1] to [3], the plate is a press-formed plate on which the concave and convex portions are formed by press working.

[5] The present invention is also characterized in that, in the plate type heat exchanger having the configuration described in any one of [1] to [4], the concave and convex portions formed on the plate are formed of: cylindrical concave and convex portions formed on a center portion of the plate; and dotted concave and convex portions formed on the plate on both sides of the center portion in an axial direction of the cylindrical concave and convex portions.

[6] The present invention is also characterized in that, in the plate type heat exchanger having the configuration described in any one of [1] to [5], the convex portions formed on one plate and a flat surface portion of another plate disposed adjacently to the plate on which the convex portions are formed are joined to each other.

[7] The present invention is also characterized in that, in the plate type heat exchanger having the configuration described in any one of [1] to [6], a large number of integral type heat transfer plates are arranged parallel to each other, wherein the integral type heat transfer plate is formed such that the first spacers or the second spacers are sandwiched between two plates, two plates are formed into an integral body by joining the convex portions formed on one plate and the flat surface portion of the other plate to each other, and the second spacers or the first spacers are disposed on both outer side surfaces of the two plates.

[8] The present invention is also characterized in that, in the plate type heat exchanger having the configuration described in [7], a large number of integral type heat transfer plates are arranged parallel to each other, wherein the integral type heat transfer plate is formed such that L-shape spacers are sandwiched between two plates, and straight-line spacers are formed on both outer side surfaces of the two plates.

[9] The present invention is also characterized in that, in the plate type heat exchanger having the configuration described in any one of [1] to [8], a liquid pool is disposed below the plates.

[0010] The present invention also provides [10] an integral type heat transfer plate which is the heat transfer plate used in the plate type heat exchanger described in any one of [1] to [9], wherein the integral type heat transfer plate is formed such that the first spacers or the second spacers are sandwiched between two plates, two plates are formed into an integral body by joining the convex portions formed on one plate and the flat surface portion of the other plate to each other, and the second spacers or the first spacers are disposed on both outer side surfaces of the two plates.

[11] The present invention is also characterized in that, in the integral type heat transfer having the configuration described in [10], L-shaped spacers are sandwiched between two plates, and straight-line spacers are disposed on both outer side surfaces of the two plates.

Advantageous Effects of Invention

[0011] According to the plate type heat exchanger of the present invention, the inlet and the outlet for at least one of fluids can be made large while allowing a heat transfer surface to maintain a large area and hence, a high heat transfer efficiency can be maintained. Further, the plate surface can be cleaned easily, and the plate type heat exchanger can be also formed in a compact shape.

Brief Description of Drawings

[0012]

Fig. 1 is a perspective view showing the schematic configuration of a plate type heat exchanger according to one embodiment of the present invention.

Fig. 2 is a perspective view showing a state where 200 pieces of press-formed plates of the plate type heat exchanger according to one embodiment of the present invention are combined with each other.

Fig. 3 is a view showing the schematic configuration of the press-formed plate.

Fig. 4 is a view showing a state where L-shaped spacers are disposed on one heat transfer surface of the press-formed plate.

Fig. 5 is a view showing a state where another plate is combined in front of the press-formed plate shown in Fig. 4.

Fig. 6 is a perspective view showing the schematic configuration of a plate type heat exchanger according to another embodiment of the present invention.

Description of Embodiments

[0013] A plate type heat exchanger according to the present invention is not particularly limited provided that the plate type heat exchanger is a plate type heat exchanger which includes: a large number of plates formed by arranging plates each having concave and convex portions parallel to each other; and a large number of spacers sandwiched between the large number of plates,

wherein the spacers include: first spacers where the first spacers which are disposed on edges of a plate surface of the plate with a predetermined distance therebetween form a first flow passage in cooperation with the plate surface; and second spacers where the second spacers which are disposed on edges of a plate surface of the plate with a predetermined distance therebetween form a second flow passage having an inlet and an outlet which differ in direction from the first flow passage in cooperation with the plate surface, and the first spacers and the second spacers are alternately arranged between the large number of plates. The plate type heat exchanger according to the present invention exhibits various functions corresponding to fluids to be used. For example, the plate type heat exchanger according to the present invention can be preferably used as an evaporator for water, a condenser for water or a heat exchanger between a high temperature gas and air.

[0014] Hereinafter, respective constitutional elements of the plate type heat exchanger are specifically described.

[Plate]

[0015] The plate according to the present invention is formed of a material having high heat transfer property. One surface of the plate forms a first heat transfer surface with which a first fluid is brought into contact, and the other surface of the plate forms a second heat transfer surface with which a second fluid is brought into contact. Concave and convex portions are formed on the heat transfer surfaces for allowing the plate to secure heat transfer efficiency.

[0016] As the shape of the plate, a plate-like member having a quadrangular shape such as a square shape or a rectangular shape may be exemplified. When the plate is a rectangular plate, usually, the plates are arranged parallel to each other in a horizontal direction while erecting long sides of each plate in a vertical direction. However, the plates may be arranged such that the plates are stacked in a horizontal direction.

[0017] The number of pieces of plates which are arranged parallel to each other can be suitably adjusted to an extent that a heat transfer area can be sufficiently ensured depending on use, application or the like. In the present invention, a large number of plates can be arranged. For example, the number of pieces of plates may be set to 200 or more. Further, the number of pieces of plates may be set to 1000 or more. As a method of arranging the plates parallel to each other, usually, the plates are arranged such that convex portions (or concave portions) of the plates are directed in the same direction. However, the plates may be arranged such that the convex portions (or the concave portions) are directed in different directions.

[0018] It is preferable that the concave and convex portions formed on the plate according to the present invention be formed by press working. With such forming by press working, the plate having the concave and convex portions can be manufactured at a low cost.

[0019] The concave and convex portions formed on the plate according to the present invention may be formed on at least a portion of each plate, and may preferably be formed over the entire surface of a heat transfer surface of each plate. Although the concave and convex portions may be formed in any shapes, for example, dotted concave and convex portions or cylindrical concave and convex portions can be named. The dotted concave and convex portions can be arranged in a matrix, for example. As a specific shape of the dotted concave and convex portions, shapes such as a cubic, rectangular parallelepiped or semispherical shape can be named.

[0020] Cylindrical concave and convex portions can be formed on the plate in place of the dotted concave and convex portions. In this case, it is preferable that the cylindrical concave and convex portions be formed on a center portion of the plate, and the dotted concave and convex portions be formed on the plate on both sides of the center portion in an axial direction of the cylindrical concave and convex portions. With such a configuration, a fluid which passes through the flow passage can be effectively guided and, at the same time, a contact area between the fluid and the plate can be enlarged so that a heat transfer effect can be enhanced. With respect to the cylindrical concave and convex portions, to ensure the smooth flow of a fluid, it is preferable to adjust a length of the cylindrical concave and convex portions at the center portion so as to prevent the cylindrical concave and convex portions from being present in the inlet and the outlet for a fluid formed by the L-shaped spacers (see Fig. 4). That is, the dotted concave and convex portions are formed in the vicinity of the inlet and the outlet for a fluid, and the cylindrical concave and convex portions are formed at an intermediate portion.

[0021] It is preferable that the plates according to the present invention be configured such that the dotted convex portions formed on the plate rotated by 180° (upside down) be brought into contact with a flat surface portion of the non-rotated plate disposed adjacently to the rotated plate. That is, for example, when the dotted convex portions are formed on the plate in a matrix array, it is preferable that the dotted convex portions formed on the rotated plate be displaced from the dotted convex portions formed on the non-rotated plate by a half pitch by rotating the rotated plate by 180°. It is preferable that the dotted convex portions and the flat surface portion be joined to each other by spot welding or the like. With such a configuration, it is possible to provide the strong rigid structure which can sufficiently withstand a pressure of a high-pressure fluid which flows through the flow passages in the inside of the plate type heat exchanger. Accordingly, although a conventional plate type heat exchanger requires support plates having a large thickness which support the plate from both sides, in the present invention, a thickness of the support plate can be reduced so that the plate type heat exchanger per se can be made

light-weighted and compact. As will be described later, it is preferable that the integral heat transfer plates each of which is formed by joining two plates by spot welding or the like be arranged parallel to each other.

[0022] Bolt through holes are formed in a periphery of each plate. A large number of plates are fixed to each other into an integral body by mounting assembling bolts in the bolt through holes. By bringing about a state where the assembling bolt is mounted in only one of four corners of the respective plates, the respective plates are rotatable about the assembling bolt which functions as a rotary axis and hence, the heat transfer surface can be easily exposed to the outside whereby the heat transfer surfaces of the plate type heat exchanger can be easily cleaned. That is, a fluid which functions as a heat source of a heat exchanger, for example, geothermal hot water, hot spring water, a biomass burnt gas, a garbage burnt gas or the like contains contaminants. Such contaminants adhere to a surface of the heat transfer plate and become a factor which impairs the heat transfer. With the above-mentioned configuration, it is possible to periodically wash away such an adhered material. Also with respect to the integral type heat transfer plate formed of two plates, the surfaces of the plates which are not joined are in an exposed state so that these surfaces can be easily cleaned.

[Spacer]

[0023] The spacers include: first spacers where the first spacers which are disposed on edges of a plate surface of the plate with a predetermined distance therebetween form a first flow passage in cooperation with the plate surface; and second spacers where the second spacers which are disposed on edges of a plate surface of the plate with a predetermined distance therebetween form a second flow passage having an inlet and an outlet which differ in direction from the first flow passage in cooperation with the plate surface, and the first spacers and the second spacers are alternately arranged between the large number of plates.

[0024] As the first spacers and the second spacers, for example, a pair of L-shaped spacers arranged in an opposedly facing manner at corners of the plate surface and a pair of straight-line spacers arranged in an extending manner on both edges of the plate surface parallel to each other are named. That is, a thin space is formed by the opposedly facing surfaces of the plates and the opposedly facing inner side surfaces of the spacers and, at the same time, portions (two portions) where the spacers are not present form the inlet and the outlet thus forming a flow passage.

[0025] In the plate type heat exchanger according to the present invention, the first flow passage having the inlet and the outlet and the second flow passage having the inlet and the outlet whose directions are different from the directions of the inlet and the outlet of the first flow passage are formed by alternately arranging one kind or two kinds of spacers. It is preferable that the inlet and the outlet of the first flow passage be orthogonal to the inlet and the outlet of the second flow passage. To be more specific, it is preferable that the first spacer be formed of a pair of L-shaped spacers arranged in an opposedly facing manner at corners of the plate surface, and the second spacers be formed of a pair of straight-line spacers arranged in an extending manner on both edges of the plate surface parallel to each other.

[0026] For example, by forming the first L-shaped spacers on the corners of the plate surface (see Fig. 4), the inlet and the outlet (511, 521) are formed in the lateral direction and, at the same time, the first flow passage having a zigzag shape is formed on the plate. A first fluid (for example, compressed air having a low temperature) flows through the first flow passage. Heat energy of a second fluid having a high temperature which flows through the second flow passage disposed adjacently to the first flow passage is propagated to a heat transfer surface which forms the first flow passage. Accordingly, when the first fluid having a temperature of approximately 30°C, for example, flows into the first flow passage from an inlet duct, the first fluid passes through the first flow passage, and is discharged from an outlet duct in a state where the first fluid is heated to approximately 500°C.

[0027] By forming the second straight-line spacers on the edges of the plate surface in a vertical direction (up and down direction) (see Fig. 2), the inlet and the outlet are formed in the longitudinal direction and, at the same time, the second flow passage is formed in the vertical direction of the plate. Heat energy of a second fluid (for example, a high temperature gas) which flows through the second flow passage is propagated to the first flow passage through the heat transfer surface. Accordingly, when the second fluid having a temperature of approximately 800°C, for example, flows into the second flow passage from the inlet duct, the second fluid passes through the second flow passage, and is discharged from the outlet duct in a state where the second fluid is cooled to approximately 500°C.

[0028] Opening areas of the inlets and the outlets of the first and second flow passages can be decided by suitably adjusting thicknesses of the spacers and the numbers of the plates. Particularly, the inlet and the outlet on a side where the straight line spacers are formed can be made large in size.

[0029] It is preferable that the spacers be respectively formed of a material having gas tightness to an extent that leakage of a fluid is prevented, a proper strength necessary for forming a casing of the plate type heat exchanger in cooperation with the plates, and heat insulation property to an extent that heat is not discharged to the outside of the heat exchanger.

[Integral type heat transfer plate]

[0030] It is preferable that the large number of plates (a group of plates) according to the present invention be configured such that a large number of integral type heat

transfer plates are arranged parallel to each other, wherein the integral type heat transfer plate is formed such that the first spacers or the second spacers are sandwiched between two plates, two plates are formed into an integral body by joining the convex portions formed on one plate and the flat surface portion of the other plate to each other, and the second spacers or the first spacers are disposed on both outer side surfaces of the two plates. Particularly, it is preferable that a large number of integral type heat transfer plates be arranged parallel to each other, wherein the integral type heat transfer plate be formed such that L-shape spacers are sandwiched between two plates, and straight-line spacers are formed on both outer side surfaces of the two plates. With such configurations, a high pressure fluid is allowed to flow through the flow passage formed between the joined plate surfaces, and the surfaces which are not joined can be brought into an exposed state so that these surfaces can be easily cleaned.

[Liquid pool]

[0031] It is preferable that in the plate type heat exchanger according to the present invention, a liquid pool be disposed below the plates. With such a configuration, an amount of liquid generated in the plate portion can be reduced so that the reduction of an area which functions as a heat transfer surface is prevented whereby lowering of a heat transfer effect can be prevented.

[0032] For example, in a heat exchanger where evaporation and condensing take place, in the case of water, a change in volume between liquid and vapor is increased approximately 1000 times . When such a change in volume occurs, it is necessary for a flow passage to secure a sufficient cross-sectional area. However, a cross-sectional area of a plate heat exchanger is fixed and hence, the cross-sectional area is usually designed with reference to vapor having a large volume. To consider the case of a condenser, vapor which enters the condenser from above is gradually condensed so that the vapor is transformed into liquid. When the liquid is pooled in a lower portion of the condenser so that a liquid surface is elevated, a heat transfer area used for condensing is decreased so that condensing ability is lowered. Accordingly, by forming a liquid pool below the plate, it is possible to prevent the decrease of a heat transfer surface caused by the elevation of the liquid surface.

[0033] In the evaporator, a liquid is elevated from below and a temperature boundary layer develops along heat transfer surfaces on both sides. It is estimated that evaporation progresses along with the elevation of the liquid. A height at which the liquid surface rises with respect to a height of the heat transfer surface of the heat exchanger in this evaporation step is basic information for estimating a heat transfer state and hence, it is often the case where the height is measured. In case of the evaporator, a latent heat ratio is approximately 10 to 20% and hence, it is necessary to perform a control such that approximately 20 to 30% of a heat transfer area is brought into contact with a liquid. By providing the liquid pool below the plate, the water level can be maintained. Accordingly, a pressure and a flow rate of the fluid can be controlled in accordance with a rotational speed of a water supply pump and the degree of opening of a flow rate control valve.

[0034] As has been described above, the plate type heat exchanger according to the present invention has the structure which enables the plate type heat exchanger to maintain high heat transfer efficiency, to be cleaned easily and to be made compact in configuration by making an inlet and an outlet for at least one fluid large while allowing a heat transfer surface to maintain a large area.

[0035] That is, with the structure where the inlet and the outlet are formed on the side surfaces of the plate by the spacers of the present invention, areas of the inlet and the outlet for at least one fluid can be increased without decreasing a heat transfer area. For example, in the case of condensing water, an area of the inlet for vapor can be increased and hence, a flow speed of vapor having a large volume before condensing can be suppressed so that a pressure loss can be suppressed. Areas of the inlet and the outlet can be increased along with the increase of the number of plates and hence, unlike a conventional plate type heat exchanger, there is no limit in the number of plates to be used so that a volume of the heat exchanger can be easily increased. Accordingly, it is possible to provide a plate type heat exchanger having high general-purpose-use property. Particularly, the flow passages are formed by combining the first and second spacers having different shapes and hence, the flow passages can be easily changed corresponding to a usage or an application.

[0036] Hereinafter, a specific embodiment of the above-mentioned plate type heat exchanger is described with reference to drawings. Fig. 1 is a perspective view showing the schematic configuration of a plate type heat exchanger according to one embodiment of the present invention. Fig. 2 is a perspective view showing a state where 200 pieces of press-formed plates of the plate type heat exchanger according to one embodiment of the present invention are combined with each other. Fig. 3 is a view showing the schematic configuration of the press-formed plate. Fig. 4 is a view showing a state where L-shaped spacers are disposed on one heat transfer surface of the press-formed plate. Fig. 5 is a view showing a state where another plate is combined in front of the press-formed plate shown in Fig. 4.

[0037] As shown in Fig. 1 and Fig. 2, the plate type heat exchanger 10 according to this embodiment (hereinafter simply referred to as "heat exchanger") is formed by arranging a large number of press-formed plates 100 formed by press working parallel to each other (see Fig. 2). As shown in Fig. 3, bolt through holes 140 are formed in an outer peripheral portion of the press-formed plate 100. As shown in Fig. 1, assembling bolts 400 for fixing the large number of press-formed plates 100 arranged parallel to each other are made to pass through these

bolt through holes 140. For example, a large number of, for example, approximately 200 pieces of press-formed plates are fixed to each other in a parallelly arranged state. A side plate 600 is disposed on both sides of the assembled press-formed plates 100 respectively.

[0038] Between the press-formed plates, L-shaped spacers (first spacers) 200 (see Fig. 4) and straight-line spacers (second spacers) 300 (see Fig. 2) are alternately sandwiched. As shown in Fig. 1, an inlet duct 510 and an outlet duct 520 of a first flow passage formed by plate surfaces and the L-shaped spacers 200 are disposed on upper and lower portions of side surface portions of the heat exchanger 10 respectively, and an inlet duct 530 and an outlet duct 540 of a second flow passage formed by plate surfaces and the straight-line spacers 300 are disposed on upper and lower portions of the heat exchanger 10 respectively. Opening areas of these inlets and outlets 510,520,530,540 are decided in accordance with the number of plates 100.

[0039] As shown in Fig. 3 and Fig. 4, the press-formed plate 100 is a rectangular planar plate having a longitudinal size of approximately 2 m and a lateral size of approximately 1 m, for example. A plurality of semispherical concave and convex portions 120 having a diameter of approximately 5 cm are formed and arranged on both upper and lower sides of the planar plate in a matrix array. Cylindrical concave and convex portions 130 having a length of approximately 75 cm are formed on a center portion of the press-formed plate 100 such that the cylindrical concave and convex portions 130 are prevented from being present at the inlet 511 and the outlet 521 of the first flow passage.

[0040] Although these press-formed plates 100 are arranged such that the semispherical convex portions are directed in one direction, the press-formed plates 100 are arranged in such a manner that every other press-formed plate 100 is rotated upside down by 180°. That is, as shown in Fig 3, a larger space is formed on a left side than on a right side in the drawing so that when the press-formed plates 100 are combined with each other while rotating one press-formed plate 100 from another press-formed plate 100 by 180°, the semispherical convex portions and flat surface portions disposed between the semispherical convex portions are brought into contact with each other. By joining the convex portions and the flat surface portions to each other, an integral heat transfer plate formed of two press-formed plates 100 is formed. As shown in Fig. 4 and Fig. 5, in this integral heat transfer plate, the L-shaped spacers 200 are sandwiched between two plates, and the straight-line spacers 300 are disposed on both outer side surfaces of the two plates. Accordingly, such an integral heat transfer plate forms an integral type heat transfer plate. A large number of this integral type heat transfer plates are arranged parallel to each other.

[0041] As shown in Fig. 4, the L-shaped spacer 200 is arranged on a left upper corner and a right lower corner of a heat transfer surface of the press-formed plate 100 respectively. On the other hand, as shown in Fig. 2, the straight-line spacer 300 is arranged on both edges of the heat transfer surface of the plate 100 in an erected state respectively in a state where the straight-line spacers 300 extend in a vertical direction. The L-shaped spacers 200 and the straight-line spacers 300 are arranged alternately between the press-formed plates 100.

[0042] In the plate type heat exchanger 10 having the above-mentioned configuration, for example, compressed air having a temperature of approximately 30°C flows into the plate type heat exchanger 10 from the first inlet duct 510 as a first fluid. Compressed air passes through the first flow passage and is discharged from the first outlet duct 520. On the other hand, a high temperature gas having a temperature of approximately 750°C flows into the plate type heat exchanger 10 from the second inlet duct 520 as a second fluid. The high temperature gas rises through the second flow passage and is discharged from the second outlet duct 540. With such a process, a heat exchange is performed in the plate type heat exchanger 10 so that a high temperature gas having a temperature of 750°C is cooled down to 500°C and, at the same time, compressed air having a temperature of 30°C is heated to 500°C.

[0043] Next, a plate type heat exchanger according to another embodiment of the present invention is described (see Fig. 6) . The plate type heat exchanger according to this embodiment is characterized in that flanges 550 to 580 for mounting the plate type heat exchanger to an outside equipment are provided to inlet and outlet ducts 510 to 540 for fluids. The plate type heat exchanger according to this embodiment is substantially equal to the plate type heat exchanger according to the above-mentioned one embodiment with respect to the configurations other than the above-mentioned configuration.

Industrial Applicability

[0044] The plate type heat exchanger according to the present invention is usefully employed by an evaporator, a condenser or the like of a water binary cycle power generation system so that the plate type heat exchanger has high industrial usefulness.

Reference Signs List

[0045]

10:	plate type heat exchanger
10A:	plate type heat exchanger
100:	press-formed plate
105:	first heat transfer surface
110:	second heat transfer surface
120:	semispherical concave portion
130:	circular cylindrical concave and convex portions
140:	bolt through hole
200:	L-shaped spacer (first spacer)
300:	straight-line spacer (second spacer)

400: assembling bolt
510: inlet duct of first flow passage
511: inlet of first flow passage
520: outlet duct of first flow passage
521: outlet of first flow passage
530: inlet duct of second flow passage
540: outlet duct of second flow passage
550: inlet flange
560: outlet flange
570: inlet flange
580: outlet flange
600: side plate (support plate)

Claims

1. A plate type heat exchanger comprising:

a large number of plates formed by arranging plates each having concave and convex portions parallel to each other; and
a large number of spacers sandwiched between the large number of plates, wherein
the spacers include: first spacers where the first spacers which are disposed on edges of a plate surface of the plate with a predetermined distance therebetween form a first flow passage in cooperation with the plate surface; and second spacers where the second spacers which are disposed on edges of a plate surface of the plate with a predetermined distance therebetween form a second flow passage having an inlet and an outlet which differ in direction from an inlet and an outlet of the first flow passage in cooperation with the plate surface, and
the first spacers and the second spacers are alternately arranged between the large number of plates.

2. The plate type heat exchanger according to claim 1, wherein the inlet and the outlet of the second flow passage are arranged orthogonal to an inlet and an outlet of the first flow passage.

3. The plate type heat exchanger according to claim 2, wherein the first spacer is formed of a pair of L-shaped spacers arranged at corners of the plate surface in an opposedly facing manner and the second spacer is formed of a pair of straight-line spacers arranged in an extending manner on both edges of the plate surface parallel to each other.

4. The plate type heat exchanger according to any one of claims 1 to 3, wherein the plate is a press-formed plate on which the concave and convex portions are formed by press working.

5. The plate type heat exchanger according to any one of claims 1 to 4, wherein the concave and convex portions formed on the plate are formed of: cylindrical concave and convex portions formed on a center portion of the plate; and dotted concave and convex portions formed on the plate on both sides of the center portion in an axial direction of the cylindrical concave and convex portions.

6. The plate type heat exchanger according to any one of claims 1 to 5, wherein the convex portions formed on one plate and a flat surface portion of another plate disposed adjacently to the plate are joined to each other.

7. The plate type heat exchanger according to any one of claims 1 to 6, wherein a large number of integral type heat transfer plates are arranged parallel to each other, wherein the integral type heat transfer plate is formed such that the first spacers or the second spacers are sandwiched between two plates, two plates are formed into an integral body by joining the convex portions formed on one plate and the flat surface portion of the other plate to each other, and the second spacers or the first spacers are disposed on both outer side surfaces of the two plates.

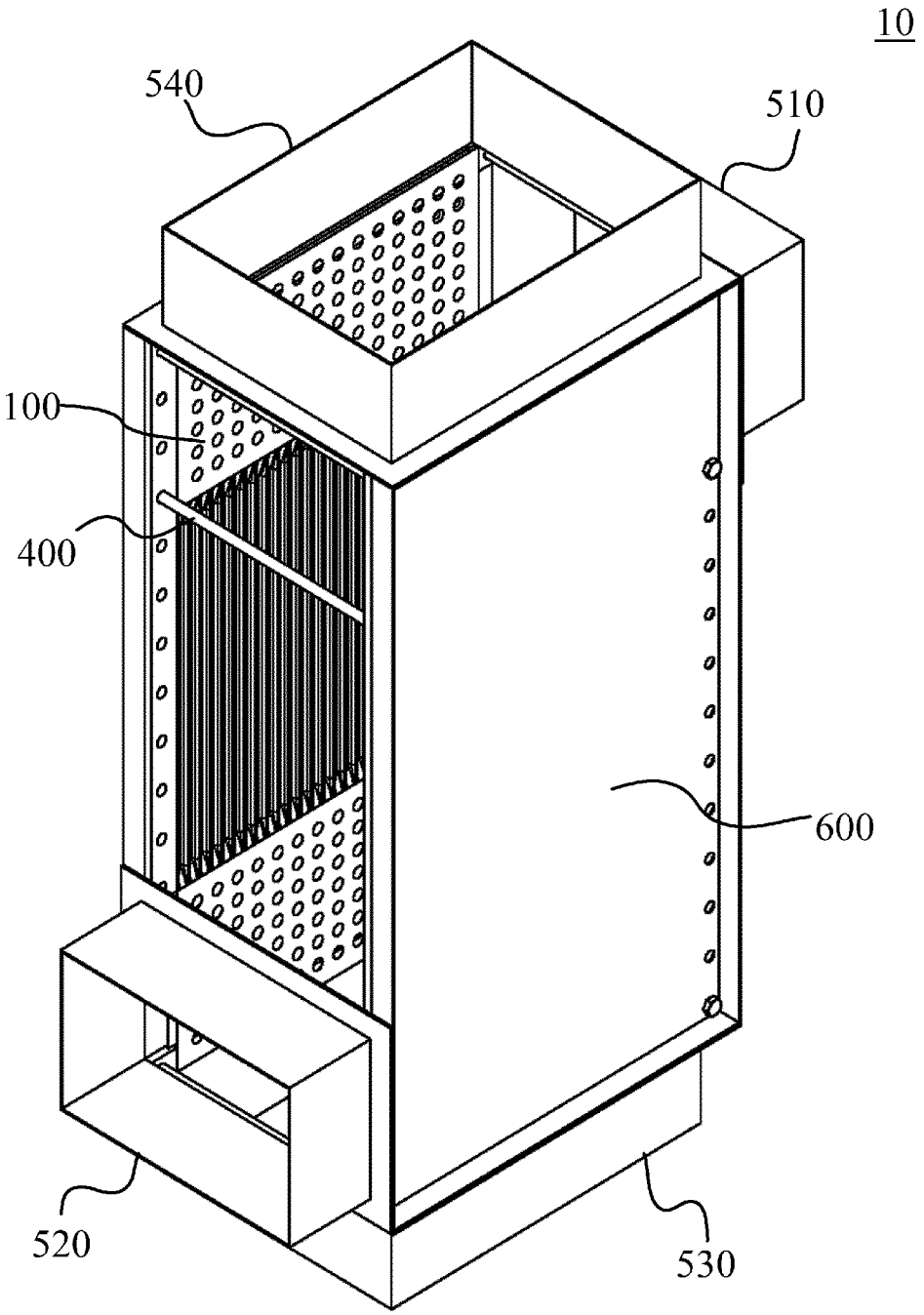
8. The plate type heat exchanger according to claim 7, wherein a large number of integral type heat transfer plates are arranged parallel to each other, wherein the integral type heat transfer plate is formed such that L-shape spacers are sandwiched between two plates, and straight-line spacers are formed on both outer side surfaces of the two plates.

9. The plate type heat exchanger according to any one of claims 1 to 8, wherein a liquid pool is disposed below the plates.

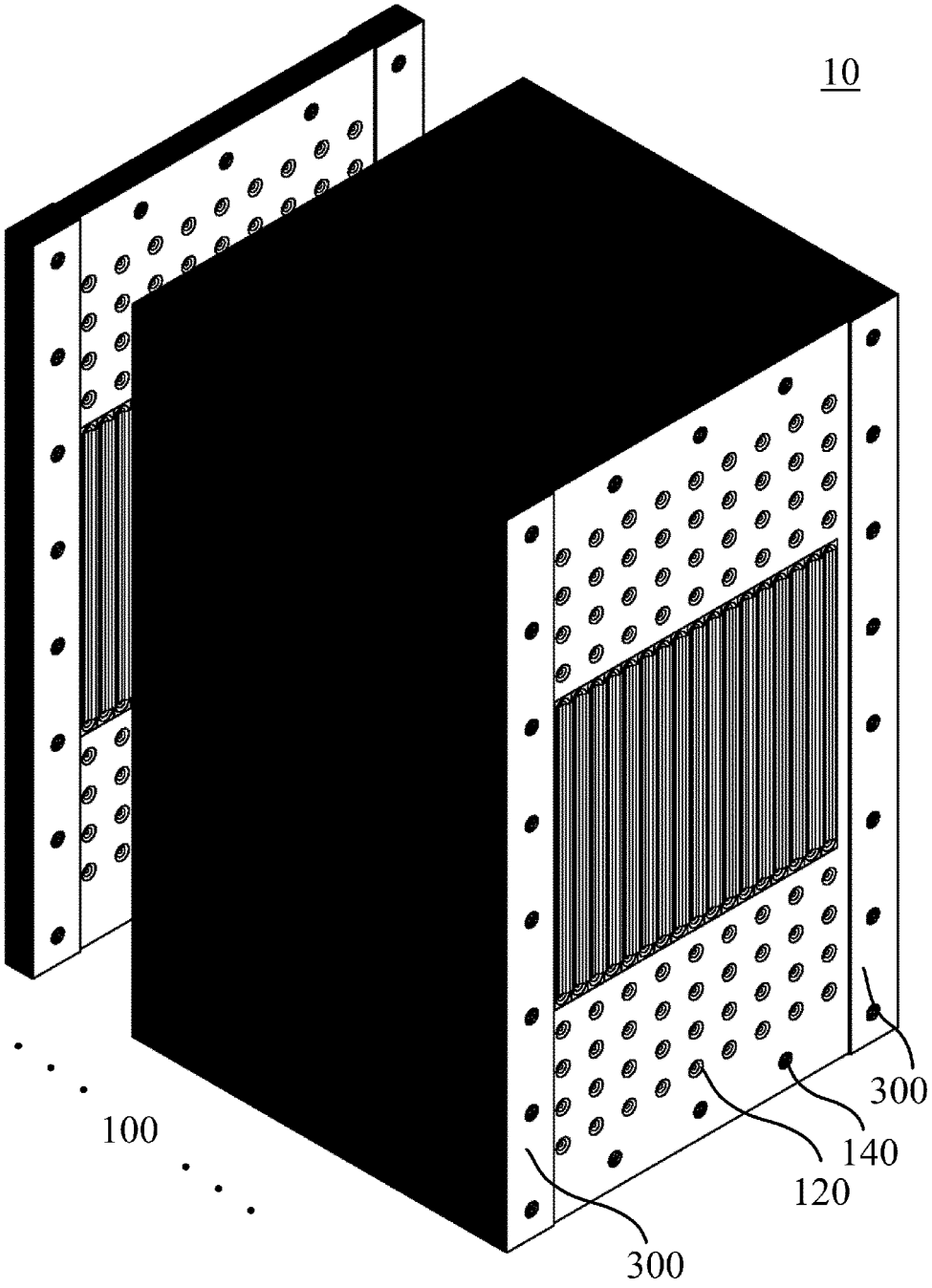
10. An integral type heat transfer plate which is the heat transfer plate used in the plate type heat exchanger described in any one of claims 1 to 9, wherein the integral type heat transfer plate is formed such that the first spacers or the second spacers are sandwiched between two plates, two plates are formed into an integral body by joining the convex portions formed on one plate and the flat surface portion of the other plate to each other, and the second spacers or the first spacers are disposed on both outer side surfaces of the two plates.

11. The integral type heat transfer plate according to claim 10, wherein L-shaped spacers are sandwiched between two plates, and straight-line spacers are disposed on both outer side surfaces of the two plates.

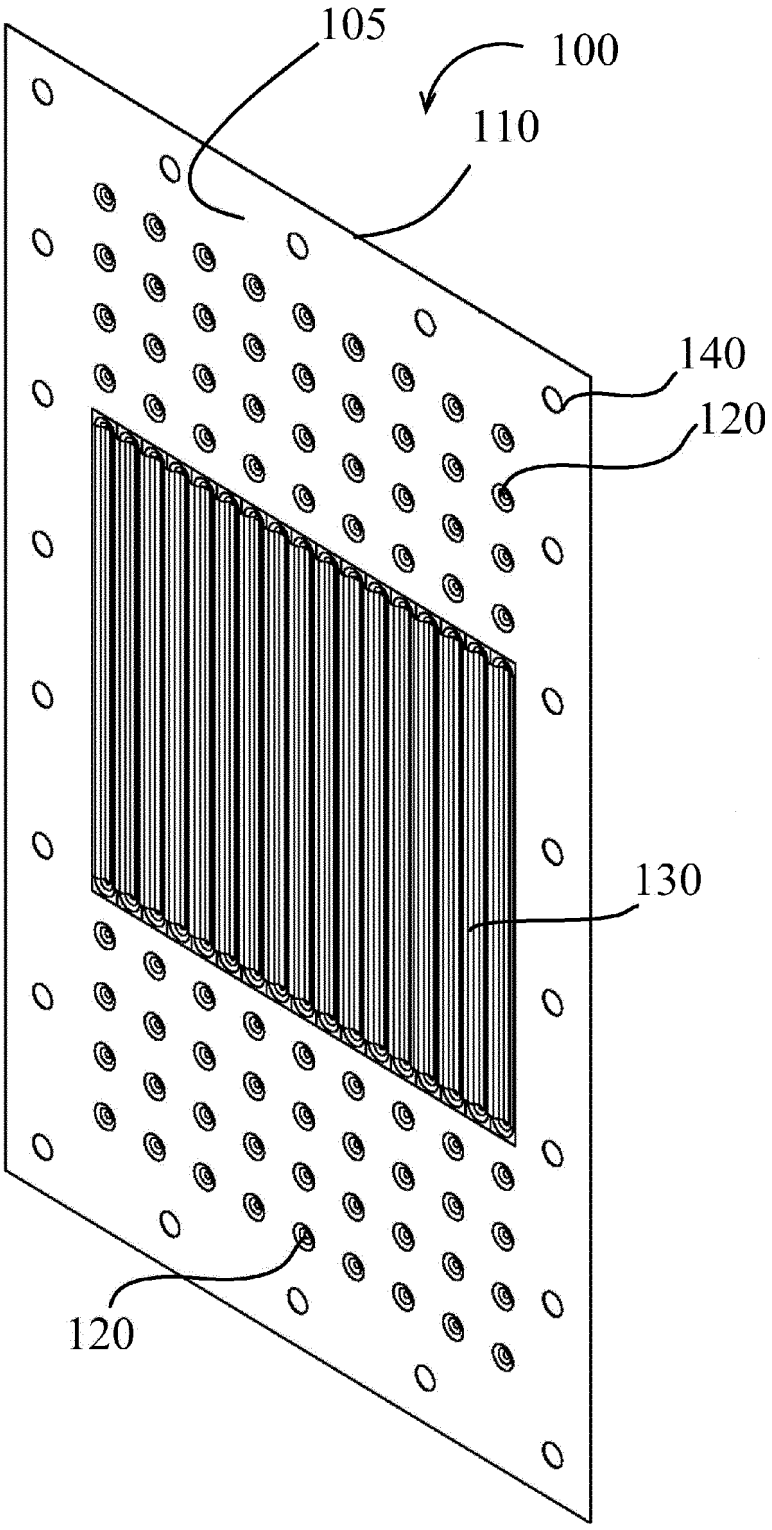
[Fig.1]



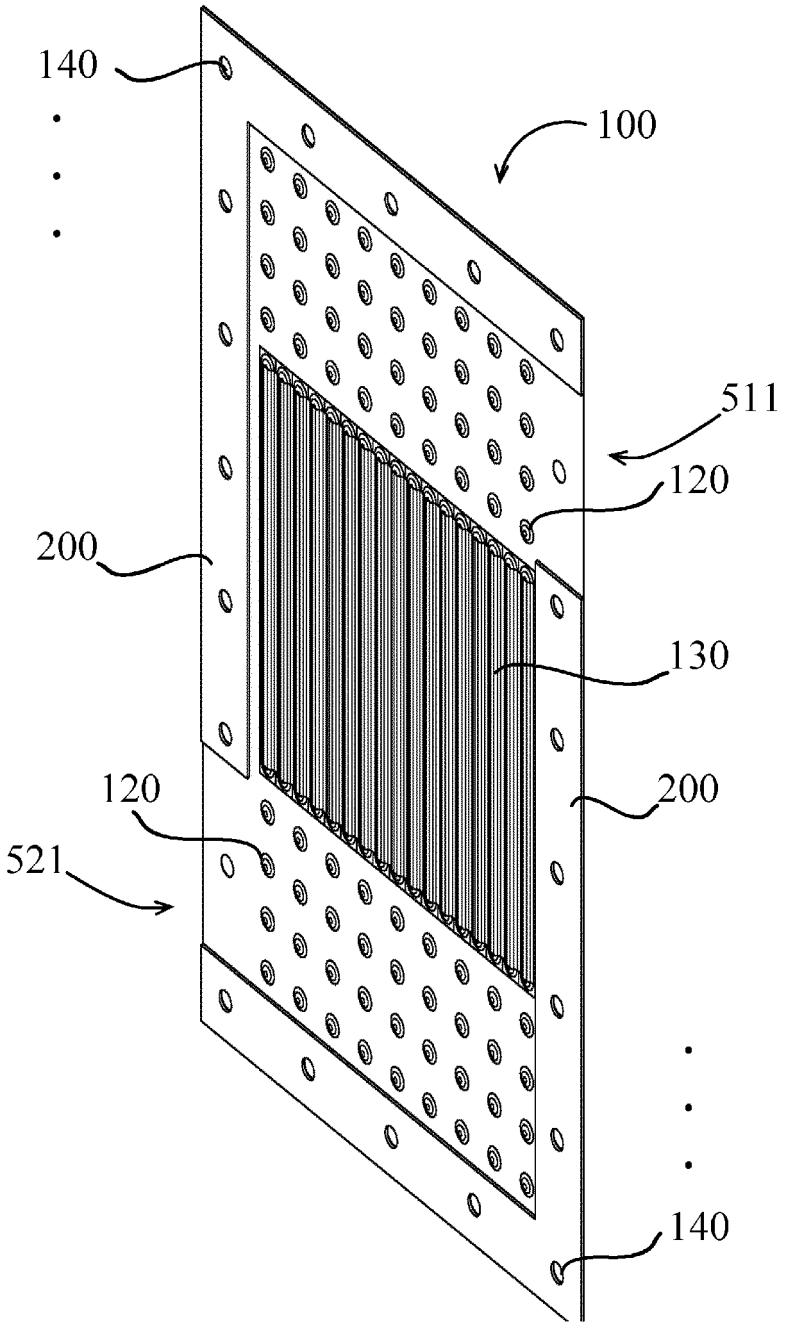
[Fig.2]



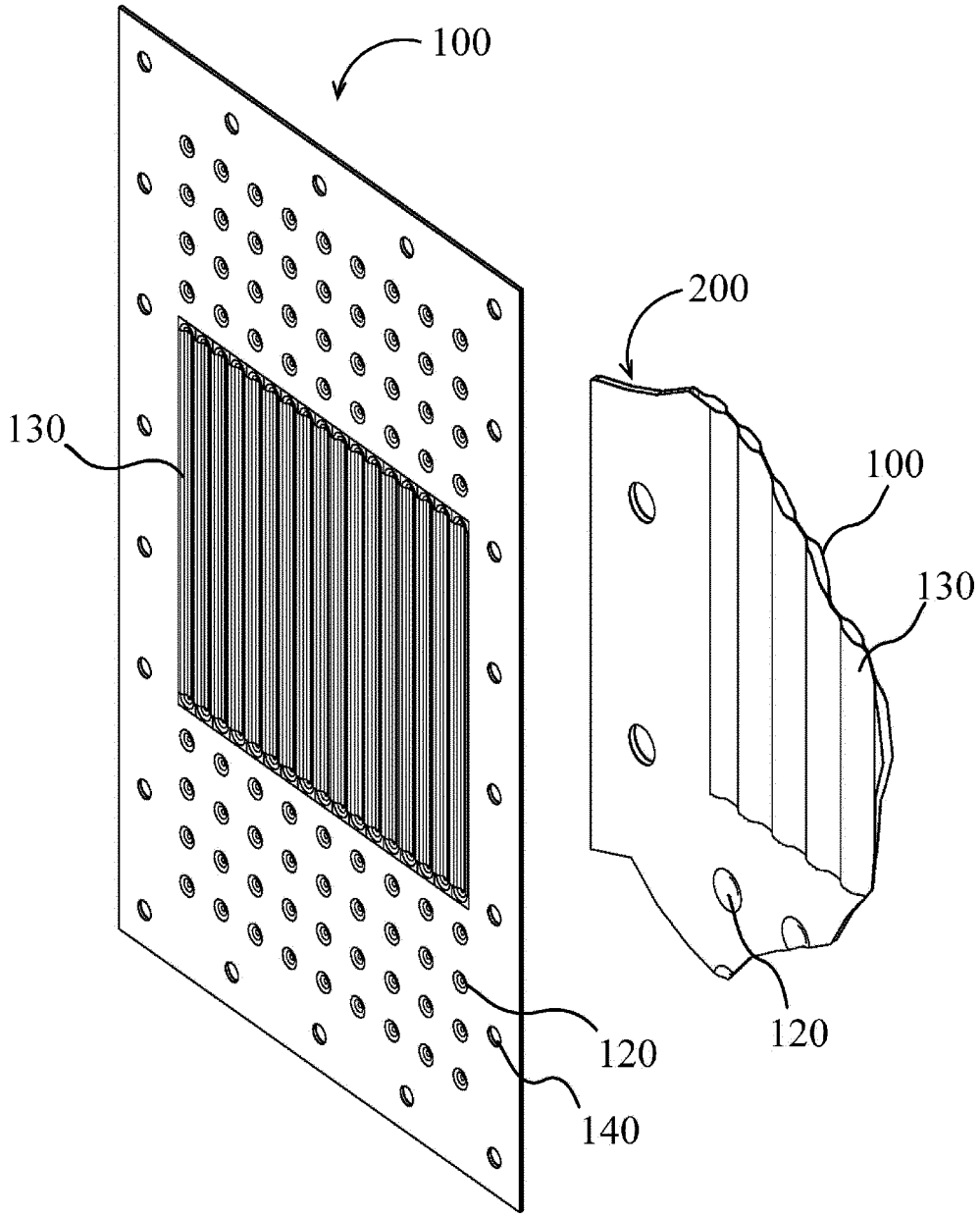
[Fig.3]



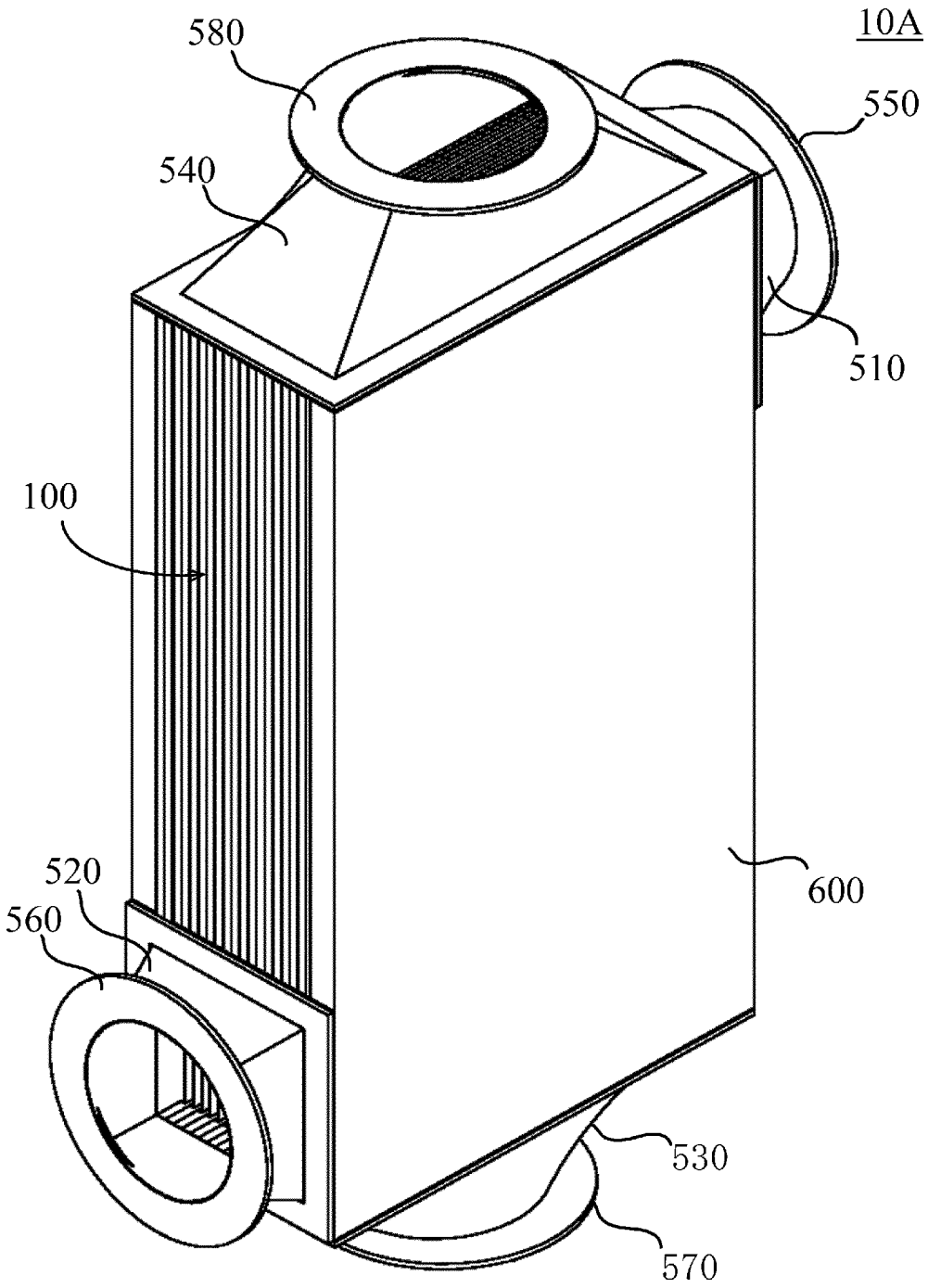
[Fig.4]



[Fig.5]



[Fig.6]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/018132

A. CLASSIFICATION OF SUBJECT MATTER
F28F3/08(2006.01)i, *F28D9/00*(2006.01)i, *F28F3/04*(2006.01)i

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, F28D9/00, F28F3/04

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2017
Kokai Jitsuyo Shinan Koho	1971-2017	Toroku Jitsuyo Shinan Koho	1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 2007-139344 A (Sumitomo Precision Products Co., Ltd.), 07 June 2007 (07.06.2007), paragraphs [0021], [0031] to [0037]; fig. 6 to 8 (Family: none)	1-2 3-4,6-11 5
Y	JP 56-146995 A (Hitachi, Ltd.), 14 November 1981 (14.11.1981), page 2, lower left column, line 18 to lower right column, line 6; fig. 2 (Family: none)	3-4,6-11

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

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Date of the actual completion of the international search	Date of mailing of the international search report
12 July 2017 (12.07.17)	25 July 2017 (25.07.17)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/018132

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 63-143486 A (Nippon Sanso Corp.), 15 June 1988 (15.06.1988), page 7, lower right column, line 3 to page 8, upper left column, line 12; fig. 9 (Family: none)	9
A	US 2003/0000687 A1 (Achint P.MATHUR), 02 January 2003 (02.01.2003), entire text; all drawings (Family: none)	1-11
A	GB 1468514 A (DAVID TEIGNMOUTH SHORE), 30 March 1977 (30.03.1977), page 2, lines 86 to 109; page 3, lines 3 to 7; fig. 1 to 4 (Family: none)	5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3445387 B **[0006]**
- JP 2015049037 A **[0006]**