(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 410 278 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
10.12.2014 Bulletin 2014/50

(21) Application number: **09841919.5**

(22) Date of filing: **21.12.2009**

(51) Int Cl.:
F28F 3/00 *(2006.01)* ***F28D 9/02*** *(2006.01)*
F28F 3/04 *(2006.01)*

(86) International application number:
PCT/JP2009/071230

(87) International publication number:
WO 2010/106717 (23.09.2010 Gazette 2010/38)

(54) PLATE-TYPE HEAT EXCHANGER AND REFRIGERATING AIR-CONDITIONING DEVICE

PLATTENWÄRMETAUSCHER UND KÄLTE-KLIMATISIERUNGSVORRICHTUNG

ÉCHANGEUR THERMIQUE DE TYPE À PLAQUES ET DISPOSITIF DE CONDITIONNEMENT D'AIR ET DE RÉFRIGÉRATION

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR

(30) Priority: **18.03.2009 JP 2009065826**

(43) Date of publication of application:
25.01.2012 Bulletin 2012/04

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EP 2 410 278 B1

Description

Technical Field

[0001] This invention relates to a plate heat exchanger as defined in the preamble of claim 1. WO 2005/098334 A1 discloses such a plate heat exchanger.

Background Art

[0002] Patent Document 1 discusses a plate heat exchanger in which a fluid inlet hole and a fluid outlet hole are elliptically shaped. Patent Document 1 also discusses a plate heat exchanger in which the diameter of a fluid inlet hole and the diameter of a fluid outlet hole are identical in size.

[0003] Patent Document 2 discusses a plate heat exchanger in which the diameter of a fluid inlet hole and the diameter of a fluid outlet hole are different in size. Patent Document 2 also discusses a plate heat exchanger which includes reinforcement members for a fluid inlet hole and a fluid outlet hole, thereby providing enhanced strength.

Citation List

Patent Documents

[0004]

Patent Document 1: JP 9-72685 A
Patent Document 2: JP 7-508581 W
Patent document 3: JP 11 248 392 A
Patent document 4: JP 2008/516181 T
Patent document 5: JP 9 089 482 A
Patent document 6: JP 2005 326135 A
Patent document 7: JP 2000 241 087 A
Patent document 8: WO 2009/013801 A1
Patent document 9: WO 91/17406 A1
Patent document 10: US 2005 155 749 A1.

Disclosure of Invention

Technical Problem

[0005] Conventional plate heat exchangers have the following problems (1) to (3):

(1) Plate heat exchangers in general have thin plates, so that the strength is low.
(2) In a plate exchanger which includes reinforcement members for an inlet hole and an outlet hole, dirt tends to accumulate in the inlet hole and the outlet hole.
(3) When large volumes of fluid flow through a plate heat exchanger, there will be a point where the flow rate reaches a limit at a fluid inlet hole and a fluid outlet hole. Accordingly, to process large volumes of fluid, the inlet hole and the outlet hole need to have larger opening areas. However, to enlarge the opening areas of the inlet hole and the outlet hole, the widths of the inlet hole and the outlet hole must be increased. Increasing the widths of the inlet hole and the outlet hole reduces strength, as well as reduces a heat transfer area. That is, the plate heat exchanger in which the inlet hole and the outlet hole have large opening areas has drawbacks in terms of strength and heat exchange capability

[0006] This invention aims to enhance the strength of a plate heat exchanger while maintaining the heat exchange capability of the plate heat exchanger, for example.

Solution to Problem

[0007] A plate heat exchanger according to this invention is, defined in claim 1.

Advantageous Effects of Invention

[0008] Stress applied to edges of each plate can be reduced. Thus, the plate heat exchanger according to this invention provides enhanced strength.

Brief Description of Drawings

[0009]

Fig. 1 is a side view of a plate heat exchanger 20;
Fig. 2 is a front view of a reinforcement side plate 1;
Fig. 3 is a front view of a second plate 2;
Fig. 4 is a front view of a first plate 3;
Fig. 5 is a front view of a reinforcement side plate 4;
Fig. 6 is an exploded perspective view of the plate heat exchanger 20;
Fig. 7 is a diagram showing dimensions of the plates 2 and 3 of the plate heat exchanger 20;
Fig. 8 is a diagram depicting the relationship between stress and the ratio of a longitudinal length and a lateral length of the plates 2 and 3.
Fig. 9 is a diagram depicting the relationship between the weight of the plate heat exchanger 20 and the ratio of the longitudinal length and the lateral length of the plates 2 and 3.
Fig. 10 is a diagram showing the plates 2 and 3 in which the diameters of first inlet and outlet holes are smaller than the diameters of second inlet and outlet holes.
Fig. 11 is a diagram showing the plate heat exchanger 20 in which the nearer each of the plates 2 and 3 is to the reinforcement side plate 1, the smaller the diameter of a first inlet hole 5.
Fig. 12 is a diagram showing dimensions of the plates 2 and 3 in which the inlet and outlet holes are positioned nearer to four corners of each plate.

Fig. 13 is a diagram describing a flow of a first fluid on the first plate 3 in which the inlet and outlet holes are positioned nearer to the four corners of the plate.
Fig. 14 is a diagram describing corrugations 9 of the first plate 3 in which the inlet and outlet holes are positioned nearer to the four corners of the plate.
Fig. 15 is a diagram showing the corrugations 9 of the second plate 2 in which the inlet and outlet holes are positioned nearer to the four corners of the plate.
Fig. 16 is a diagram showing the corrugations 9 of the first plate 3 in which the inlet and outlet holes are positioned nearer to the four corners of the plate.
Fig. 17 is a diagram showing the plates 2 and 3 in which the first inlet and outlet holes are differently shaped from the second inlet and outlet holes.
Fig. 18 is a diagram showing the plates 2 and 3 in which the first inlet and outlet holes are differently shaped from the second inlet and outlet holes.
Fig. 19 is a diagram showing the plates 2 and 3 in which the first inlet and outlet holes are differently shaped from the second inlet and outlet holes.
Fig. 20 is a diagram comparing a case in which the first inlet and outlet holes and the second inlet and outlet holes are identical in shape, and a case in which the first inlet and outlet holes and the second inlet and outlet holes are different in shape.
Fig. 21 is a diagram showing the plates 2 and 3 in which the first inlet and outlet holes and the second inlet and outlet holes are formed in an identical non-circular shape.
Fig. 22 is a diagram showing the plates 2 and 3 in which the first inlet and outlet holes and the second inlet and outlet holes are formed in an identical non-circular shape.
Fig. 23 is a diagram showing the plates 2 and 3 in which the first inlet and outlet holes and the second inlet and outlet holes are formed in an identical non-circular shape.
Fig. 24 is a diagram showing the plates 2 and 3 in which the first inlet and outlet holes and the second inlet and outlet holes are formed in an identical non-circular shape; and
Fig. 25 is a diagram showing a heating and hot water system 29.

Description of Embodiments

First embodiment

[0010] Figs. 1 to 6 are diagrams describing a plate heat exchanger 20 according to a first embodiment. Fig. 1 is a side view of the plate heat exchanger 20. Fig. 2 is a front view of a reinforcement side plate 1. Fig. 3 is a front view of a second plate 2. Fig. 4 is a front view of a first plate 3. Fig. 5 is a front view of a reinforcement side plate 4. Fig. 6 is an exploded perspective view of the plate heat exchanger 20.

[0011] As shown in Fig. 1, the plate heat exchanger 20 includes a plurality of stacked plates 2 and 3. The plate heat exchanger 20 also includes the reinforcement side plates 1 and 4 stacked at the forefront (an A side in Fig. 1) and the rear end (a B side in Fig. 1), respectively.

[0012] As shown in Figs. 3 and 4, each of the plates 2 and 3 is formed as a plate of an approximately rectangular shape. Each of the plates 2 and 3 includes a first inlet hole 5 near one edge (an upper side) in a long-side (longitudinal) direction of the approximately rectangular shape. Each of the plates 2 and 3 includes a first outlet hole 6 near another edge (a lower side) in the longitudinal direction opposite from the first inlet hole 5. Each of the plates 2 and 3 includes a second inlet hole 7 near the same edge (the lower side) in the longitudinal direction as the first outlet hole 6. Each of the plates 2 and 3 includes a second outlet hole 8 near the same edge (the upper side) in the longitudinal direction as the first inlet hole 5. Each of the plates 2 and 3 includes the first inlet hole 5 and the first outlet hole 6 near the same edge (a left side) in a short-side (lateral) direction of the approximately rectangular shape. Each of the plates 2 and 3 includes the second inlet hole 7 and the second outlet hole 8 near another edge (a right side) in the lateral direction opposite from the first inlet hole 5 and the first outlet hole 6.

[0013] That is, the first inlet hole 5, the first outlet hole 6, the second inlet hole 7, and the second outlet hole 8 are provided at four corners of each of the plates 2 and 3. The first inlet hole 5 and the first outlet hole 6 will be referred to as first inlet and outlet holes. Likewise, the second inlet hole 7 and the second outlet hole 8 will be referred to as second inlet and outlet holes.

[0014] Like the plates 2 and 3, the reinforcement side plates 1 and 4 are also formed as plates in an approximately rectangular shape, as shown in Figs. 2 and 5. As shown in Fig. 2, the reinforcement side plate 1 stacked at the forefront includes the first inlet hole 5 (a first inlet duct), the first outlet hole 6 (a first outlet duct), the second inlet hole 7 (a second inlet duct), and the second outlet hole 8 (a second outlet duct) at the same positions as in the plates 2 and 3.

[0015] On the other hand, as shown in Fig. 5, the reinforcement side plate 4 stacked at the rear end does not include the first inlet hole 5, the first outlet hole 6, the second inlet hole 7, and the second outlet hole 8. In Fig. 5, the positions of the first inlet hole 5, the first outlet hole 6, the second inlet hole 7, and the second outlet hole 8 are indicated by dashed lines, but these holes are not actually present in the reinforcement side plate 4.

[0016] Each of the plates 2 and 3 and the reinforcement side plate 1 are stacked such that the respective first inlet holes 5, first outlet holes 6, second inlet holes 7, and second outlet holes 8 are aligned with one another. The second plate 2 and the first plate 3 are stacked alternately.

[0017] The plates 2 and 3 and the reinforcement side plates 1 and 4 are formed approximately identically in an approximately rectangular shape.

[0018] As shown in Figs. 3 and 4, each of the plates 2 and 3 has a plurality of V-shaped concave portions and convex portions (corrugations 9) arranged in longitudinal arrays. The corrugations 9 have ends 13 at both sides in the lateral direction. The corrugations 9 are formed in the shape of a V having turning points 12, each turning point 12 being longitudinally misaligned with respect to the corresponding ends 13 at both sides. The pitch (width) of the corrugations 9 is indicated as W in Fig. 4. The corrugations 9 are provided such that the direction thereof is reversed between the second plate 2 and the first plate 3. That is, in the second plate 2, the corrugations 9 are formed in the shape of a V with each turning point 12 positioned lower than the corresponding ends 13 at both sides. On the other hand, in the first plate 3, the corrugations 9 are formed in the shape of a V (a reversed V) with each turning point 12 positioned higher than the corresponding ends 13 at both sides.

[0019] In this way, the V-shaped corrugations 9 are formed in the plates 2 and 3 by reversing the direction of the V shape between the plates 2 and 3. By stacking the plates 2 and 3 alternately, flow paths with high heat transfer efficiency are defined between the plates 2 and 3. That is, as shown in Fig. 6, a first flow path is defined between the back surface of the second plate 2 and the front surface of the first plate 3 such that a first fluid entered from the first inlet hole 5 flows to the first outlet hole 6. Likewise, a second flow path is defined between the back surface of the first plate 3 and the front surface of the second plate 2 such that a second fluid entered from the second inlet hole 7 flows to the second outlet hole 8.

[0020] The first fluid flowing through the first flow path is heat-exchanged with the second fluid flowing through the second flow path via the plates 2 and 3.

[0021] Fig. 7 is a diagram showing dimensions of the plates 2 and 3 of the plate heat exchanger 20. In Fig. 7, a length L1 indicates a length of the plates 2 and 3 in the longitudinal direction. A length L2 indicates a length of the plates 2 and 3 in the lateral direction. A length L3 indicates a length from the first inlet hole 5 to a plate edge proximate to the first inlet hole 5 in the lateral direction. A length 4 indicates a length from the first outlet hole 6 to a plate edge proximate to the first outlet hole 6 in the lateral direction. A length L5 indicates a length from the second inlet hole 7 to a plate edge proximate to the second inlet hole 7 in the lateral direction. A length L6 indicates a length from the second outlet hole 8 to a plate edge proximate to the second outlet hole 8 in the lateral direction.

[0022] Fig. 8 is a diagram depicting the relationship between stress and the ratio (length ratio) of the longitudinal length and the lateral length of the plates 2 and 3. The horizontal axis in Fig. 8 depicts the ratio (length ratio) between the longitudinal length and the lateral length of the plates 2 and 3. That is, the horizontal axis in Fig. 8 depicts the ratio of the longitudinal length L1 of the plates 2 and 3 to the lateral length L2 of the plates 2 and 3. The vertical axis in Fig. 8 depicts the stress applied to the edges (periphery) of the plates 2 and 3. In Fig. 8, stress is expressed as a stress ratio. The reference value of the stress ratio is a value indicated by the second point from the right, namely, a point P, in Fig. 8. Each point in Fig. 8 represents a calculated value of a stress ratio relative to a length ratio. The line in Fig. 8 represents values calculated from each point by using a least-square method.

[0023] As shown in Fig. 8. the shorter the lateral length L2 of the plates 2 and 3 is relative to the longitudinal length L1 of the plates 2 and 3, the smaller the stress applied to the periphery of the plates 2 and 3. Thus, the length L2 should preferably be as short as possible relative to the length L1. Specifically, the length L2 should preferably be shortened such that the length L1 is 4 or more times the length L2. However, due to limitations on the manufacture of the plate heat exchanger 20, the length L2 cannot be shortened significantly. Accordingly, the length L2 should preferably be shortened such that the length L1 is approximately from 4 to 6.5 times the length L2.

[0024] By making the lengths L3, L4, L5, and L6 shorter, the stress applied to the edges of the plates 2 and 3 is reduced. Specifically, the lengths L3, L4, L5, and L6 should preferably be set to not more than 6 percent of the lateral length L2 of the plates 2 and 3. The lengths L3, L4, L5, and L6 may be set to not more than 5.6 mm, irrespective of the lateral length L2 of the plates 2 and 3. However, due to limitations on the manufacture of the plate heat exchanger 20, the lengths L3, L4, L5, and L6 cannot be shortened significantly. Accordingly, the lengths L3, L4, L5, and L6 should preferably be set to between not less than 3 percent and not more than 6 percent of the lateral length L2 of the plates 2 and 3. Likewise, the lengths L3, L4, L5, and L6 should preferably be set to not less than 3 mm and not more than 5.6 mm

[0025] Fig. 9 is a diagram depicting the relationship between the ratio of the longitudinal length and the lateral length of the plates 2 and 3 and the weight of the plate heat exchanger 20. Specifically, Fig. 9 depicts the extent to which the weight of the plate heat exchanger 20 can be reduced by shortening the lateral length of the plates 2 and 3 without changing the longitudinal length of the plates 2 and 3.

[0026] As in Fig. 8, the horizontal axis in Fig. 9 depicts the ratio (length ratio) of the longitudinal length and the lateral length of the plates 2 and 3. The vertical axis in Fig. 9 depicts the reduction ratio of the weight of the plate heat exchanger 20. The reduction ratio of the weight of the plate heat exchanger 20 is a value calculated based on the weight of the plate heat exchanger 20 manufactured with the length ratio selected as the reference value of the stress ratio in Fig. 8 (the value indicated by the second point from the right, namely, the point P).

[0027] By making the length L2 shorter, the size of the plate heat exchanger 20 is reduced, so that the weight of the plate heat exchanger 20 can be reduced. However, by making the length L2 shorter, not only the weight can be reduced due to the reduced overall size, but also the

thickness of the plates 2 and 3 and the thickness of the reinforcement side plates 1 and 4 can be reduced, so that the weight can be reduced further. That is, by making the length L2 shorter, the strength of the plate heat exchanger 20 is enhanced. Accordingly, the thickness of the plates 2 and 3 and the thickness of the reinforcement side plates 1 and 4 can be reduced, so that the weight of the plate heat exchanger 20 can be reduced.

[0028] As a result, by shortening the length L2 relative to the length L1, the weight of the plate heat exchanger 20 can be reduced more than by the weight reduction due to reduction in overall size.

[0029] As described above, in the plate heat exchanger 20 according to the first embodiment, the lateral length L2 of the plates 2 and 3 is shortened relative to the longitudinal length L1 of the plates 2 and 3, so that the strength of the plate heat exchanger 20 is enhanced.

[0030] In the plate heat exchanger 20 according to the first embodiment, the lengths between the inlet or outlet holes 5, 6, 7, and 8 and the plate edge (the lengths L3, L4, L5, and L6) are also shortened, so that the strength of the plate heat exchanger 20 is enhanced.

[0031] Furthermore, due to the enhanced strength of the plate heat exchanger 20, the weight of the plate heat exchanger 20 can be reduced.

[0032] By making the lateral length L2 shorter, a fluid entered from the first inlet hole 5 or the second inlet hole 7 is also facilitated to spread in the lateral direction. This eliminates the need to provide distribution facilitating members around the first inlet hole 5 and the second inlet hole 7 so as to facilitate spreading of the fluid. The enhanced strength of the plate heat exchanger 20 also eliminates the need to provide reinforcement members around the inlet holes (the first inlet hole 5, the second inlet hole 7). Thus, because there is no need to provide distribution facilitating members or reinforcement members, press working of the plates 2 and 3 is simplified. Accordingly, the cost of manufacturing the plate heat exchanger 20 can be reduced. Variation in height of the corrugations 9 can also be reduced. That is, the plate heat exchanger 20 of stable quality can be manufactured.

[0033] When stagnation occurs in a fluid in a plate heat exchanger, dirt and scales tend to accumulate in a location where the stagnation occurred. The plates 2 and 3 are prone to corrosion in the location where dirt and scales are accumulated. If a heat exchanger in which stagnation may occur in a fluid is used in an evaporator, a drift may occur causing an uneven distribution of temperature. This may cause the fluid to freeze in some locations. When the fluid freezes, the strength of the heat exchanger is reduced. However, in the plate heat exchanger 20 according to the first embodiment, the lateral length of the plates 2 and 3 is short, so that the possibility of stagnation in a fluid is lessened. Thus, the possibility of accumulation of dirt and scales is lessened, and the strength is not reduced. The plate heat exchanger 20 according to the first embodiment is effective not only when the fluid is water but also for other types of fluid which have a tendency to drift due to a small density and a high pressure loss (e.g., a hydrocarbon refrigerant or a low-GWP refrigerant). With a chlorofluorocarbon. refrigerant, effectiveness is also provided for preventing accumulation of refrigerant oil in the heat exchanger. This permits power consumption to be reduced in an apparatus using the plate heat exchanger 20 according to the first embodiment.

Second embodiment

[0034] In a second embodiment, there will be described the plate heat exchanger 20 in which the diameters of the first inlet and outlet holes are smaller than the diameters of the second inlet and outlet holes. That is, in the second embodiment, there will be described the plate heat exchanger 20 in which the opening areas of the first inlet and outlet holes are smaller than the opening areas of the second inlet and outlet holes.

[0035] Fig. 10 is a diagram showing the plates 2 and 3 in which the diameters of the first inlet and outlet holes are smaller than the diameters of the second inlet and outlet holes.

[0036] For example, when the plate heat exchanger 20 is used to exchange heat between a liquid such as water and a refrigerant such as chlorofluorocarbon, there is a risk that the plates may wear out (become thinner) due to erosion at an inlet hole for the liquid (the second inlet hole 7 here). For this reason, the diameters of the inlet and outlet holes for the liquid (the second inlet hole 7, the second outlet hole 8) need to be sufficiently large. However, there is no need to make the diameters of the inlet and outlet holes for the refrigerant (the first inlet hole 5, the first outlet hole 6) as large as the diameters of the inlet and outlet holes for the liquid (the second inlet hole 7, the second outlet hole 8). That is, the diameters of the first inlet hole 5 and the first outlet hole 6 may be smaller than the diameters of the second inlet hole 7 and the second outlet hole 8. When the diameters of the first inlet hole 5 and the first outlet hole 6 are reduced as described above, the lateral length of the plates 2 and 3 can be correspondingly shortened. Thus, the strength of the plate heat exchanger 20 is enhanced, and the weight of the plate heat exchanger 20 can be reduced, as described in the first embodiment.

[0037] The refrigerant is not limited to chlorofluorocarbon, and may also be a hydrocarbon refrigerant or a low-GWP refrigerant. A CO2 refrigerant requires the plate heat exchanger 20 to be strong due to a high working pressure. When the CO2 refrigerant is used, it is especially effective to configure the inlet and outlet holes for the refrigerant to be smaller than the inlet and outlet holes for the liquid. Since the CO2 refrigerant has a higher density and a smaller pressure loss compared to the chlorofluorocarbon refrigerant, the diameters of the first inlet hole 5 and the first outlet hole 6 can be further reduced.

[0038] Fig. 11 is a diagram showing the plate heat exchanger 20 configured such that the nearer each of the

plates 2 and 3 is to the reinforcement side plate 1, the smaller the diameter of the first inlet hole 5.

[0039] The plate heat exchanger 20 shown in Fig. 11 is configured such that not only the diameters of the first inlet and outlet holes are smaller than the diameters of the second inlet and outlet holes, but also the nearer each of the stacked plates 2 and 3 is to the reinforcement side plate 1, the smaller the diameter of the first inlet hole 5. That is, the nearer each of the stacked plates 2 and 3 is to the reinforcement side plate 1 than to the reinforcement side plate 4 , the smaller the diameter of the first inlet hole 5. In other words, the nearer each of the stacked plates 2 and 3 is to the entrance side of the first fluid, the smaller the diameter of the first inlet hole 5. Specifically, the first inlet hole 5 is extremely small like a fine nozzle in the plates 2 and 3 stacked near the reinforcement side plate 1.

[0040] Because the first inlet hole 5 is extremely small in the plates 2 and 3 stacked near the reinforcement side plate 1, the first fluid can flow at high speed even when a large number of the plates 2 and 3 are stacked. This also facilitates distribution of the first fluid toward the plates 2 and 3 stacked near the reinforcement side plate 4.

[0041] Furthermore, the nearer each of the stacked plates 2 and 3 is to the reinforcement side plate 4, the larger the diameter of the first inlet hole 5 is. This facilitates an even distribution of the first fluid through the first flow path defined by each pair of the plates 2 and 3.

Third embodiment

[0042] In a third embodiment, there will be described the plate heat exchanger 20 in which the inlet and outlet holes are positioned not only nearer to the edges of each plate in the lateral direction, but also nearer to the edges of each plate in the longitudinal direction. That is, in the third embodiment, there will be described the plate heat exchanger 20 in which the inlet and outlet holes are positioned nearer to the four corners of the plates 2 and 3.

[0043] Fig. 12 is a diagram showing dimensions of the plates 2 and 3 in which the inlet and outlet holes are positioned nearer to the four corners of each plate. In Fig. 12, a length L7 indicates a length from the first inlet hole 5 to a plate edge proximate to the first inlet hole 5 in the longitudinal direction. A length L8 indicates a length from the first outlet hole 6 to a plate edge proximate to the first outlet hole 6 in the longitudinal direction. A length L9 indicates a length from the second inlet hole 7 to a plate edge proximate to the second inlet hole 7 in the longitudinal direction. A length L10 indicates a length from the second outlet hole 8 to a plate edge proximate to the second outlet hole 8 in the longitudinal direction.

[0044] The lengths L7, L8, L9, and L10 are approximately equivalent to the lengths L3, L4, L5, and L6 shown in Fig. 7, respectively. In this way, by making the lengths L7, L8, L9, and L10 shorter, the stress applied to the periphery of each plate can be further reduced.

[0045] Specifically, in the plates 2 and 3 shown in Fig. 12, the diameters of the first inlet and outlet holes are smaller than the diameters of the second inlet and outlet holes. Accordingly, the centers of the first inlet and outlet holes are positioned nearer to the corners of the plates 2 and 3 relative to the centers of the second inlet and outlet holes.

[0046] In this way, by positioning the first inlet and outlet holes having smaller diameters (the first inlet hole 5, the first outlet hole 6) nearer to the four corners of the plates 2 and 3, the distance from the first inlet hole 5 to the first outlet hole 6 is increased. That is, the length of the first flow path is increased. Accordingly, the heat transfer area is increased, and the heat exchange capability of the plate heat exchanger 20 is enhanced.

[0047] Fig. 13 is a diagram describing a flow of the first fluid on the first plate 3 in which the inlet and outlet holes are positioned nearer to the four corners of the plate. Fig. 13 only applies to the first plate 3 instead of the plates 2 and 3. This is because a sealing portion 11 is shown in Fig. 13. That is, the sealing portion 11 is provided at different locations between the second plate 2 and the first plate 3.

[0048] By positioning the first inlet hole 5 having a smaller diameter nearer to the corner of the plates 2 and 3, an entrance region 10 for the first flow path can be provided near the first inlet hole 5. The entrance region 10 is a narrow region between the plate edge and the sealing portion 11. This means that the width of the entrance region 10 (a length L11 from the plate edge to the sealing portion 11) is narrower than the lateral width (the length L2) of the first plate 3. The first fluid entered from the first inlet hole 5 passes through the narrow entrance region 10, then spreads in the lateral direction of the plate heat exchanger 20, and flows to the first outlet hole 6.

[0049] The sealing portion 11 is a wall which prevents the first fluid entered from the first inlet hole 5 from flowing to the second outlet hole 8. The sealing portion 11 is formed as a protrusion raised in the stacking direction of the plates 2 and 3. The sealing portion 11 is normally provided around the second outlet hole 8 in a circular shape. However, the sealing portion 11 is provided here, starting from near the edge (the upper side) in the longitudinal direction where the first inlet hole 5 and the second outlet hole 8 are located and extending toward the edge (the lower side) in the longitudinal direction where the second inlet hole 7 and the second outlet hole 8 are located in such a manner as to gradually curve toward the edge (the right side) in the lateral direction near the second outlet hole 8. Specifically, in Fig. 13, the sealing portion 11 is formed to gradually curve to the right in a downward direction.

[0050] The sealing portion 11 facilitates the first fluid which has flowed through the entrance region 10 to spread toward the edge (the right side) in the lateral direction near the second outlet hole 8. That is, the entrance region 10 and the sealing portion 11 provide a guiding effect for guiding the first fluid toward the edge

(the right side) in the lateral direction near the second outlet hole 8. This guiding effect can prevent the first fluid from stagnating around the sealing portion 11 or near the periphery of the plates 2 and 3, thereby enhancing the heat exchange capability. This guiding effect can also reduce the pressure loss of the first fluid. That is, the plate heat exchanger 20 with enhanced performance can be provided.

[0051] When the sealing portion 11 is provided around the second outlet hole 8 in a circular shape, as is normally done, it is necessary to provide a distribution facilitating member around the first inlet hole 5 so as to prevent the first fluid from drifting. The distribution facilitating member is formed, for example, in a complex shape such as a radial shape. Thus, it is difficult to manufacture the plate heat exchanger 20 including the distribution facilitating member. However, the plate heat exchanger 20 according to the third embodiment simply includes the sealing portion 11 which is curved, and thus is simple to manufacture. For this reason, the plate heat exchanger 20 according to the third embodiment is highly suitable for mass production.

[0052] Fig. 14 is a diagram describing the corrugations 9 in the first plate 3 in which the inlet and outlet holes are positioned nearer to the four corners. Fig. 15 is a diagram showing the corrugations 9 in the second plate 2 in which the inlet and outlet holes are positioned nearer to the four corners. Fig. 16 is a diagram showing the corrugations 9 in the first plate 3 in which the inlet and outlet holes are positioned nearer to the four corners.

[0053] As has been described in the first embodiment, each of the plates 2 and 3 includes the corrugations 9 arranged in a plurality of longitudinal arrays, the corrugations 9 having the ends 13 at both sides in the lateral direction and also having the turning points 12 longitudinally misaligned with respect to the corresponding ends 13 at both sides, so that the corrugations 9 are V-shaped. The turning points 12 of the corrugations 9 in the plates 2 and 3 shown in Figs. 3 and 4 are positioned at the lateral center. That is, the corrugations 9 are formed in a bilaterally symmetrical manner.

[0054] In the plates 2 and 3 shown in Fig. 14, the diameters of the first inlet and outlet holes are smaller than the diameters of the second inlet and outlet holes. That is, in Fig. 14, the diameters of the first inlet hole 5 and the first outlet hole 6 are smaller than the diameters of the second inlet hole 7 and the second outlet hole 8. For this reason, if the turning points 12 are positioned at the lateral center as in the plates 2 and 3 shown in Figs. 3 and 4, this will create regions where the corrugations 9 are not formed near the first inlet hole 5 and the first outlet hole 6. Thus, in the regions near the first inlet hole 5 and the first outlet hole 6, the corrugations 9 are formed by shifting the positions of the turning points 12 of the corrugations 9 nearer to the first inlet hole 5 and the first outlet hole 6, respectively. That is, as shown in Fig. 14, a line 15 linking the turning points 12 of the corrugations 9 is defined in a gradual curve, curving toward the first inlet hole 5 and the first outlet hole 6, respectively, from a center line 14 at the lateral center.

[0055] In this way, the corrugations 9 can also be formed in the regions near the first inlet hole 5 and the first outlet hole 6, so that the heat transfer area is increased. Accordingly, the heat exchange capability of the plate heat exchanger 20 is enhanced. The plates 2 are joined with the respective adjacent plates 3 at portions where the corrugations 9 are formed. Generally speaking, the plates 2 and 3 are prone to separation from one another in regions near the inlet and outlet holes. However, by forming the corrugations 9 also in the regions near the inlet and outlet holes, the joining points between the plates 2 and 3 are increased in number, so that the plates 2 and 3 can be prevented from separating from one another. Further, the position of each turning point 12 of the corrugations 9 gradually moves from the first inlet hole 5 toward the lateral center and from the lateral center toward the first outlet hole 6. This makes it possible to smoothly transfer the first fluid entered from the first inlet hole 5 to the lateral center and from the lateral center to the first outlet hole 6. Accordingly, the pressure loss of the first fluid can be reduced.

[0056] As in the first plate 3, the corrugations 9 are also formed in the second plate 2 by shifting the positions of the turning points 12 nearer to the first inlet hole 5 and the first outlet hole 6 in the regions near the first inlet hole 5 and the first outlet hole 6 having smaller diameters, respectively, as shown in Fig. 16.

Fourth embodiment

[0057] In a fourth embodiment, there will be described the plate heat exchanger 20 in which the shapes of the first inlet and outlet holes and the second inlet and outlet holes are modified.

[0058] Figs. 17 to 19 are diagrams showing the plates 2 and 3 in which the first inlet and outlet holes are shaped differently from the second inlet and outlet holes while maintaining required opening areas.

[0059] In Fig. 17, the first inlet and outlet holes and the second inlet and outlet holes are formed in approximately elliptical shapes different from each other. In Fig. 18, a circle is divided into two such that one of the two portions is the first inlet or outlet hole and the other portion is the second outlet or inlet hole. In Fig. 19, an approximately rectangular shape is divided into two such that one of the two portions is the first inlet or outlet hole and the other portion is the second outlet or inlet hole.

[0060] In Figs. 17 to 19, the diameters of the first inlet and outlet holes are smaller than the diameters of the second inlet and outlet holes.

[0061] Fig. 20 is a diagram comparing a case in which the first inlet and outlet holes and the second inlet and outlet holes are identical in shape, and a case in which the first inlet and outlet holes and the second inlet and outlet holes are different in shape. Fig. 20 shows the longitudinal side of the plates 2 and 3 where the first outlet

hole 6 and the second inlet hole 7 are located. Fig. 20(a) shows the plates 2 and 3 in which the first outlet hole 6 and the second inlet hole 7 are both circularly shaped. On the other hand, Fig. 20(b) shows the plates 2 and 3 in which a circle is divided into two such that one of the two portions is the first inlet or outlet hole and the other portion is the second outlet or inlet hole, as shown in Fig. 18. In Fig. 20(a) and Fig. 20(b), the diameters of the first inlet and outlet holes are smaller than the diameters of the second inlet and outlet holes.

[0062] The first outlet hole 6 shown in Fig. 20(a) is a circle having a diameter of"12 mm", and the second inlet hole 7 is a circle having a diameter of "28 mm". The distance between the first outlet hole 6 and the second inlet hole 7 is "3 mm". Accordingly, the opening area of the first outlet hole 6 is "36 πm^2", and the opening area of the second inlet hole 7 is "196 πm^2". The length from the edge of the first outlet hole 6 to the edge of the second inlet hole 7 is "43 mm".

[0063] On the other hand, the first outlet hole 6 shown in Fig. 20(b) is a quarter of a circle having a diameter of "24 mm", and the second inlet hole 7 is three-quarters of a circle of "31 mm". The distance between the first outlet hole 6 and the second inlet hole 7 is "3 mm". Accordingly, the opening area of the first outlet hole 6 is "36 πm^2", and the opening area of the second inlet hole 7 is "192 πm^2". The length from the edge of the first outlet hole 6 to the edge of the second inlet hole 7 is "31 mm".

[0064] That is, the opening area of the first outlet hole 6 shown in Fig. 20(a) and the opening area of the second inlet hole 7 shown in Fig. 20(b) are both "36 πm^2" and thus are the same. The opening area of the first outlet hole 6 shown in Fig. 20(a) and the opening area of the second inlet hole 7 shown in Fig. 20(b) are "196 πm^2" and "192 πm^2", respectively, and thus are approximately the same. However, the length from the edge of the first outlet hole 6 to the edge of the second inlet hole 7 is "43 mm" in the plates 2 and 3 shown in Fig. 20(a), whereas this length is "31 mm" in the plates 2 and 3 shown in Fig. 20(b). That is, the length from the edge of the first outlet hole 6 to the edge of the second inlet hole 7 is significantly shorter in the plates 2 and 3 shown in Fig. 20(b) than in the plates 2 and 3 shown in Fig. 20(a). This means that by forming the first outlet hole 6 and the second inlet hole 7 as shown in Fig. 20(b), the lateral length of the plates 2 and 3 can be significantly shortened while maintaining the required opening areas of the first outlet hole 6 and the second inlet hole 7.

[0065] Figs. 21 to 24 are diagrams showing the plates 2 and 3 in which the first inlet and outlet holes and the second inlet and outlet holes are formed in identical non-circular shapes while maintaining the required opening areas.

[0066] In Fig. 21, the first inlet and outlet holes and the second inlet and outlet holes are formed identically in an approximately elliptical shape. In Figs. 22 and 23, the first inlet and outlet holes and the second inlet and outlet holes are formed identically in a fan-like shape. In Fig. 24, the first inlet and outlet holes and the second inlet and outlet holes are formed identically in a star-like shape.

[0067] By forming the first inlet and outlet holes and the second inlet and outlet holes in various combinations of shapes as described above, the lateral length of the plates 2 and 3 can be shortened. Thus, the effects described in the first embodiment can be obtained. When the first inlet and outlet holes and the second inlet and outlet holes are shaped identically, the plate heat exchanger 20 can be configured with the plates 2 and 3 of a single type.

Fifth embodiment

[0068] In a fifth embodiment, there will be described a heating and hot water system 29, which is a usage example of the plate heat exchanger 20 described in the above embodiments.

[0069] Fig. 25 is a diagram showing the heating and hot water system 29.

[0070] The heating and hot water system 29 includes a compressor 21, the plate heat exchanger 20, an expansion valve 22, a heat exchanger 23, a water heater 24, a heater 25, a refrigerant path 26, and a water path 27. The plate heat exchanger 20 here is the plate heat exchanger 20 described in the above embodiments. The compressor 21, the plate heat exchanger 20, the expansion valve 22, the heat exchanger 23, and the refrigerant path 26 constitute a heat exchange system 28.

[0071] A refrigerant flows through the refrigerant path 26 by circulating sequentially through the compressor 21, the plate heat exchanger 20, the expansion valve 22, and the heat exchanger 23. As described above, the compressor 21 compresses the refrigerant. The plate heat exchanger 20 exchanges heat between the refrigerant compressed by the compressor 21 and a fluid (water in this case) flowing through the water path 27. Here, the refrigerant is cooled and the water is warmed by heat exchange in the plate heat exchanger 20. The expansion valve 22 controls expansion of the refrigerant heat-exchanged by the plate heat exchanger 20. The heat exchanger 23 exchanges heat between air and the refrigerant expanded based on control by the expansion valve 22. Here, the refrigerant is warmed and the air is cooled by heat exchange in the heat exchanger 23. Then, the warmed refrigerant enters the compressor 21.

[0072] On the other hand, the water flows through the water path 27 among the plate heat exchanger 20, the water heater 24, and the heater 25. As described above, the water is warmed by heat exchange in the plate heat exchanger 20. Then, the warmed water flows to the water heater 24 or the heater 25. The water for hot-water supply may be different from the water heat-exchanged by the plate heat exchanger 20. That is, the water heater 24 or the like may further exchange heat between the water flowing through the water path 27 and the water for hot-water supply.

[0073] The plate heat exchanger 20 described in the above embodiments provides enhanced strength, a compact and lightweight structure, and enhanced efficiency. Thus, the heat exchange system 28 using the plate heat exchanger 20 described in the above embodiments also provides enhanced efficiency. The heating and hot water system 29 using the heat exchange system 28 also provides enhanced efficiency.

[0074] Here, a heat exchange system (an air-to-water (ATW) system) has been described, wherein the plate heat exchanger 20 described in the above embodiments heats water by using a compressed refrigerant. However, the implementation is not limited to this, and a refrigeration cycle (a refrigeration air conditioner) may be configured for exchanging heat by using the plate heat exchanger 20 described in the above embodiments so as to heat or cool a fluid such as air.

[0075] The above embodiments are summarized as follows:

> The plate heat exchanger 20 is configured with a plurality of stacked plates such that flow holes which act as inlets or outlets for a fluid are formed at four corners of each plate, and inlet ducts and outlet ducts are provided in the plurality of stacked plates. The plate heat exchanger 20 is characterized in that the ratio of the height (H) to the width (W) of the plates is in a range of 4 to 6.5.

[0076] The plate heat exchanger 20 is configured with a plurality of stacked plates such that flow holes which act as inlets or outlets for a fluid are formed at four corners of each plate, and inlet ducts and outlet ducts are provided in the plurality of stacked plates. The plate heat exchanger 20 is characterized in that the widthwise distance between each of the first and second fluid inlets and outlets and the periphery of the plate is 3 to 6 % of the width (W) of the plate.

[0077] The plate heat exchanger 20 is configured with a plurality of stacked plates such that flow holes which act as inlets or outlets for a fluid are formed at four corners of each plate, and inlet ducts and outlet ducts are provided in the plurality of stacked plates. The plate heat exchanger 20 is characterized in that the widthwise distance between each of the first and second fluid inlets and outlets and the periphery of the plate is 3 to 5.6 mm.

[0078] The plate heat exchanger 20 is configured with a plurality of stacked plates such that flow holes which act as inlets or outlets for a fluid are formed at four corners of each plate, and inlet ducts and outlet ducts are provided in the plurality of stacked plates. The plate heat exchanger 20 is characterized in that the diameters of the first inlet and outlet are differently sized from the diameters of the second fluid inlet and outlet.

[0079] The plate heat exchanger 20 is configured with a plurality of stacked plates such that flow holes which act as inlets or outlets for a fluid are formed at four corners of each plate, and inlet ducts and outlet ducts are provided in the plurality of stacked plates. The plate heat exchanger 20 is characterized in that the centers of the first fluid inlet and outlet are misaligned with the centers of the second fluid inlet and outlet such that the fluid inlets and outlets are shifted nearer to the periphery of the plate.

[0080] The plate heat exchanger 20 is configured with a plurality of stacked plates such that flow holes which act as inlets or outlets for a fluid are formed at four corners of each plate, and inlet ducts and outlet ducts are provided in the plurality of stacked plates. The plate heat exchanger 20 is characterized in that crest portions formed at turning points of waves are arranged to gradually curve from the center of the plate such that the turning points of the waves are formed in regions near the inlet and outlet.

[0081] The plate heat exchanger 20 is configured with a plurality of stacked plates such that flow holes which act as inlets or outlets for a fluid are formed at four corners of each plate, and inlet ducts and outlet ducts are provided in the plurality of stacked plates. The plate heat exchanger 20 is characterized in that the centers of the diameters of the first fluid inlet and outlet are misaligned with the centers of the diameters of the second inlet and outlet, and the first inlet and outlet and the second inlet and outlet are formed in a combination of different shapes such as circular shapes or polygonal shapes while maintaining required opening areas according to a processing flow amount of the second fluid.

[0082] The plate heat exchanger 20 is configured with a plurality of stacked plates such that flow holes which act as inlets or outlets for a fluid are formed at four corners of each plate, and inlet ducts and outlet ducts are provided in the plurality of stacked plates. The plate heat exchanger 20 is characterized in that the first inlet and outlet and the second inlet and outlet are formed in a combination of an identical shape such as a circular shape or a polygonal shape while maintaining required opening areas according to a processing flow amount of the second fluid.

Reference Signs List

[0083] 1, 4: reinforcement side plates, 2: second plate, 3: first plate, 5: first inlet hole, 6: first outlet hole, 7: second inlet hole, 8: second outlet hole, 9: corrugations, 10: entrance region, 11: sealing portion, 12: turning point, 13: ends, 14: center line in the lateral direction, 15: line linking the turning points 12, 20: plate heat exchanger, 21: compressor, 22: expansion valve, 23: heat exchanger, 24: water heater, 25: heater, 26: refrigerant path, 27: water path, 28: heat exchange system

Claims

1. A plate heat exchanger configured with a plurality of stacked plates (2, 3),
   wherein each plate of the plurality of stacked plates

includes:

a first inlet hole (5) which acts as an inlet for a first fluid, the first inlet hole being located near one edge in a longitudinal direction;
a first outlet hole (6) which acts as an outlet for the first fluid, the first outlet hole being located near another edge opposite from the first inlet hole in the longitudinal direction;
a second inlet hole (7) which acts as an inlet for a second fluid, the second inlet hole being located near one edge in the longitudinal direction; and
a second outlet hole (8) which acts as an outlet for the second fluid, the second outlet hole being located near another edge opposite from the second inlet hole in the longitudinal direction,
wherein the each plate and an adjacent plate define therebetween either one of a first flow path and a second flow path, the first flow path passing the first fluid entered from the first inlet hole to the first outlet hole such that the first fluid spreads in a lateral direction, and the second flow path passing the second fluid entered from the second inlet hole to the second outlet hole such that the second fluid spreads in the lateral direction, and the each plate exchanges heat between the first fluid flowing through the first flow path and the second fluid flowing through the second flow path, wherein
each of an opening area of the first inlet hole and an opening area of the first outlet hole is smaller than either of an opening area of the second inlet hole and an opening area of the second outlet hole,
wherein the each plate includes V-shaped convex portions and concave portions arranged in a plurality of arrays in the longitudinal direction, each of the convex portions and concave portions having ends (13) at both ends in the lateral direction and also having a turning point (12) longitudinally misaligned with the ends, so that the convex portions and concave portions are formed in a V shape, and
characterised in that the V-shaped convex portions and concave portions are arranged such that, in a vicinity of a center portion in the longitudinal direction, the turning point is formed at a center in the lateral direction, and in a vicinity of at least either first hole of the first inlet hole and the first outlet hole, a position of the turning point is gradually shifted away from the center in the lateral direction as a position of each of the V-shaped convex portions and concave portions becomes nearer to the either first hole.

2. The plate heat exchanger according to claim 1, wherein the each plate is configured such that a length (L1) in the longitudinal direction is 4 or more times a length (L2) in the lateral direction.

3. The plate heat exchanger according to claim 1, wherein each of a length (L3) from the first inlet hole to a plate edge proximate to the first inlet hole in the lateral direction, a length (L4) from the first outlet hole to a plate edge proximate to the first outlet hole in the lateral direction, a length (L5) from the second inlet hole to a plate edge proximate to the second inlet hole in the lateral direction, and a length (L6) from the second outlet hole to a plate edge proximate to the second outlet hole in the lateral direction is not more than 6 percent of the length (L2) in the lateral direction.

4. The plate heat exchanger according to claim 1, wherein each of a length (L3) from the first inlet hole to a plate edge proximate to the first inlet hole in the lateral direction, a length (L4) from the first outlet hole to a plate edge proximate to the first outlet hole in the lateral direction, a length (L5) from the second inlet hole to a plate edge proximate to the second inlet hole in the lateral direction, and a length (L6) from the second outlet hole to a plate edge proximate to the second outlet hole in the lateral direction is not more than 5.6 mm.

5. The plate heat exchanger according to claim 1, wherein a center of the first inlet hole and a center of the first outlet hole are positioned nearer to a plate edge relative to a center of the second inlet hole and a center of the second outlet hole.

6. The plate heat exchanger according to claim 1, wherein a first plate (3) and a second plate (2) are stacked alternately,
wherein the first inlet hole and the second outlet hole are positioned near a same edge in the longitudinal direction, and
wherein the first plate includes a sealing portion (11) for preventing a fluid entered from the first inlet hole from flowing to the second outlet hole, the sealing portion being formed as a protrusion raised in a stacking direction of the plurality of stacked plates such that the sealing portion extends from near the edge where the first inlet hole and the second outlet hole are located toward an opposite edge in the longitudinal direction, so as to gradually approach an edge in the lateral direction near the second outlet hole.

7. The plate heat exchanger according to claim 1, wherein the plurality of stacked plates are stacked such that the first inlet hole of the each plate is aligned with first inlet holes of other plates, so that the first fluid sequentially flows from the first inlet hole of the each plate stacked at one side of the stacking direc-

tion into the first inlet hole of the each plate stacked at another side of the stacking direction, and
wherein the nearer the each plate of the plurality of stacked plates is to the one side from which the first fluid enters, the smaller a diameter of the first inlet hole.

8. The plate heat exchanger according to claim 1,
wherein the first inlet hole and the second outlet hole are formed near a same edge in the longitudinal direction, and the second inlet hole and the first outlet hole are formed near a same edge in the longitudinal direction, and
wherein a shape of the first inlet hole is different from a shape of the second outlet hole, and a shape of the second inlet hole is different from a shape of the first outlet hole.

9. The plate heat exchanger according to claim 8,
wherein the first inlet hole and the second outlet hole are formed by dividing one hole of a circular, elliptical, or polygonal shape into two holes, and
wherein the second inlet hole and the first outlet hole are formed by dividing one hole of a circular, elliptical, or polygonal shape into two holes.

10. A refrigeration air conditioner comprising the plate heat exchanger according to claim 1.

Patentansprüche

1. Ein Plattenwärmetauscher, der mit einer Mehrzahl von gestapelten Platten (2, 3) ausgebildet ist, wobei jede Platte der Mehrzahl von gestapelten Platten umfasst:

Ein erstes Einlassloch (5), das als ein Einlass für ein erstes Fluid dient, wobei das erste Einlassloch in der Nähe von einem Rand in einer Längsrichtung angeordnet ist;
ein erstes Auslassloch (6), das als ein Auslass für das erste Fluid dient, wobei das erste Auslassloch in der Nähe von einem anderen Rand gegenüberliegend von dem ersten Einlassloch in der Längsrichtung angeordnet ist;
ein zweites Einlassloch (7), das als ein Einlass für ein zweites Fluid dient, wobei das zweite Einlassloch in der Nähe von einem Rand in der Längsrichtung angeordnet ist; und
ein zweites Auslassloch (8), das als ein Auslass für das zweite Fluid dient, wobei das zweite Auslassloch in der Nähe von einem anderen Rand gegenüberliegend von dem zweiten Einlassloch in der Längsrichtung angeordnet ist,
wobei die jede Platte und eine benachbarte Platte dazwischen einen von einem ersten Fließpfad und einem zweiten Fließpfad definieren, wobei der erste Fließpfad das von dem ersten Einlassloch eingetretene erste Fluid zu dem ersten Auslassloch dergestalt führt, dass sich das erste Fluid in einer Lateralrichtung ausbreitet, und der zweite Fließpfad das von dem zweiten Einlassloch eingetretene zweite Fluid so zu dem zweiten Auslassloch führt, dass sich das zweite Fluid in der Lateralrichtung ausbreitet, und wobei die jede Platte Wärme zwischen dem ersten Fluid, das durch den ersten Fließpfad fließt, und dem zweiten Fluid, das durch den zweiten Fließpfad fließt, austauscht,
wobei jeder aus einem Öffnungsbereich des ersten Einlasslochs und einem Öffnungsbereich des ersten Auslasslochs kleiner ist als einer von einem Öffnungsbereich des zweiten Einlasslochs und von einem Öffnungsbereich des zweiten Auslasslochs,
wobei die jede Platte V-förmige Konvexabschnitte und Konkavabschnitte umfasst, die in einer Mehrzahl von Anordnungen in der Längsrichtung angeordnet sind, wobei jeder der Konvexabschnitte und der Konkavabschnitte Enden (13) an beiden Enden in der Laterialrichtung aufweist und auch einen Wendepunkt (12) in Längsrichtung nicht fluchtend mit den Enden aufweist, so dass die Konvexabschnitte und Konkavabschnitte in einer V-Form ausgebildet sind,
dadurch gekennzeichnet, dass
die V-förmigen Konvexabschnitte und Konkavabschnitte dergestalt angeordnet sind, dass, in einer Umgebung eines Zentrumsabschnitts in der Längsrichtung, der Wendepunkt an einem Zentrum in der Lateralrichtung ausgebildet ist, und dass, in einer Umgebung von zumindest einem ersten Loch von dem ersten Einlassloch und dem ersten Auslassloch, eine Position des Wendepunkts graduell wegverschoben ist von dem Zentrum in der Lateralrichtung während eine Position von jedem der V-förmigen Konvexabschnitte und Konkavabschnitte sich dem einen ersten Loch nähert.

2. Der Plattenwärmetauscher gemäß Anspruch 1,
wobei die jede Platte so konfiguriert ist, dass eine Länge (L 1) in der Längsrichtung viermal oder mehr als viermal einer Länge (L 2) in der Lateralrichtung beträgt.

3. Der Plattenwärmetauscher gemäß Anspruch 1
wobei jede einer Länge (L 3) von dem ersten Einlassloch zu einem Plattenrand nahegelegen zu dem ersten Einlassloch in der Lateralrichtung, einer Länge (L 4) von dem ersten Auslassloch zu einem Plattenrand nahegelegen zu dem ersten Auslassloch in der Lateralrichtung, einer Länge (L 5) von dem zweiten Einlassloch zu einem Plattenrand nahegelegen

zu dem zweiten Einlassloch in der Lateralrichtung, und einer Länge (L 6) von dem zweiten Auslassloch zu einem Plattenrand nahegelegen zu dem zweiten Auslassloch in der Lateralrichtung nicht mehr beträgt als 6 % der Länge (L 2) in der Lateralrichtung.

4. Der Plattenwärmetauscher gemäß Anspruch 1, wobei jede einer Länge (L 3) von dem ersten Einlassloch zu einem Plattenrand, nahegelegen zu dem ersten Einlassloch in der Lateralrichtung, einer Länge (L 4) von dem ersten Auslassloch zu einem Plattenrand nahegelegen zu dem ersten Auslassloch in der Lateralrichtung, einer Länge (L 5) von dem zweiten Einlassloch zu einem Plattenrand nahegelegen zu dem zweiten Einlassloch in der Lateralrichtung, und einer Länge (L 6) von dem zweiten Auslassloch zu einem Plattenrand nahegelegen zur dem zweiten Auslassloch in der Lateralrichtung nicht mehr als 5,6 mm beträgt.

5. Der Plattenwärmetauscher gemäß Anspruch 1, wobei ein Zentrum des ersten Einlasslochs und ein Zentrum des ersten Auslasslochs näher zu einem Plattenrand relativ zu einem Zentrum des zweiten Einlasslochs und einem Zentrum des zweiten Auslasslochs positioniert sind.

6. Der Plattenwärmetauscher gemäß Anspruch 1, wobei eine erste Platte (3) und eine zweite Platte (2) abwechselnd gestapelt sind,
wobei das erste Einlassloch und das zweite Auslassloch nahe eines selben Randes in der Längsrichtung positioniert sind, und
wobei die erste Platte einen Abdichtabschnitt (11) umfasst zum Hindern eines Fluids, das von dem ersten Einlassloch eingetreten ist, am Fließen zu dem zweiten Auslassloch, wobei der Abdichtabschnitt als ein Vorsprung ausgebildet ist, der in eine Stapelrichtung der Mehrzahl von gestapelten Platten dergestalt erhöht ist, dass sich der Abdichtabschnitt von nahe des Randes, wo das erste Einlassloch und das zweite Auslassloch angeordnet sind, hin zu einem gegenüberliegenden Rand in der Längsrichtung erstreckt, um graduell einen Rand in der Lateralrichtung nahe des zweiten Auslasslochs anzunähern.

7. Der Plattenwärmetauscher gemäß Anspruch 1, wobei die Mehrzahl von gestapelten Platten dergestalt gestapelt ist, dass das erste Einlassloch von der jeden Platte mit ersten Einlasslöchern von anderen Platten fluchtet, so dass das erste Fluid aufeinanderfolgend von dem ersten Einlassloch von der jeden Platte gestapelt an einer Seite von der Stapelrichtung in das erste Einlassloch von der jeden Platte gestapelt an einer anderen Seite der Stapelrichtung fließt, und
wobei je näher die jede Platte von der Mehrzahl von gestapelten Platten zu der einen Seite, von der das erste Fluid eintritt, ist, umso kleiner ein Durchmesser des ersten Einlasslochs ist.

8. Der Plattenwärmetauscher gemäß Anspruch 1, wobei das erste Einlassloch und das zweite Auslassloch nahe einem selben Rand in der Längsrichtung ausgebildet sind und das zweite Einlassloch und das erste Auslassloch nahe eines selben Randes in der Längsrichtung ausgebildet sind, und
wobei eine Form des ersten Einlasslochs unterschiedlich von einer Form des zweiten Auslasslochs ist und eine Form des zweiten Einlasslochs unterschiedlich von einer Form des ersten Auslasslochs ist.

9. Der Plattenwärmetauscher gemäß Anspruch 8, wobei das erste Einlassloch und das zweite Auslassloch ausgebildet sind durch Teilen eines Lochs einer kreisförmigen, elliptischen oder einer mehreckigen Form in zwei Löcher, und
wobei das zweite Einlassloch und das erste Auslassloch ausgebildet sind durch Teilen eines Lochs einer kreisförmigen, elliptischen oder mehreckigen Form in zwei Löcher.

10. Ein Kühlmittel-Klimagerät umfassend den Wärmetauscher gemäß Anspruch 1.

Revendications

1. Échangeur de chaleur à plaques configuré avec une pluralité de plaques empilées (2, 3),
dans lequel chaque plaque de la pluralité de plaques empilées comprend :

un premier trou d'entrée (5) qui agit en tant qu'orifice d'entrée d'un premier fluide, le premier trou d'entrée étant situé à proximité d'un bord dans une direction longitudinale ;
un premier trou de sortie (6) qui fait office d'orifice de sortie du premier fluide, le premier trou de sortie étant situé à proximité d'un autre bord opposé au premier trou d'entrée dans la direction longitudinale ;
un second trou d'entrée (7) qui fait office d'orifice d'entrée d'un second fluide, le second trou d'entrée étant situé à proximité d'un bord dans la direction longitudinale ; et
un second trou de sortie (8) qui fait office d'orifice de sortie du second fluide, le second trou de sortie étant situé à proximité d'un autre bord opposé au second trou d'entrée dans la direction longitudinale ;
dans lequel chaque plaque et une plaque adjacente définissent entre elles l'un ou l'autre d'un premier chemin d'écoulement et d'un second chemin d'écoulement, le premier chemin

d'écoulement laissant passer le premier fluide entré en provenance du premier trou d'entrée vers le premier trou de sortie de telle sorte que le premier fluide s'étende dans une direction latérale, et le second chemin d'écoulement laissant passer le second fluide entré en provenance du deuxième trou d'entrée vers le second trou de sortie de telle sorte que le second fluide s'étende dans la direction latérale, et chaque plaque d'échange de la chaleur entre le premier fluide qui s'écoule à travers le premier chemin d'écoulement et le second fluide qui s'écoule à travers le second chemin d'écoulement ;
dans lequel chacune d'une surface d'ouverture du premier trou d'entrée et d'une surface d'ouverture du premier trou de sortie est plus petite que l'une ou l'autre d'une surface d'ouverture du second trou d'entrée et d'une surface d'ouverture du second trou de sortie ;
dans lequel chaque plaque comprend des parties convexes et des parties concaves en forme de V agencées en une pluralité d'ensembles dans la direction longitudinale, chacune des parties convexes et des parties concaves présentant des extrémités (13) au niveau des deux extrémités dans la direction latérale et présentant également un point de virage (12) désaligné de manière longitudinale par rapport aux extrémités, de telle sorte que les parties convexes et les parties concaves soient formées en une forme de V ; et
caractérisé en ce que les parties convexes et les parties concaves en forme de V sont agencées de telle sorte que, à proximité d'une partie centrale dans la direction longitudinale, le point de virage soit formé au niveau d'un centre dans la direction latérale, et à proximité au moins de l'un ou l'autre du premier trou d'entrée et du premier trou de sortie, la position du point de virage soit décalée de manière progressive à partir du centre dans la direction latérale au fur et à mesure que la position de chacune des parties convexes et de parties concaves en forme de V se rapproche de l'un ou l'autre du premier trou.

2. Échangeur de chaleur à plaques selon la revendication 1,
dans lequel chaque plaque est configurée de telle sorte que la longueur (L1) dans la direction longitudinale soit égale à 4 fois ou plus la longueur (L2) dans la direction latérale.

3. Échangeur de chaleur à plaques selon la revendication 1,
dans lequel chacune de la longueur (L3) à partir du premier trou d'entrée vers un bord de plaque à proximité du premier trou d'entrée dans la direction latérale, de la longueur (L4) à partir du premier trou de sortie vers un bord de plaque à proximité du premier trou de sortie dans la direction latérale, de la longueur (L5) à partir du second trou d'entrée vers un bord de plaque à proximité du second trou d'entrée dans la direction latérale, et de la longueur (L6) à partir du second trou de sortie vers un bord de plaque à proximité du second trou de sortie dans la direction latérale, n'est pas supérieure à 6 pour cent de la longueur (L2) dans la direction latérale.

4. Échangeur de chaleur à plaques selon la revendication 1,
dans lequel chacune de la longueur (L3) à partir du premier trou d'entrée vers un bord de plaque à proximité du premier trou d'entrée dans la direction latérale, de la longueur (L4) à partir du premier trou de sortie vers un bord de plaque à proximité du premier trou de sortie dans la direction latérale, de la longueur (L5) à partir du second trou d'entrée vers un bord de plaque à proximité du second trou d'entrée dans la direction latérale, et de la longueur (L6) à partir du second trou de sortie vers un bord de plaque à proximité du second trou de sortie dans la direction latérale, n'est pas supérieure à 5,6 mm.

5. Échangeur de chaleur à plaques selon la revendication 1,
dans lequel le centre du premier trou d'entrée et le centre du premier trou de sortie sont positionnés plus près d'un bord de plaque que le centre du second trou d'entrée et le centre du second trou de sortie.

6. Échangeur de chaleur à plaques selon la revendication 1,
dans lequel une première plaque (3) et une deuxième plaque (2) sont empilées de manière alternée, dans lequel le premier trou d'entrée et le second trou de sortie sont positionnés à proximité d'un même bord dans la direction longitudinale ; et
dans lequel la première plaque comprend une partie étanchéité (11) destinée à empêcher un fluide qui a pénétré à partir du premier trou d'entrée de s'écouler vers le second trou de sortie, la partie étanchéité étant formée sous la forme d'une saillie relevée dans la direction d'empilement de la pluralité de plaques empilées de telle sorte que la partie étanchéité s'étend à partir de la proximité du bord où le premier trou d'entrée et le second trou de sortie se situent vers un bord opposé dans la direction longitudinale, de façon à s'approcher de manière progressive vers un bord dans la direction transversale à proximité du second trou de sortie.

7. Échangeur de chaleur à plaques selon la revendication 1,
dans lequel la pluralité de plaques empilées sont empilées de telle sorte que le premier trou d'entrée de chaque plaque est aligné avec les premiers trous

d'entrée des autres plaques, de telle sorte que le premier fluide s'écoule de manière séquentielle à partir du premier trou d'entrée de chaque plaque empilée au niveau d'un côté de la direction d'empilement dans le premier trou d'entrée de chaque plaque empilée au niveau d'un autre côté de la direction d'empilement ; et

dans lequel plus chaque plaque de la pluralité de plaques empilées se rapproche du côté à partir duquel le premier fluide pénètre, plus le diamètre du premier trou d'entrée est petit.

8. Échangeur de chaleur à plaques selon la revendication 1,

dans lequel le premier trou d'entrée et le second trou de sortie sont formés à proximité d'un même bord dans la direction longitudinale, et le second trou d'entrée et le premier trou de sortie sont formés à proximité d'un même bord dans la direction longitudinale ; et

dans lequel la forme du premier trou d'entrée est différente de la forme du second trou de sortie, et la forme du second trou d'entrée est différente de la forme du premier trou de sortie.

9. Échangeur de chaleur à plaques selon la revendication 8,

dans lequel le premier trou d'entrée et le second trou de sortie sont formés en divisant un trou de forme circulaire, elliptique ou polygonale en deux trous ; et

dans lequel le second trou d'entrée et le premier trou de sortie sont formés en divisant un trou de forme circulaire, elliptique ou polygonale en deux trous.

10. Climatiseur de réfrigération comprenant l'échangeur de chaleur à plaques selon la revendication 1.

Fig. 1

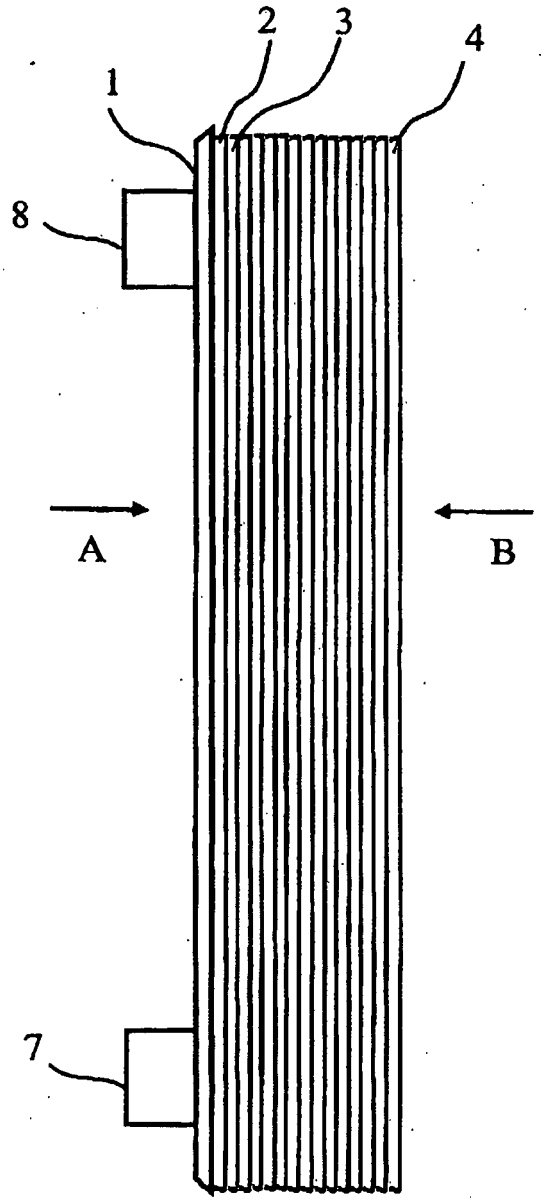


Fig. 2

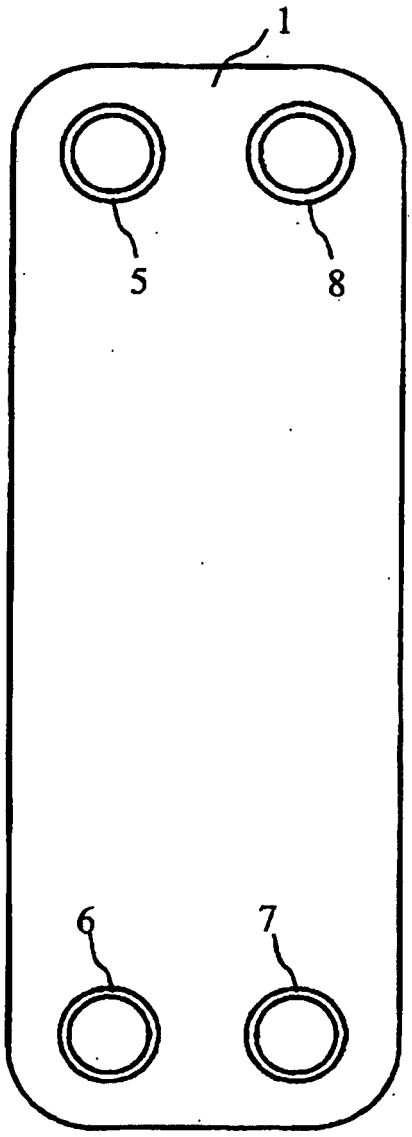


Fig. 3

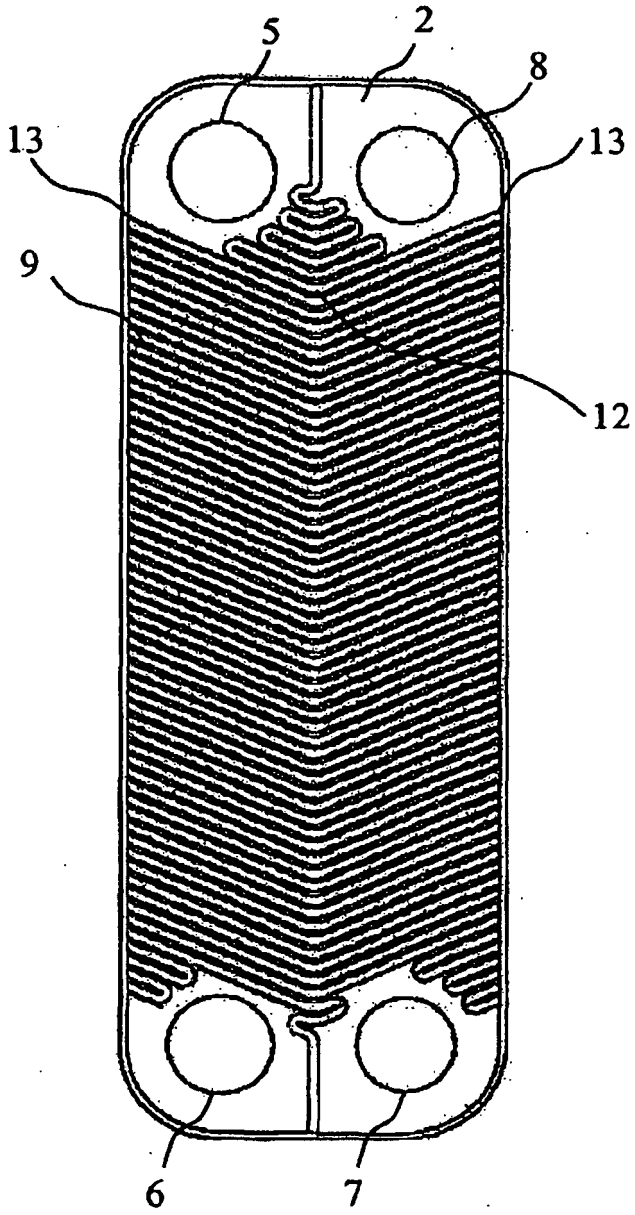


Fig. 4

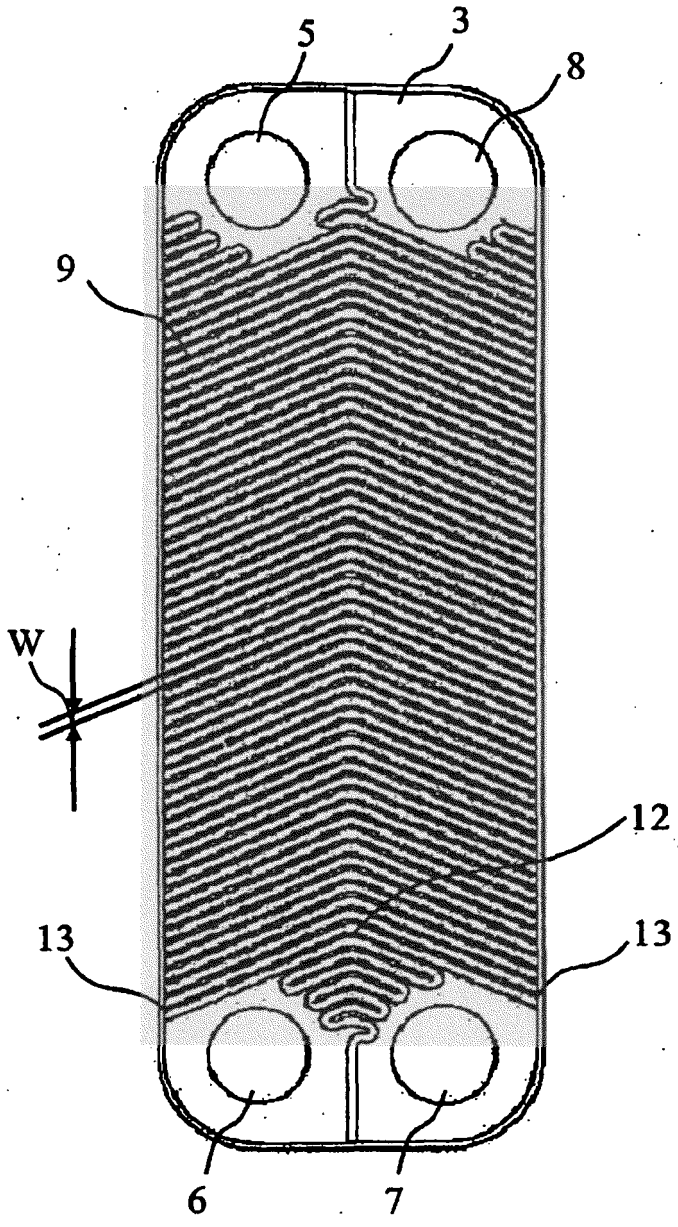


Fig. 5

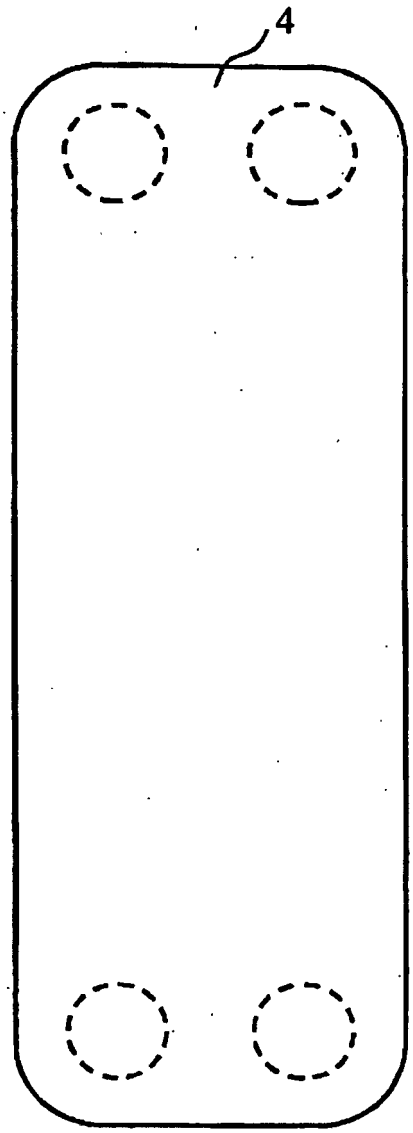


Fig.6

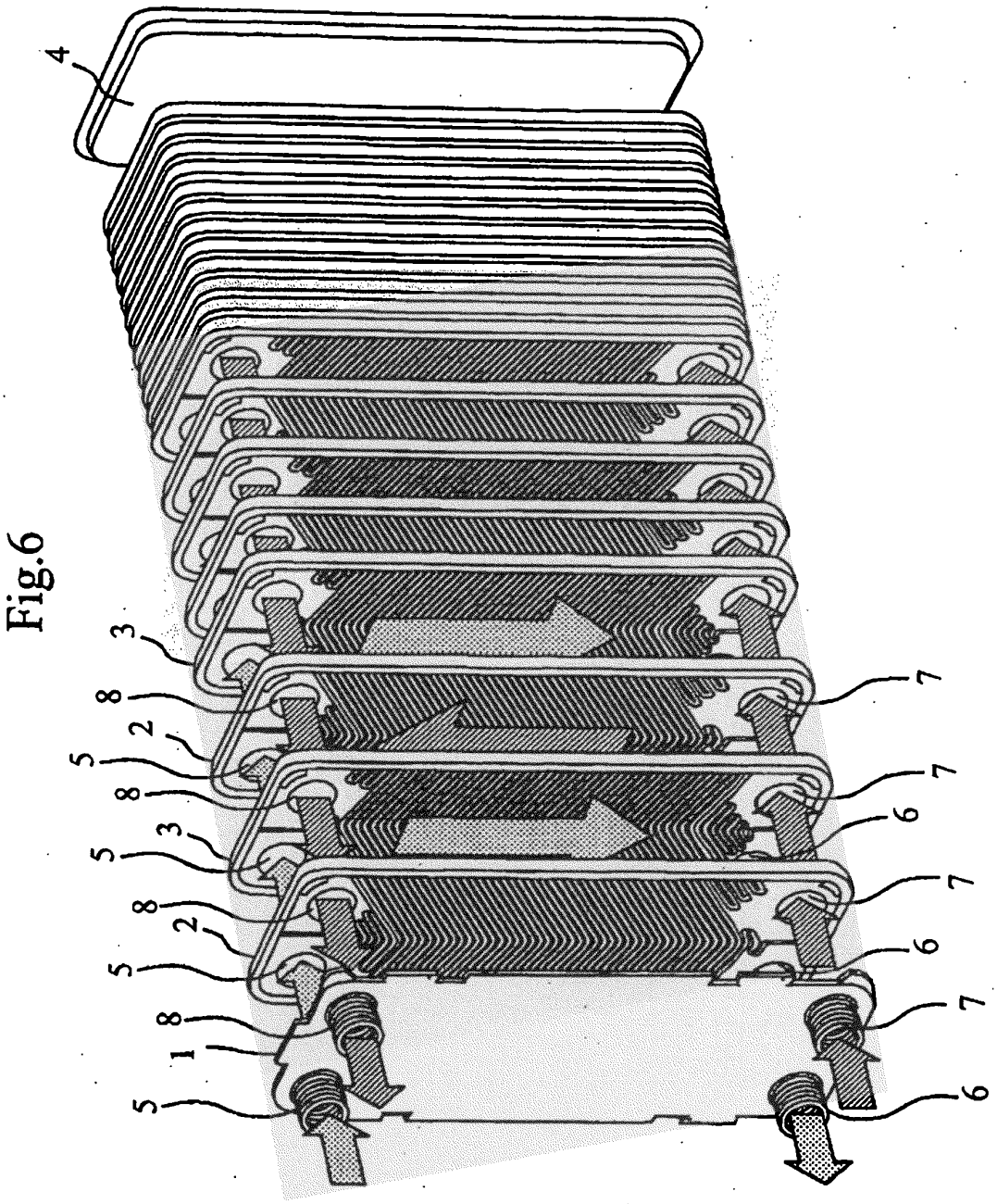


Fig. 7

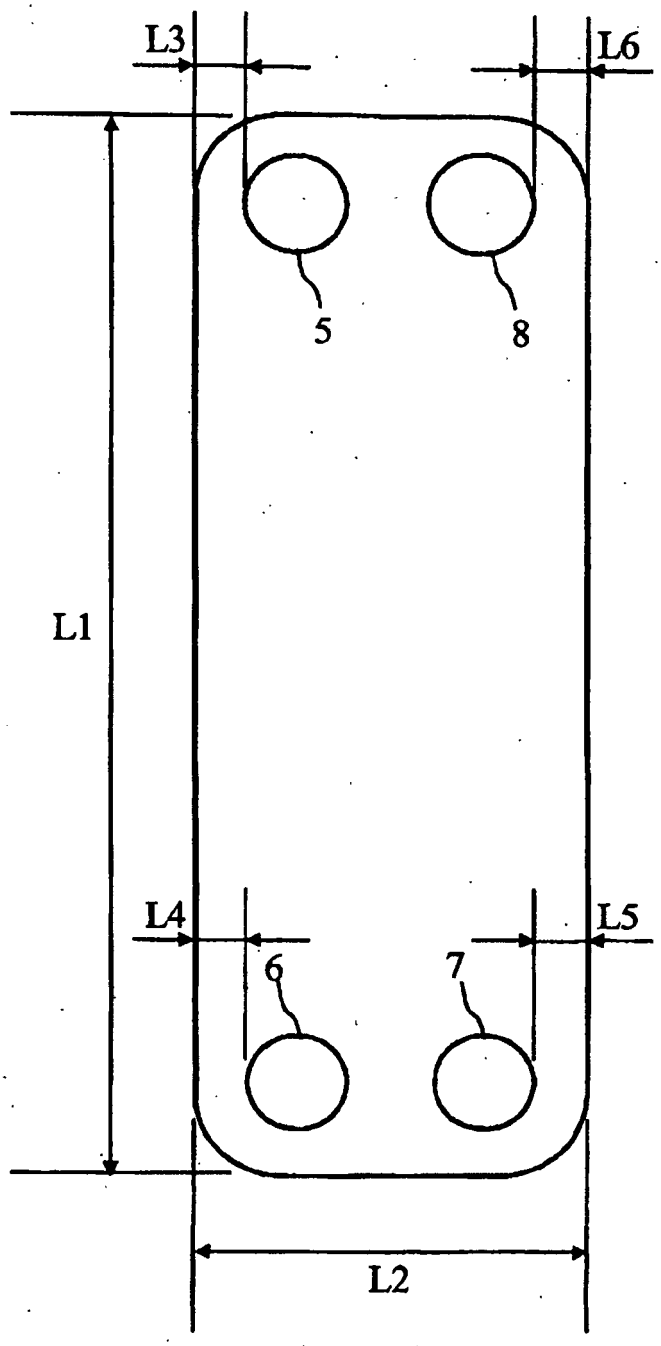


Fig. 8

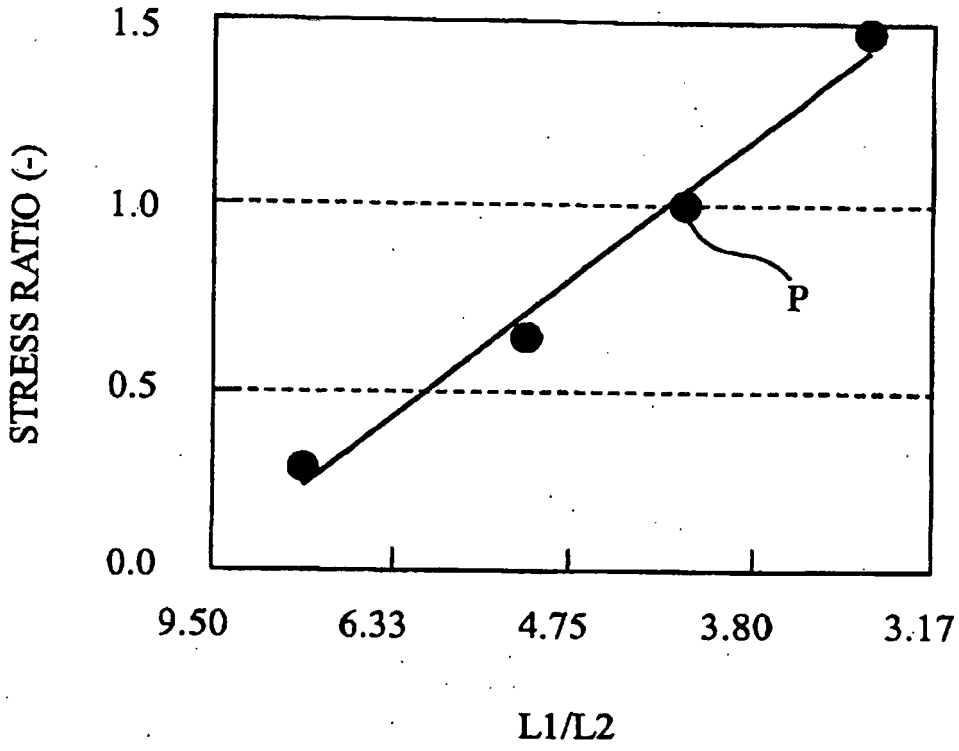


Fig. 9

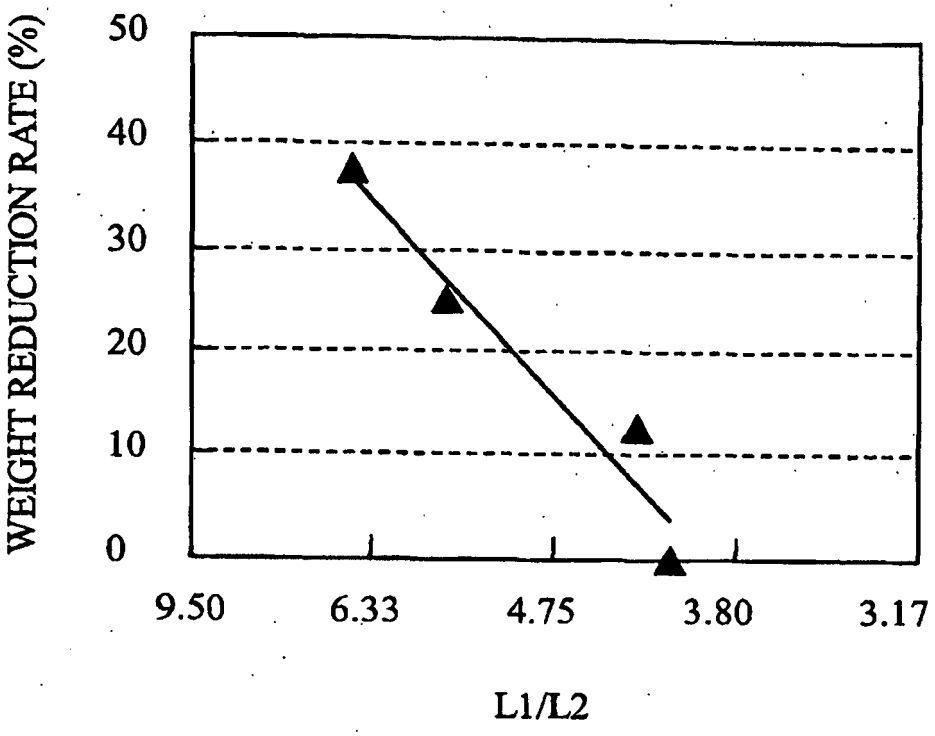


Fig. 10

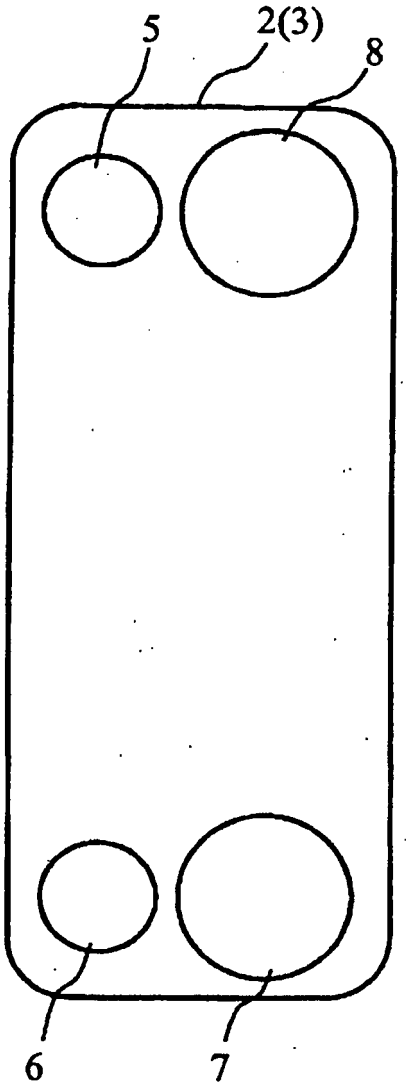


Fig.11

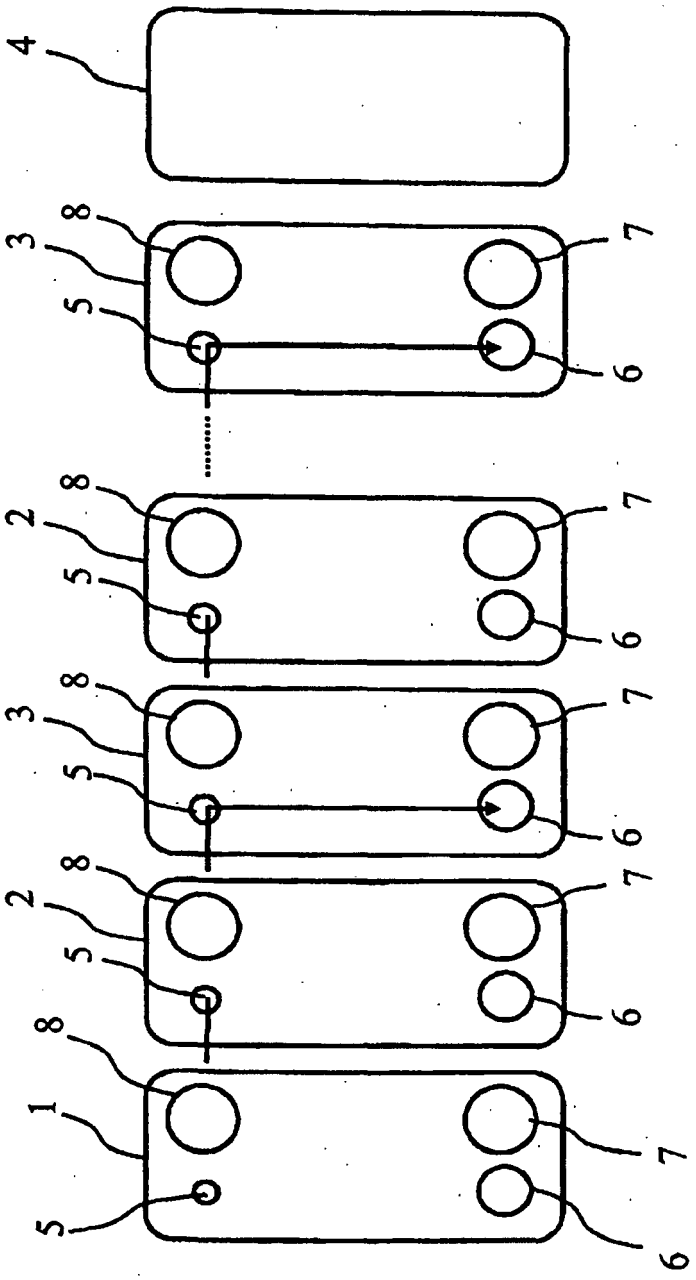


Fig. 12

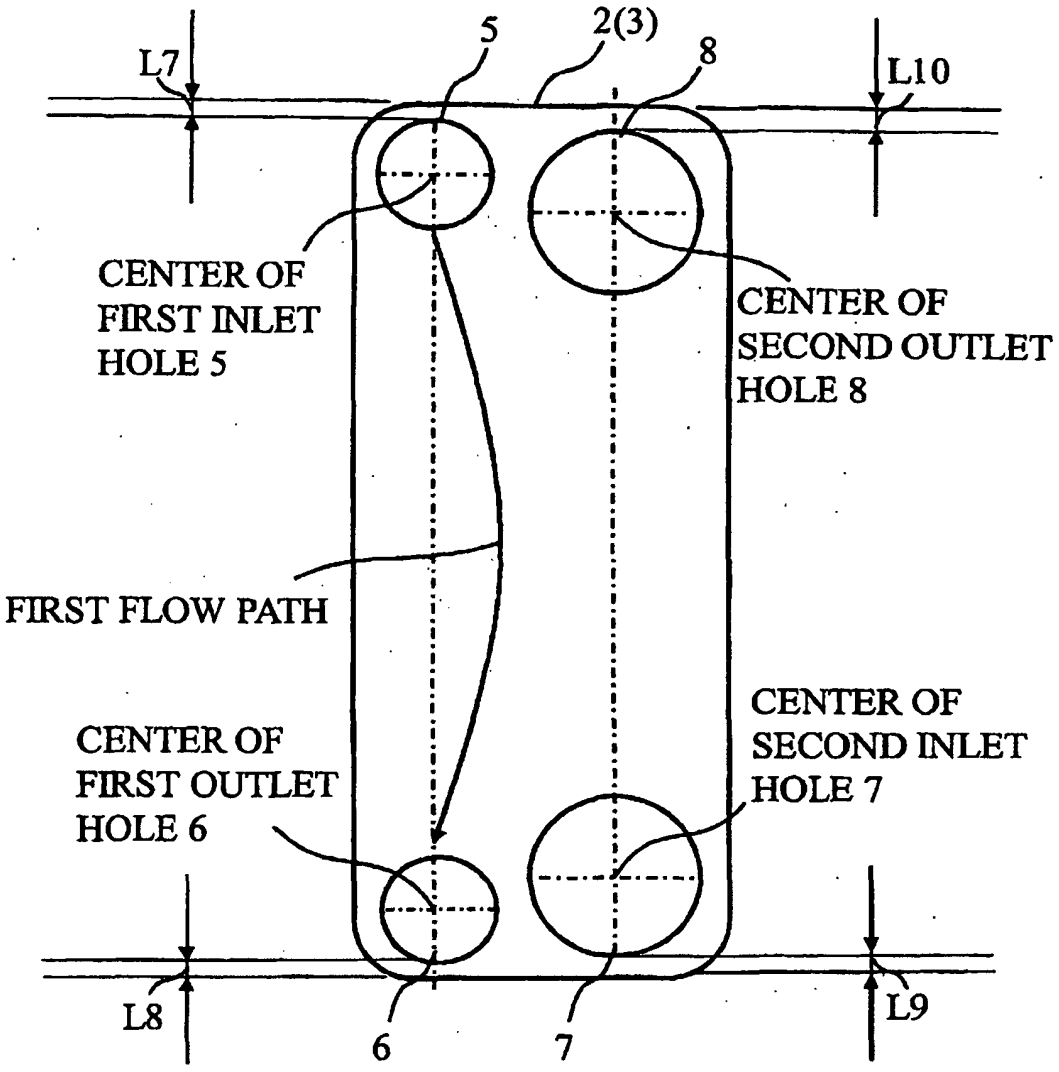

L7
5
2(3)
8
L10
CENTER OF FIRST INLET HOLE 5
CENTER OF SECOND OUTLET HOLE 8
FIRST FLOW PATH
CENTER OF FIRST OUTLET HOLE 6
CENTER OF SECOND INLET HOLE 7
L8
6
7
L9

Fig. 13

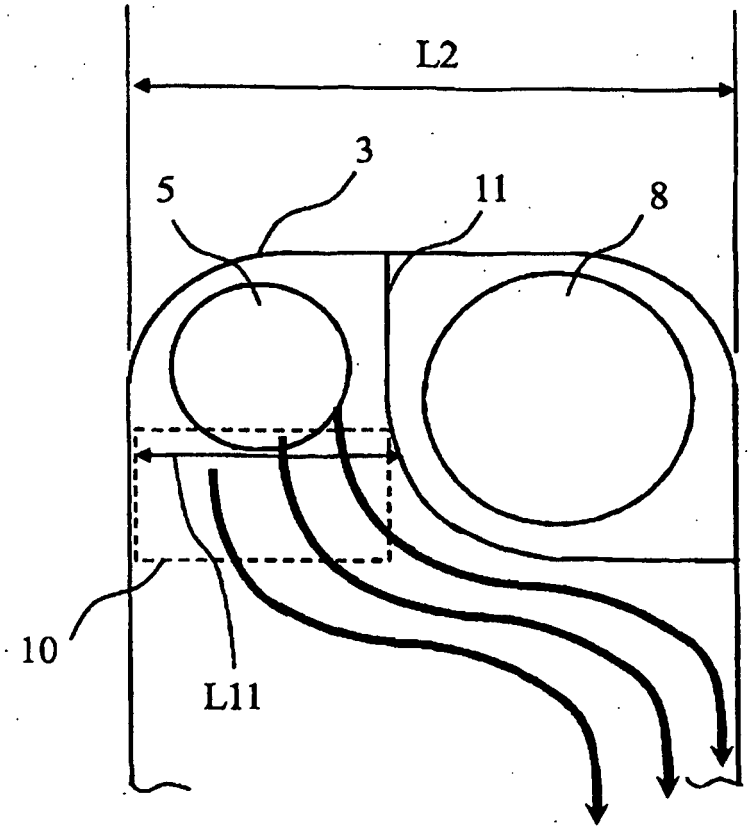


Fig. 14

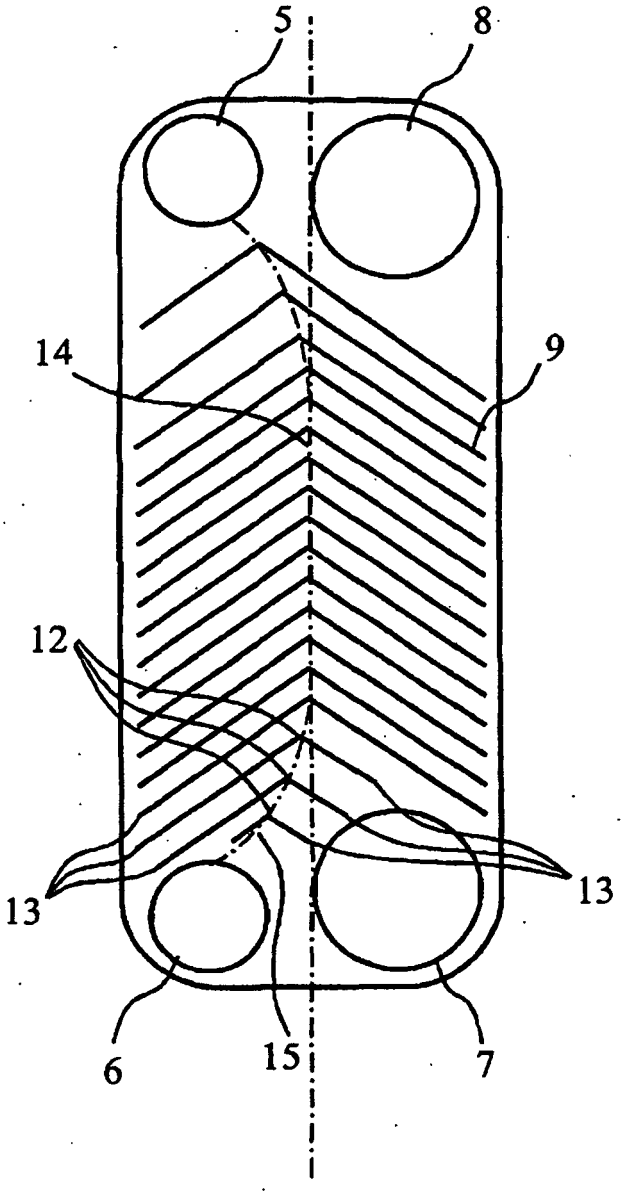


Fig. 15

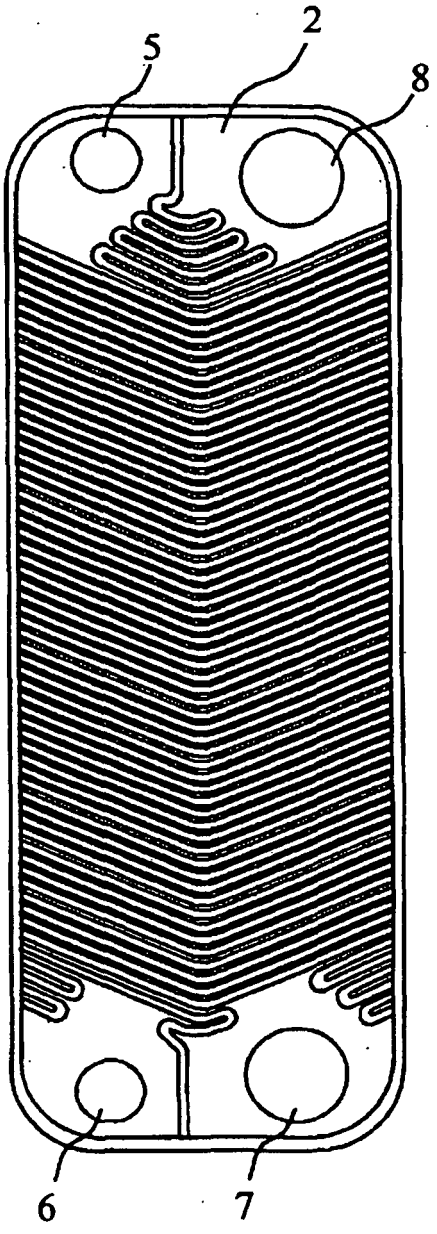


Fig. 16

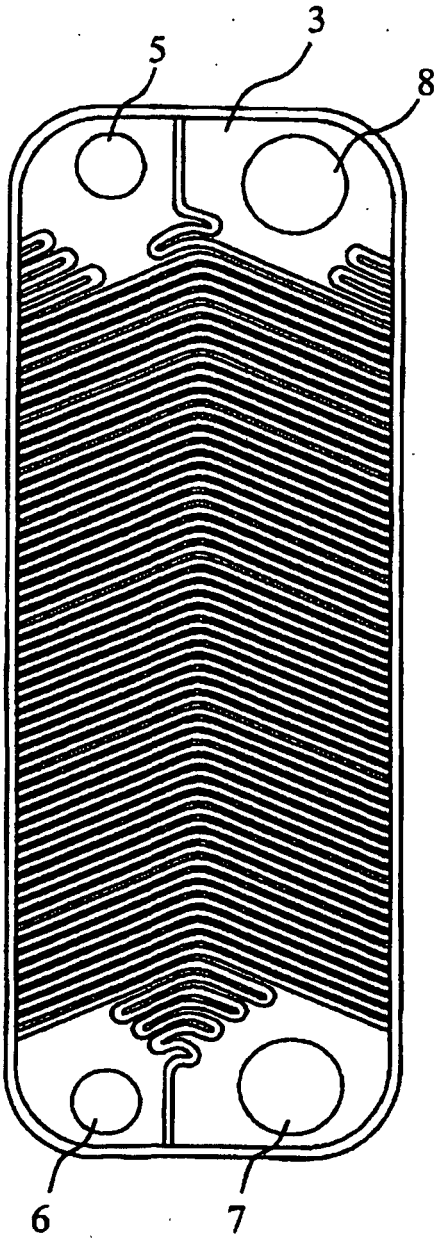


Fig. 17

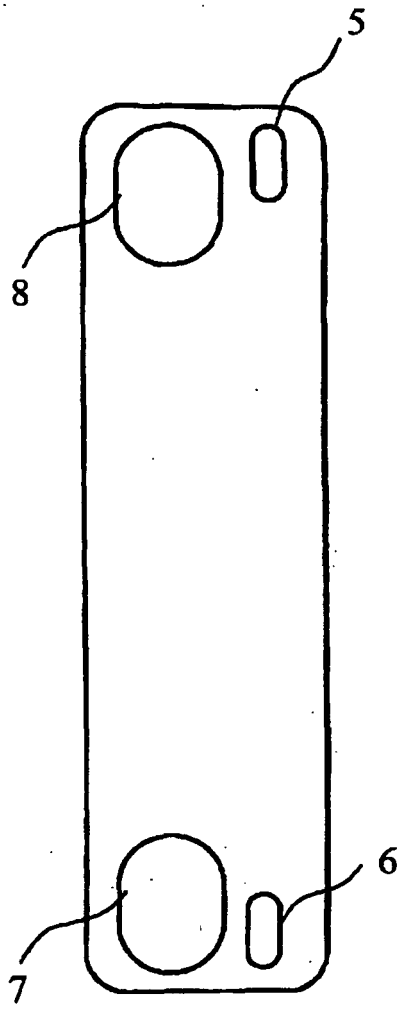


Fig. 18

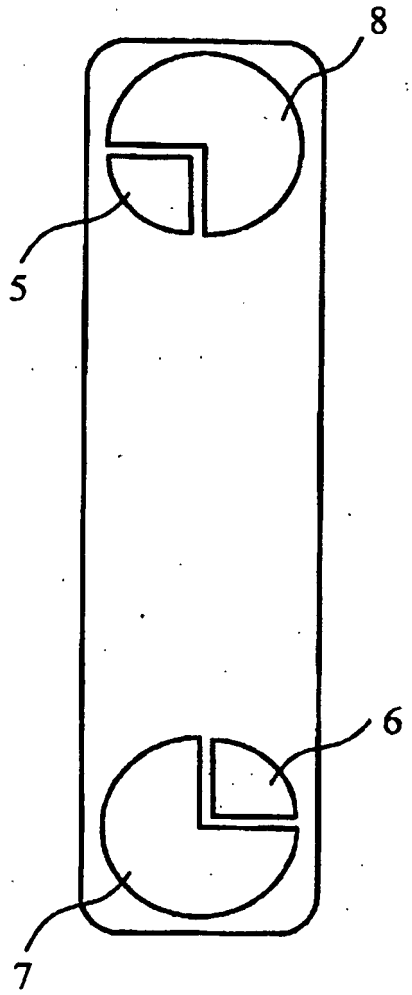


Fig. 19

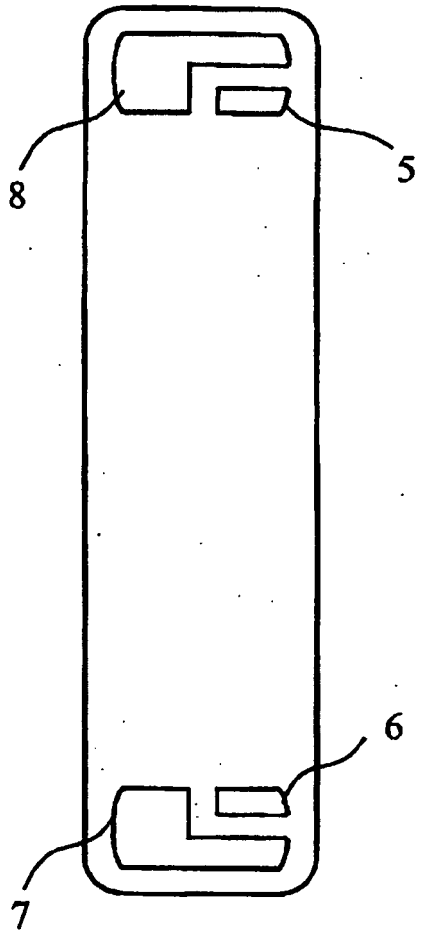
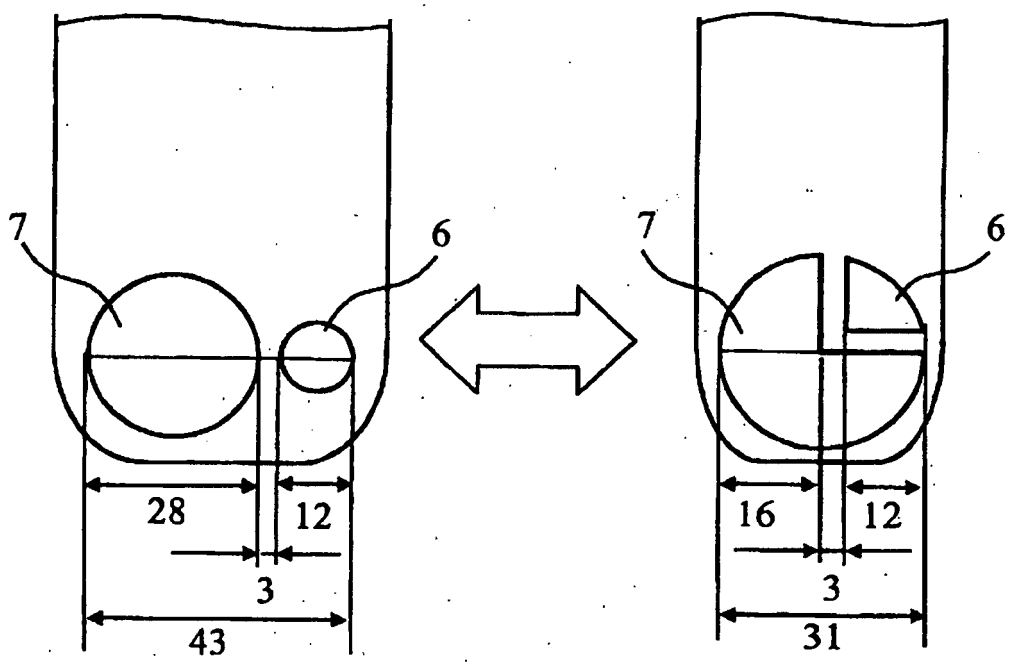


Fig. 20



(a) (b)

Fig. 21

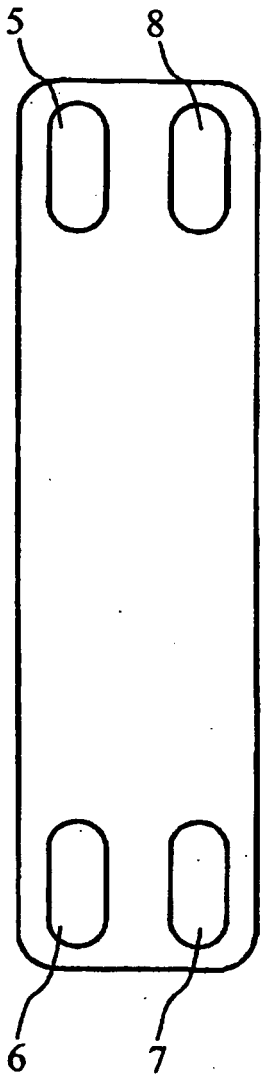


Fig. 22

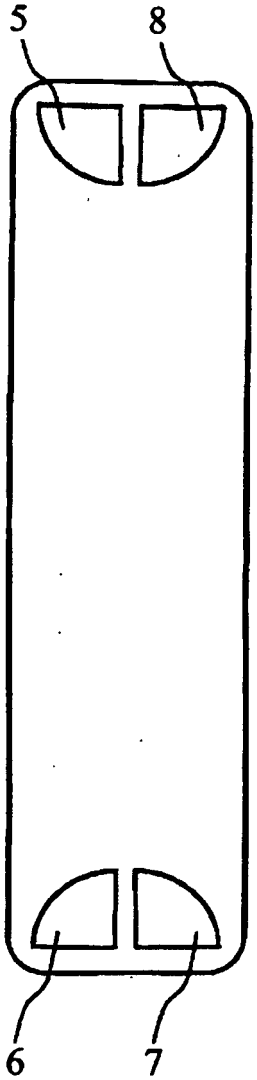


Fig. 23

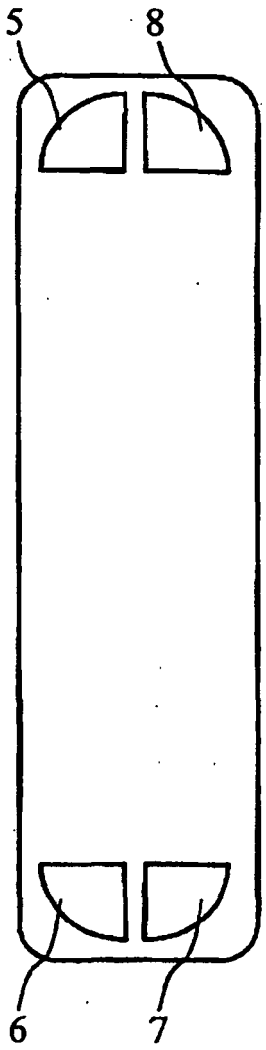


Fig. 24

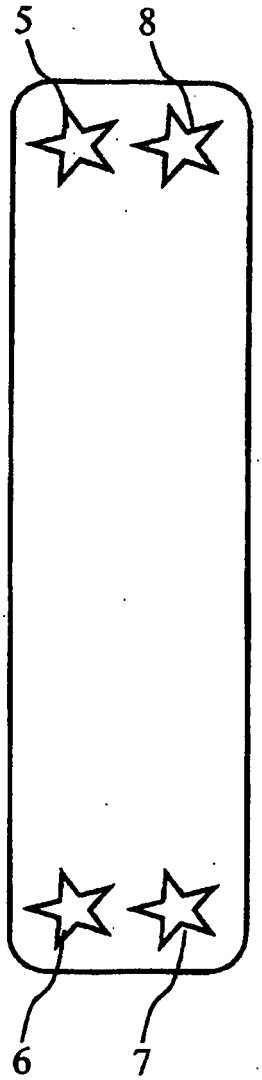
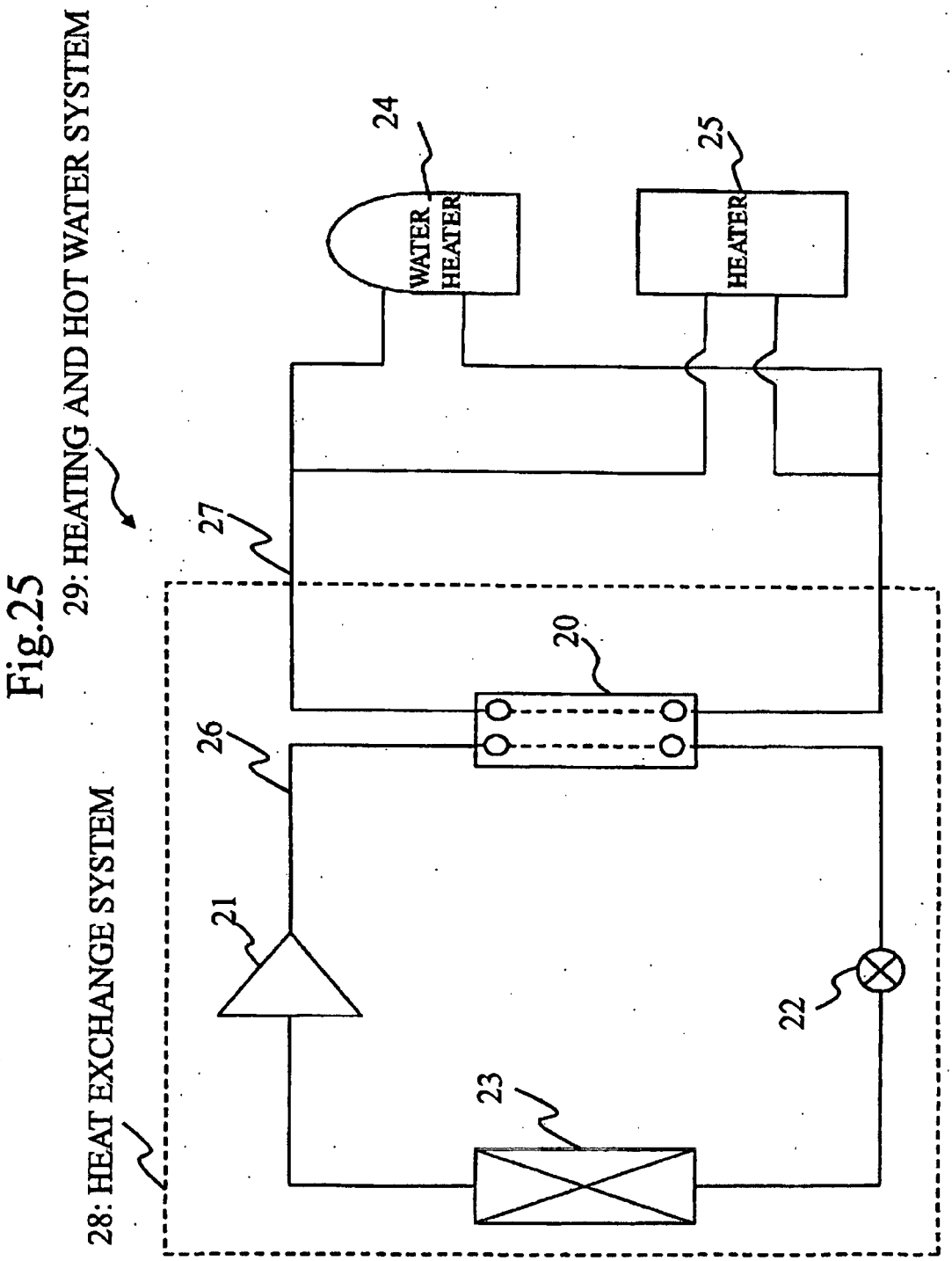


Fig.25


29: HEATING AND HOT WATER SYSTEM
28: HEAT EXCHANGE SYSTEM
24
WATER HEATER
25
HEATER
27
20
26
21
22
23

REFERENCES CITED IN THE DESCRIPTION

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