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(54) Fluid guide plate and associated plate heat exchanger

(57) A fluid guide plate (10) and a plate heat exchanger (20) are provided. The fluid guide plate (10) includes a first heat exchanging surface (11), a second heat exchanging surface (12), and a plurality of heat exchanging portions (13) formed by recessing the first heat exchanging surface (11) and disposed in protrusion at the second heat exchanging surface (12). Each of the heat exchanging portions (13) has a polygonal planar contour. The plate heat exchanger (20) includes a plurality of fluid guide plates (21, 22). The heat exchanging portions (213, 223) on the fluid guide plates (21, 22) are staggered to form a channel system. Accordingly, the heat exchanging portions (213, 223) allow fluids (100, 101) to vigorously flow and form a longitudinal vortex in the channel system to further generate a strong turbulence for enhancing heat transfer efficiency and reducing pressure drops of the fluids (100, 101). Further, the fluid guide plates (10, 21, 22) of the present invention are capable of significantly reducing mold developments and lowering production costs.

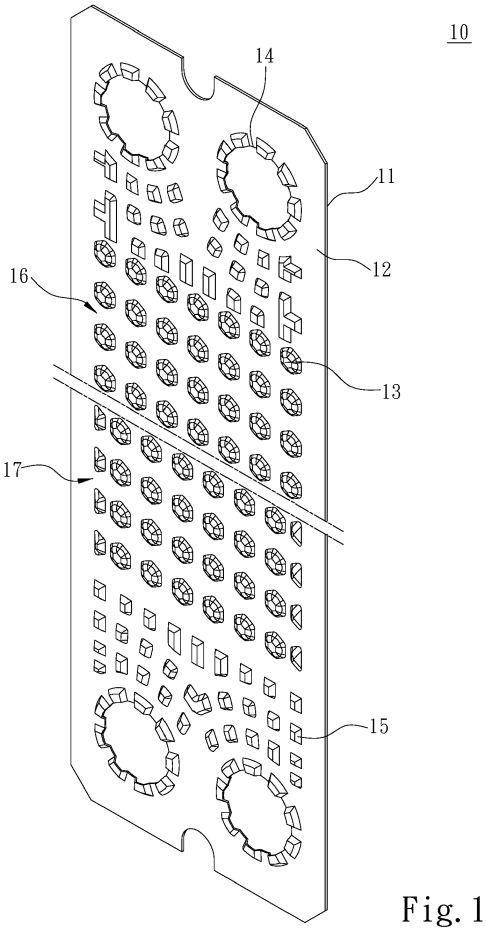

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a plate heat exchanger, and particularly to a plate heat exchanger including a fluid guide plate having a heat exchanging portion with a polygonal planar contour.

BACKGROUND OF THE INVENTION

[0002] Current plate heat exchangers are generally formed from stamped curved stainless steel plates in a parallel arrangement. One of most common curved patterns is curved chevron. The curved chevron patterns of the two adjacent plates are a combination of the two adjacent plates placed at 180 degrees inverted to each other. As such, convex ribs of the two adjacent plates form an intersecting contact point to further form a juxtaposed channel system. This juxtaposed channel system allows a fluid flown into the plate heat exchanger to produce a strong turbulence, hence achieving a design with a high heat transfer effect. For example, assume that a travel approach of the fluid in the plate heat exchanger is designed in a way that, a cold fluid passes through one side channel, a hot fluid passes through a next side channel, and a cold fluid passes through a second next channel. Accordingly, heat exchange of the cold and hot fluids in the plate heat exchanger is thoroughly performed to achieve maximized conversion efficiency.

[0003] Taiwan Patent publication Nos. 201030306, 201408982 and Taiwan Patent No. I445917 disclose examples of plate heat exchangers in curved chevron patterns. Further, according to differences in angles, the curved chevron patterns may be categorized into high theta plates and low theta plates. More specifically, the curved chevron pattern of low theta plates has a smaller included angle, whereas the curved chevron pattern of high theta plates has a larger included angle. Under a constant flow rate, low theta plates have a lower pressure drop as well as a smaller heat transfer coefficient. Conversely, high theta plates usually have a higher pressure drop as well as a larger heat transfer coefficient. In general, low theta plates are frequently applied for cooling (or heating) a high mass flow rate or a low heat transfer capacity (a low specific heat fluid or a small change in temperature), whereas high theta plates are usually applied for cooling (or heating) a small mass flow rate or a high heat transfer capacity (a high specific heat fluid, or a large change in a latent heat phase or temperature). For manufacturers of plate heat exchangers, in response to different application requirements, molds for high theta plates and low theta plates need to be simultaneously fabricated to produce plate heat exchangers in different specifications, leading to increased production costs. Therefore, there is a need for a solution for a design that at the same time provides advantages of both high theta plates and low theta plates as well as reduced production costs.

SUMMARY OF THE INVENTION

[0004] It is a primary object of the present invention to overcome issues of low theta plates and high theta plates having respective advantages and disadvantages as well as high costs caused by two sets of production molds of the plates.

[0005] To achieve the above object, the present invention provides a fluid guide plate applied in a plate heat exchanger. The fluid guide plate includes a first heat exchanging surface and a second heat exchanging surface correspondingly provided at one side of the fluid guide plate, and a plurality of heat exchanging portions. The heat exchanging portions are formed by recessing the first heat exchanging surface towards the second heat exchanging surface and are disposed in protrusion at the second heat exchanging surface. Further, each of the heat exchanging portions has a polygonal planar contour.

[0006] In one embodiment of the present invention, each of the heat exchanging portions has a right hexagonal planar contour.

[0007] In one embodiment of the present invention, the fluid guide plate further includes at least two fluid openings penetrated through the first heat exchanging surface and the second heat exchanging surface. The heat exchanging portions are disposed between the fluid openings.

[0008] In one embodiment of the present invention, the fluid guide plate further includes a plurality of fluid guide portions located between the fluid openings and the heat exchanging portions. The fluid guide portions are formed by recessing the first heat exchanging surface towards the second heat exchanging surface and are disposed in protrusion at the second heat exchanging surface.

[0009] In one embodiment of the present invention, a distance between two adjacent heat exchanging portions is 1mm to 5mm.

[0010] In one embodiment of the present invention, each of the heat exchanging portions has a protruding height extended from the second heat exchanging surface, and a protruding width formed between any two opposite sides of the heat exchanging portion. A ratio of the protruding height to the protruding width is 0.18 to 0.22.

[0011] In one embodiment of the present invention, the heat exchanging portions are arranged to form a first guide group and a second guide group. The heat exchanging portions of the first guide group and the heat exchanging portions of the second guide group are in a staggered arrangement.

[0012] To achieve the above object, the present invention provides a plate heat exchanger. The plate heat exchanger includes a first fluid guide plate, a second fluid guide plate disposed at a distance from the first fluid guide plate, and a stopping member. The stopping member is located between the first fluid guide plate and the second

fluid guide plate, and jointly form a heat exchanging space with the first fluid guide plate and the second fluid guide plate. The heat exchanging space includes a fluid entrance for a fluid to enter the heat exchanging space, and a fluid exit for the fluid to exit the heat exchanging space. The first fluid guide plate includes a third heat exchanging surface facing the second fluid guide plate, a fourth heat exchanging surface disposed at one side away from the second fluid guide plate, and a plurality of first heat exchanging portions formed by recessing the third heat exchanging surface towards the fourth heat exchanging surface and disposed in protrusion at the third heat exchanging surface. The second fluid guide plate includes a fifth heat exchanging surface facing the first fluid guide plate, a sixth heat exchanging surface disposed at one side away from the first fluid guide plate, and a plurality of second heat exchanging portions formed by recessing the sixth heat exchanging surface towards the fifth heat exchanging surface and disposed in protrusion at the fifth heat exchanging surface. Each of the first heat exchanging portions and the second heat exchanging portions has a polygonal planar contour. The first heat exchanging portions and the second heat exchanging portions are in a staggered arrangement.

[0013] In one embodiment of the present invention, each of the first heat exchanging portions and the second heat exchanging portions has a right hexagonal planar contour.

[0014] In one embodiment of the present invention, the first fluid guide plate further includes at least two first fluid openings penetrated through the third heat exchanging surface and the fourth heat exchanging surface. The first heat exchanging portions are disposed between the first fluid openings. The second fluid guide plate further includes at least two second fluid openings penetrated through the fifth heat exchanging surface and the sixth heat exchanging surface. The second heat exchanging portions are disposed between the second fluid openings.

[0015] In one embodiment of the present invention, the first fluid guide plate includes a plurality of first fluid guide portions located between the first fluid openings and the first heat exchanging portions. The first fluid guide portions are formed by recessing the third heat exchanging surface towards the fourth heat exchanging surface, and are disposed in protrusion at the fourth heat exchanging surface. The second fluid guide plate includes a plurality of second fluid guide portions located between the second fluid openings and the second heat exchanging portions. The second fluid guide portions are formed by recessing the sixth heat exchanging surface towards the fifth heat exchanging surface and are disposed in protrusion at the fifth heat exchanging surface.

[0016] In one embodiment of the present invention, a distance between two adjacent first heat exchanging portions is 1mm to 5mm, and a distance between two adjacent second heat exchanging portions is 1mm to 5mm.

[0017] In one embodiment of the present invention, each of the first heat exchanging portions has a first protruding height extended from the fourth heat exchanging surface, and a first protruding width formed between any two opposite sides of the first heat exchanging portion. A ratio of the first protruding height to the first protruding width is 0.18 to 0.22. Each of the second heat exchanging portions has a second protruding height extended from the fifth heat exchanging surface, and a second protruding width formed between any two opposite sides of the second heat exchanging portion. A ratio of the second protruding height to the second protruding width is 0.18 to 0.22.

[0018] In one embodiment of the present invention, the first heat exchanging portions on the first fluid guide plate are arranged to form a third guide group and a fourth guide group. The first heat exchanging portions of the third guide group and the first heat exchanging portions of the fourth guide group are in a staggered arrangement.

[0019] In one embodiment of the present invention, the second heat exchanging portions on the second fluid guide plate are arranged to form a fifth guide group and a sixth guide group. The second heat exchanging portion of the fifth guide group and the second heat exchanging portions of the sixth guide group are in a staggered arrangement.

[0020] Compared to a conventional heat exchanger having a curved chevron pattern, the fluid guide plate and the plate heat exchanger of the present invention provide following advantages.

1. The fluid guide plate of the present invention has the same specification and thus needs only one set of mold. Compared to a low theta plate and a high theta plate of a conventional solution that is in one specification and however requires two sets of molds, the fluid guide plate of the present invention reduces production costs by about 50%.
2. In the present invention, the heat exchanging portions have a polygonal planar contour, and the heat exchanging portions of the adjacent fluid guide plates are in a staggered arrangement to form a channel system. Accordingly, the heat exchanging portions allow two fluids to vigorously flow and form a longitudinal vortex in the channel system to further produce a strong turbulence for enhancing heat transfer efficiency and lowering pressure drops of the two fluids.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 is a schematic diagram of a structure of a fluid guide plate of the present invention.

Fig. 2 is a schematic diagram of a structure of a plate heat exchanger of the present invention.

Fig. 3 is a schematic diagram of heat exchange between fluids in a plate heat exchanger of the present

invention.

Fig. 4 is a schematic diagram of relative positions of a first fluid guide plate and a stopping member of the present invention.

Fig. 5 is a schematic diagram of relative positions of a second fluid guide plate and a stopping member of the present invention.

Fig. 6 is a schematic diagram of channel pressure distributions of the present invention, a low theta plate and a high theta plate.

Fig. 7 is a comparison diagram of heat transfer of the present invention, a low theta plate and a high theta plate.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] The foregoing, as well as additional objects, features and advantages of the invention will be more readily apparent from the following detailed description, which proceeds with reference to the accompanying drawings.

[0023] The present invention provides a fluid guide plate 10 and a plate heat exchanger 20 applied to the fluid guide plate 10, as shown in Fig. 1 and Fig. 2. Referring to Fig. 1, the fluid guide plate 10 includes a first heat exchanging surface 11, a second heat exchanging surface 12 disposed correspondingly to the first heat exchanging surface 11 at the other side of the first heat exchanging surface 11, a plurality of heat exchanging portions 13 formed at the first heat exchanging surface 11 and the second heat exchanging surface 12, at least two fluid openings 14 penetrated through the first heat exchanging surface 11 and the second heat exchanging surface 12, and a plurality of fluid guide portions 15 formed at the first heat exchanging surface 11 and the second heat exchanging surface 12. The heat exchanging potions 13 and the fluid guide portions 15 are disposed between the fluid openings 14, and the fluid guide portions 14 are disposed between the fluid openings 14 and the heat exchanging portions 13. In the embodiment, preferably, the fluid guide plate 10 includes four fluid openings 14. Further, preferably, for example, the heat exchanging portions 13 and the fluid guide portions 15 are formed by a stamping process. Each of the heat exchanging portions 13 has a right hexagonal planar contour. The heat exchanging portions 13 and the fluid guide portions 15 are formed by recessing the first heat exchanging surface 11 towards the second heat exchanging surface 12 and are disposed in protrusion at the second heat exchanging surface 12. Regarding a structure ratio of the heat exchanging portions 13, each of the heat exchanging portions 13 has a protruding height extended from the second heat exchanging surface 12, and a protruding width formed between any two opposite sides of the heat exchanging portion 13. Preferably, a ratio of the protruding height to the protruding width is 0.18 to 0.22. Regarding a distribution pattern of the heat exchanging portions 13, preferably, a distance between two adjacent heat exchanging portions 13 is 1mm to 5mm. Further, the heat exchanging portions 13 are arranged to form a first guide group 16 and a second guide group 17. The heat exchanging portions 13 of the first guide group 16 and the heat exchanging portions 13 of the second guide group 17 are in a staggered arrangement.

[0024] Referring to Fig. 2 to Fig. 5, the plate heat exchanger 20 includes at least one first fluid guide plate 21, at least one second fluid guide plate 22 disposed at a distance from each first fluid guide plate 21, at least one stopping member 23 located between each first fluid guide plate 21 and each second fluid guide plate 22, a first input pipe 24 for inputting a first fluid 100, a first output pipe 25 for outputting the first fluid 100, a second input pipe 26 for inputting a second fluid 101, a second output pipe 27 for outputting the second fluid 101, and four fluid sealing members 28 disposed at a distance from one another. It should be noted that, each of the first fluid guide plate 21 and each of the second fluid guide plate 22 have identical structural features from the foregoing fluid guide plate 10, and are herein distinguished for better describing an assembly of the plate heat exchanger 20.

[0025] In the embodiment, the first input pipe 24, the first output pipe 25, the second input pipe 26 and the second output pipe 27 are located at a same side, and are assembled to one first fluid guide plate 21. In other possible embodiments, positions for disposing the first input pipe 24, the first output pipe 25, the second input pipe 26 and the second output pipe 27 may be adjusted according to actual requirements. Details of the four fluid sealing members 28 are to be described shortly.

[0026] In the embodiment, one single first fluid guide plate 21 and one single second fluid plate 22 placed next to each other are taken as an example for illustrating respective structures and an arrangement relationship, as the first fluid guide plate 21 and the second fluid guide plate 22 that are adjacent to each other at the left side in Fig. 2 and Fig. 3. The first fluid guide plate 21 includes a third heat exchanging surface 211 facing the second fluid guide plate 22, a fourth heat exchanging surface 212 disposed at one side away from the second fluid guide plate 22, a plurality of first heat exchanging portions 213 formed by recessing the third heat exchanging surface 211 towards the fourth heat exchanging surface 212 and disposed in protrusion at the fourth heat exchanging surface 212, at least two first fluid openings 214 penetrated through the third heat exchanging surface 211 and the fourth heat exchanging surface 212, and a plurality of first fluid guide portions 215 formed by recessing the third heat exchanging surface 211 towards the fourth heat exchanging surface 212 and disposed in protrusion at the fourth heat exchanging surface 212. The first heat exchanging portions 213 and the first fluid guide portions 215 are disposed between the first fluid openings 214, and the first fluid guide portions 215 are disposed between the first fluid openings 214 and the first heat exchanging portions 213. In the embodiment, preferably,

the first fluid guide plate 214 includes four first fluid openings 214. Further, in the embodiment, each of the first heat exchanging portions 213 has a right hexagonal planar contour. Regarding a structural ratio of the first heat exchanging potions 213, each of the first heat exchanging portions 213 has a first protruding height 216 extended from the fourth heat exchanging surface 212, and a first protruding width 217 formed between any two opposite sides of the first heat exchanging portion 213. Preferably, a ratio of the first protruding height 216 to the first protruding width 217 is 0.18 to 0.22. Regarding a distribution pattern of the first heat exchanging portions 213, preferably, a distance between two adjacent first heat exchanging portions 213 is 1mm to 5mm. Further, the first heat exchanging portions 213 on the first fluid guide plate 21 are arranged to form a third guide group 218 and a fourth guide group 219. The first heat exchanging portions 213 of the third guide group 218 and the first heat exchanging portions 213 of the fourth guide group 219 are in a staggered arrangement.

[0027] The second fluid guide plate 22 includes a fifth heat exchanging surface 221 facing the first fluid plate 21, a sixth heat exchanging surface 222 disposed at one side away from the first fluid guide plate 21, a plurality of second heat exchanging portions 223 formed by recessing the sixth heat exchanging surface 222 towards the fifth heat exchanging surface 221 and disposed in protrusion at the fifth heat exchanging surface 221, at least two second fluid openings 224 penetrated through the fifth heat exchanging surface 221 and the sixth heat exchanging surface 222, and a plurality of second fluid guide portions 225 formed by recessing the sixth heat exchanging surface 222 towards the fifth heat exchanging surface 221 and disposed in protrusion at the fifth heat exchanging surface 221. The second heat exchanging portions 223 and the second fluid guide portions 225 are disposed between the second fluid openings 224, and the second fluid guide portions 225 are disposed between the second fluid openings 224 and the second heat exchanging portions 223. In the embodiment, preferably, the second fluid guide plate 22 includes four second fluid openings 224. Further, in the embodiment, each of the second heat exchanging portions 223 has a right hexagonal planar contour. Regarding a structure ratio of the second heat exchanging portions 223, each of the second heat exchanging portions 223 has a second protruding height 226 extended from the fifth heat exchanging surface 221, and a second protruding width 227 formed between any two opposite sides of the second heat exchanging portion 223. Preferably, a ratio of the second protruding height 226 to the second protruding width 227 is 0.18 to 0.22. Regarding a distribution pattern of the second heat exchanging portions 223, preferably, a distance between two adjacent heat exchanging portions 223 is 1mm to 5mm. Further, the second heat exchanging portions 223 on the second fluid guide plate 22 are arranged to form a fifth guide group 228 and a sixth guide group 229. The second heat exchanging portions 223 of the fifth guide group 228 and the second heat exchanging portions 223 of the sixth guide group 229 are in a staggered arrangement.

[0028] Referring to Fig. 2, in the embodiment, according to the positions of the first input pipe 24, the first output pipe 25, the second input pipe 26 and the second output pipe 27, the four fluid sealing members 28 are configured at the same side and are assembled to one first fluid guide plate 21. In other possible embodiments, positions of the four fluid sealing members 28 may be adjusted according to the first input pipe 24, the first output pipe 25, the second input pipe 26 and the second output pipe 27. The four sealing members 28 seal the first fluid openings 214 of one first fluid guide plate 21.

[0029] Referring to Fig. 2 and Fig. 3, in the embodiment, the plate heat exchanger 20 includes three first fluid guide plates 21, two second fluid guide plates 22 and four stopping members 23. However, the quantities of the above components are not limited by the exemplary numbers. When the first fluid guide plates 21, the second fluid guide plates 22 and the stopping members 23 are assembled, each of the first stopping members 23, each of the first fluid guide plates 23 and each of the second fluid guide plates 22 jointly form a heat exchanging space. As such, from the first input pipe 24 towards the four fluid sealing members 28, the first fluid guide plates 21, the second fluid guide plates 22 and the stopping members 23 sequentially from a first heating space 30, a second heat exchanging space 40, a third heat exchanging space 50 and a fourth heat exchanging space 60, as shown in Fig. 3. Further, when the first fluid guide plates 21, the second fluid guide plates 22 and the stopping members 23 are assembled, the first fluid openings 214 respectively correspond to the second fluid openings 224. Further, each of the stopping members 23 allows only two of the heat exchanging spaces 30, 40, 50 and 60 to be in communication with two of the first fluid openings 214 and two of the second fluid openings 224, while the other two first fluid openings 214 and the other two second fluid openings 224 are separated. As such, one of the first fluid openings 214 and the one corresponding second fluid opening 224 form a fluid entrance 70 at one end, while the other first fluid opening 214 and the other second fluid opening 224 form a fluid exit 80 at the other end. In other words, in the embodiment, the plate heat exchanger 20 includes four fluid entrances 70 and four fluid exits 80. Further, the first heat exchanging portions 213 of each of the first fluid guide plates 21 and the second heat exchanging portions 223 of each of the second fluid plates 22 are in a staggered arrangement, as shown in Fig. 4.

[0030] Referring to Fig. 2 and Fig. 3, when the first input pipe 24 transports the first fluid 100, the first fluid 100 passes through one of the fluid entrances 70 to enter the first heat exchanging space 30. In addition to entering the first heat exchanging space 30, the first fluid 100 also continues flowing towards one of the second fluid openings 224 of the adjacent fluid guide plate 22. At this point,

being stopped by one of the stopping members 23, the first fluid 100 is prohibited from entering the second heat exchanging space 40. Next, the first fluid 100 continues flowing towards one of the first fluid openings 214 of one of the first fluid guide plates 21, and passes through another fluid entrance 70 to enter the third heat exchanging space 50. Similar to the above traveling method, the second fluid 101 passes through the second input pipe 26 to sequentially enter the second heat exchanging space 40 and the fourth heat exchanging space 60. Therefore, the first fluid 100 and the second fluid 101 respectively enter the adjacent heat exchanging spaces 30, 40, 50 and 60. After respectively entering the adjacent heat exchanging spaces 30, 40, 50 and 60, the first fluid 100 and the second fluid 101 pass between the first heat exchanging portions 213 and the second heat exchanging portions 223 to further form a longitudinal vortex between the first heat exchanging portions 213 and the second heat exchanging portions 223. Meanwhile, the longitudinal vortex formed by the first heat exchanging portions 213 and the second heat exchanging portions 223 may vigorously stir the first fluid 100 and the second fluid 101 in the heat exchanging spaces 30, 40, 50 and 60, so as to promote disturbing temperature boundary layers of the first fluid 100 and the second fluid 101 such that temperatures in the heat exchanging spaces 30, 40, 50 and 60 become more even. Thus, with strong turbulences generated by the longitudinal vortex, the plate heat exchanger 20 enhances the heat transfer efficiency between the first fluid 100 and the second fluid 101. After heat exchange is performed between the first fluid 100 and the second fluid 101, the first fluid 100 and the second fluid 101 exit the heat exchanging spaces 30, 40, 50 and 60 via different fluid exits 80. The first fluid 100 and the second fluid 101 are respectively outputted via the first output pipe 25 and the second output pipe 27. In the embodiment, preferably, the first fluid 100 and the second fluid 101 enter the heat exchanging spaces 30, 40, 50 and 60 from different directions.

[0031] In the embodiment, the fluid entrances 70 are parallel to the fluid exits 80. For example, assume that a connecting direction between the fluid entrance 70 and the fluid exit 80 of the first heat exchanging space 30 is parallel to a connecting direction between the fluid entrance 70 and the fluid exit 80 of the second heat exchanging space 40. Input and output directions along which the first fluid 100 and the second fluid 101 travel from the fluid entrances 70 to the fluid exits 80 are parallel to the connecting direction. Referring to Fig. 4 and Fig. 5, each of the first heat exchanging portions 213 and the second heat exchanging portions 223 has a right hexagonal planar contour, and any two opposite sides of each of the first heat exchanging portions 213 and any two sides of each of the second heat exchanging portions 223 are parallel to the connecting direction. In other words, each of the heat exchanging portions 213 has six vertices, and a connecting direction of two opposite vertices is parallel to the connecting direction. The second heat exchanging portions 223 are similarly configured. It should be noted that, configuration orientations of the first heat exchanging portions 213 and the second heat exchanging portions 223 are not limited to the above example.

[0032] In the embodiment, the first heat exchanging portions 213 are arranged in a quantity of seven. Fig. 6 shows a diagram of data of channel pressure distributions of a high theta plate H, a low theta plate L, and the first fluid guide plate 21 of the present invention. For the first fluid guide plate 21 of the present invention, the value 1 on the horizontal axis represents the pressure of the first heat exchanging portion 213 at the first row minus the pressure of the first heat exchanging portion 213 at the second row, the value 2 represents the pressure of the first heat exchanging portion 213 at the third row minus the pressure of the first heat exchanging portion 213 at the fourth row, and so forth. In other words, the value 1 represents the channel pressure between the first row and the second row. Further, the left side of the horizontal axis represents the fluid input end, and the right side of the horizontal axis represents the fluid output end. In overall, the pressure drop of the fluid guide plate 21 is similarly to that of the conventional low theta plate L.

[0033] In the embodiment, the first fluid 100 may be hot water, and the second fluid 101 may be cold water. Further, the first fluid 100 sequentially enters the first heat exchanging space 30 and the third heat exchanging space 50, and the second fluid 101 sequentially enters the fourth heat exchanging space 60 and the second heat exchanging space 40. Referring to Fig. 7, for the first fluid guide plate 21, the value 1 on the horizontal axis represents a heat transfer coefficient of the first heat exchanging space 30, the value 2 represents a heat transfer of the second heat exchanging space 40, and so forth. In overall, the heat transfer coefficient of the first fluid guide plate 21 is similar to that of the conventional high theta plate H.

[0034] As demonstrated, the plate heat exchanger 20 of the present invention simultaneously provides advantages of the low pressure drop of the conventional low theta plate L and the high heat transfer coefficient of the conventional high theta plate H. That is to say, with the present invention, respective molds of the high theta plate H and the low theta plate L for respectively manufacturing the high theta plate H and the low theta plate L need not be at the same time manufactured. In other words, compared to the high theta plate H and the low theta plate L, the plate heat exchanger 20 of the present invention is capable of significantly reducing mold developments and lowering production costs.

[0035] In conclusion, the present invention provides a fluid guide plate and an associated plate heat exchanger. The fluid guide plate includes a first heat exchanging surface, a second heat exchanging surface, and a plurality of heat exchanging portions formed by recessing the first heat exchanging surface towards the second heat exchanging surface and disposed in protrusion at the sec-

ond heat exchanging surface. Each of the heat exchanging portions has a right hexagonal planar contour. The plate heat exchanger includes a plurality of the above fluid guide plates. The heat exchanging portions of adjacent fluid guide plates are in a staggered arrangement to form a channel system. Accordingly, the heat exchanging portions allow fluids to respectively vigorously flow to form a longitudinal vortex in the channel system, so as to further generate a strong turbulence for enhancing heat transfer efficiency and reducing pressure drops of the fluids. Further, the fluid guide plate of the present invention is capable of significantly reducing mold developments and lowering production costs.

Claims

1. A fluid guide plate (10), applied in a plate heat exchanger, the fluid guide plate (10) comprising:

   a first heat exchanging surface (11) and a second heat exchanging surface (12) correspondingly disposed at one side of the fluid guide plate (10); and
   a plurality of heat exchanging portions (13), formed by recessing the first heat exchanging surface (11) towards the second heat exchanging surface (12) and disposed in protrusion at the second heat exchanging surface (12), each of the heat exchanging portions (13) having a polygonal planar contour.

2. The fluid guide plate (10) of claim 1, wherein each of the heat exchanging portions (13) has a right hexagonal planar contour.

3. The fluid guide plate (10) of claim 1 or 2, further comprising:

   at least two fluid openings (14), penetrated through the first heat exchanging surface (11) and the second heat exchanging surface (12);
   wherein, the heat exchanging portions (13) are disposed between the fluid openings (14).

4. The fluid guide plate (10) of any of the claims 1 to 3, further comprising:

   a plurality of fluid guide portions (15), located between the fluid openings (14) and the heat exchanging portions (13), formed by recessing the first heat exchanging surface (11) towards the second heat exchanging surface (12) and disposed in protrusion at the second heat exchanging surface (12).

5. The fluid guide plate (10) of any of the claims 1 to 4, wherein a distance between two adjacent heat exchanging portions (13) is 1mm to 5mm.

6. The fluid guide plate (10) of any one of claims 1 to 5, wherein each of the heat exchanging portions (13) has a protruding height extended from the second heat exchanging surface (12), and a protruding width formed between any two opposite sides of the heat exchanging portion (13), a ratio of the protruding height to the protruding width being 0.18 to 0.22.

7. The fluid guide plate (10) of any one of claims 1 to 6, wherein the heat exchanging portions (13) are arranged to form a first guide group (16) and a second guide group (17), the heat exchanging portions (13) of the first guide group (16) and the heat exchanging portions (13) of the second guide group (17) being in a staggered arrangement.

8. A plate heat exchanger (20), comprising:

   a first fluid guide plate (21), and a second fluid guide plate (22) disposed at a distance from the first fluid guide plate (21); and
   a stopping member (23), located between the first fluid guide plate (21) and the second fluid guide plate (22), jointly forming a heat exchanging space (30) with the first fluid guide plate (21) and the second fluid guide plate (22), the heat exchanging space (30) comprising a fluid entrance (70) for a fluid (100) to enter the heat exchanging space (30) and a fluid exit (80) for the fluid (100) to exit the heat exchanging space (30);
   wherein, the first fluid guide plate (21) comprises a third heat exchanging surface (211) facing the second fluid guide plate (22), a fourth heat exchanging surface (212) disposed at one side away from the second fluid guide plate (22), and a plurality of first heat exchanging portions (213) formed by recessing the third heat exchanging surface (211) towards the fourth heat exchanging surface (212) and disposed in protrusion at the fourth heat exchanging surface (212); the second fluid guide plate (22) comprising a fifth heat exchanging surface (221) facing the first fluid guide plate (21), a sixth heat exchanging surface (222) disposed at one side away from the first fluid guide plate (21), and a plurality of second heat exchanging portions (223) formed by recessing the sixth heat exchanging surface (222) towards the fifth heat exchanging surface (221) and disposed in protrusion at the fifth heat exchanging surface (221); each of the first heat exchanging portions (213) and the second heat exchanging portions (223) has a polygonal planar contour, and the first heat exchanging portions (213) and the second heat exchanging portions (223) are in a staggered arrangement.

9. The plate heat exchanger (20) of claim 8, wherein each of the first heat exchanging portions (213) and the second heat exchanging portions (223) has a right hexagonal planar contour.

10. The plate heat exchanger (20) of claim 8 or 9, wherein the first fluid guide plate (21) further comprises at least two first fluid openings (214) penetrated through the third heat exchanging surface (211) and the fourth heat exchanging surface (212), the first heat exchanging portions (212) disposed between the first fluid openings (214); the second fluid guide plate (22) further comprises at least two second fluid openings (224) penetrated through the fifth heat exchanging surface (221) and the sixth heat exchanging surface (222), the second heat exchanging surfaces (222) disposed between the second fluid openings (224).

11. The plate heat exchanger (20) of any of the claims 8 to 10, wherein the first fluid guide plate (21) comprises a plurality of first fluid guide portions (215) located between the first fluid openings (214) and the first heat exchanging portions (213), the first fluid guide portions (215) formed by recessing the third heat exchanging surface (211) towards the fourth heat exchanging surface (212) and disposed in protrusion at the fourth heat exchanging surface (212); the second fluid guide plate (22) comprises a plurality of second fluid guide portions (225) located between the second fluid openings (224) and the second heat exchanging portions (223), the second fluid guide portions (225) formed by recessing the sixth heat exchanging surface (222) towards the fifth heat exchanging surface (221) and disposed in protrusion at the fifth heat exchanging surface (221).

12. The plate heat exchanger (20) of any of the claims 8 to 11, wherein a distance between two adjacent first heat exchanging portions (213) is 1mm to 5mm, and a distance between two adjacent second heat exchanging portions (223) is 1mm to 5mm.

13. The plate heat exchanger (20) of any one of claims 8 to 12, wherein each of the first heat exchanging portions (213) has a first protruding height (216) extended from the fourth heat exchanging surface (212), and a first protruding width (217) formed between any two opposite sides of the first heat exchanging portion (213), a ratio of the first protruding height (216) to the first protruding width (217) being 0.18 to 0.22; each of the second heat exchanging portions (223) has a second protruding height (226) extended from the fifth heat exchanging surface (221) and a second protruding width (227) formed between any two opposite sides of the second heat exchanging portion (223), a ratio of the second protruding height (226) to the second protruding width (227) being 0.18 to 0.22.

14. The plate heat exchanger (20) of any one of claims 8 to 13, wherein the first heat exchanging portions (213) on the first fluid guide plate (21) are arranged to form a third guide group (218) and a fourth guide group (219), the first heat exchanging portions (213) of the third guide group (218) and the first heat exchanging portions (213) of the fourth guide group (219) being in a staggered arrangement.

15. The plate heat exchanger (20) of any one of claims 8 to 14, wherein the second heat exchanging portions (223) on the second fluid guide plate (22) are arranged to form a fifth guide group (228) and a sixth guide group (229), the second heat exchanging portions (223) of the fifth guide group (228) and the second heat exchanging portions (223) of the sixth guide group (229) being in a staggered arrangement.

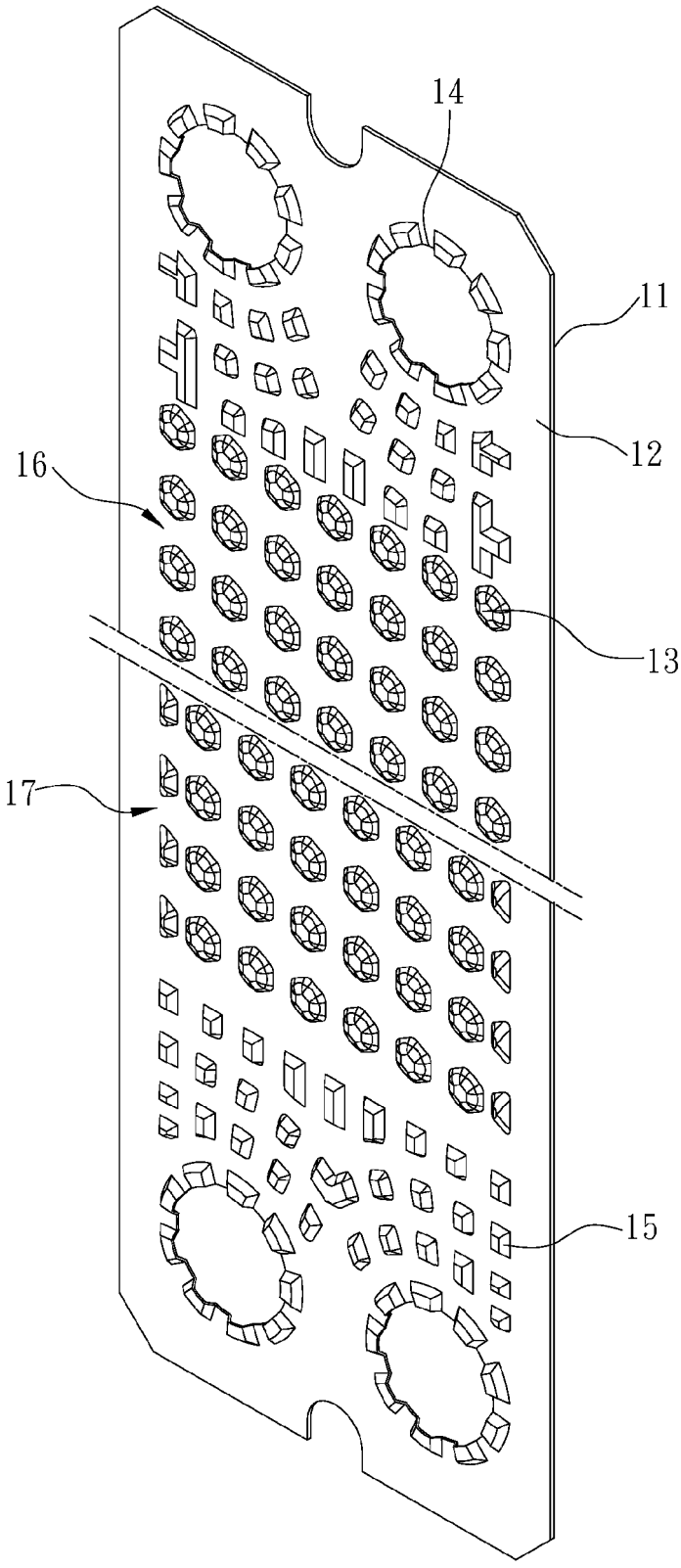

Fig. 1

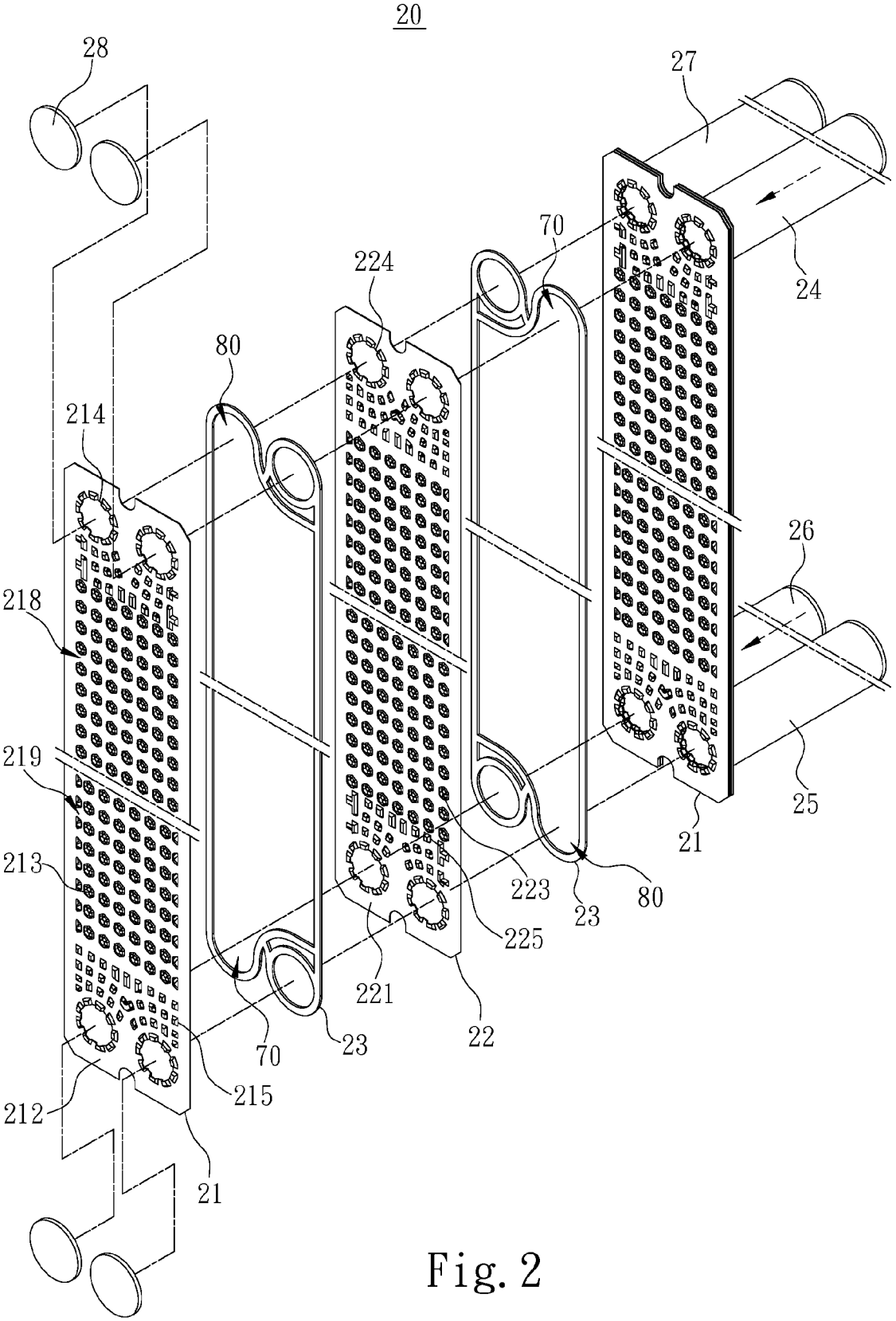
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Fig. 2

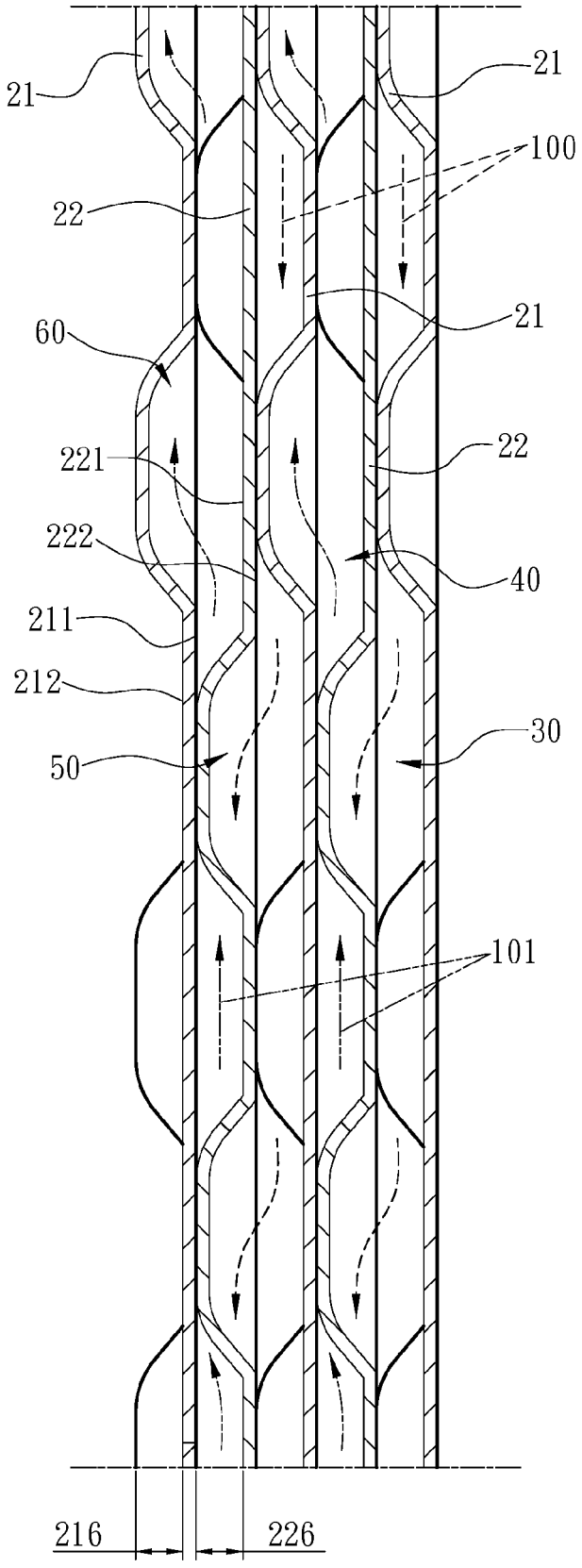

Fig. 3

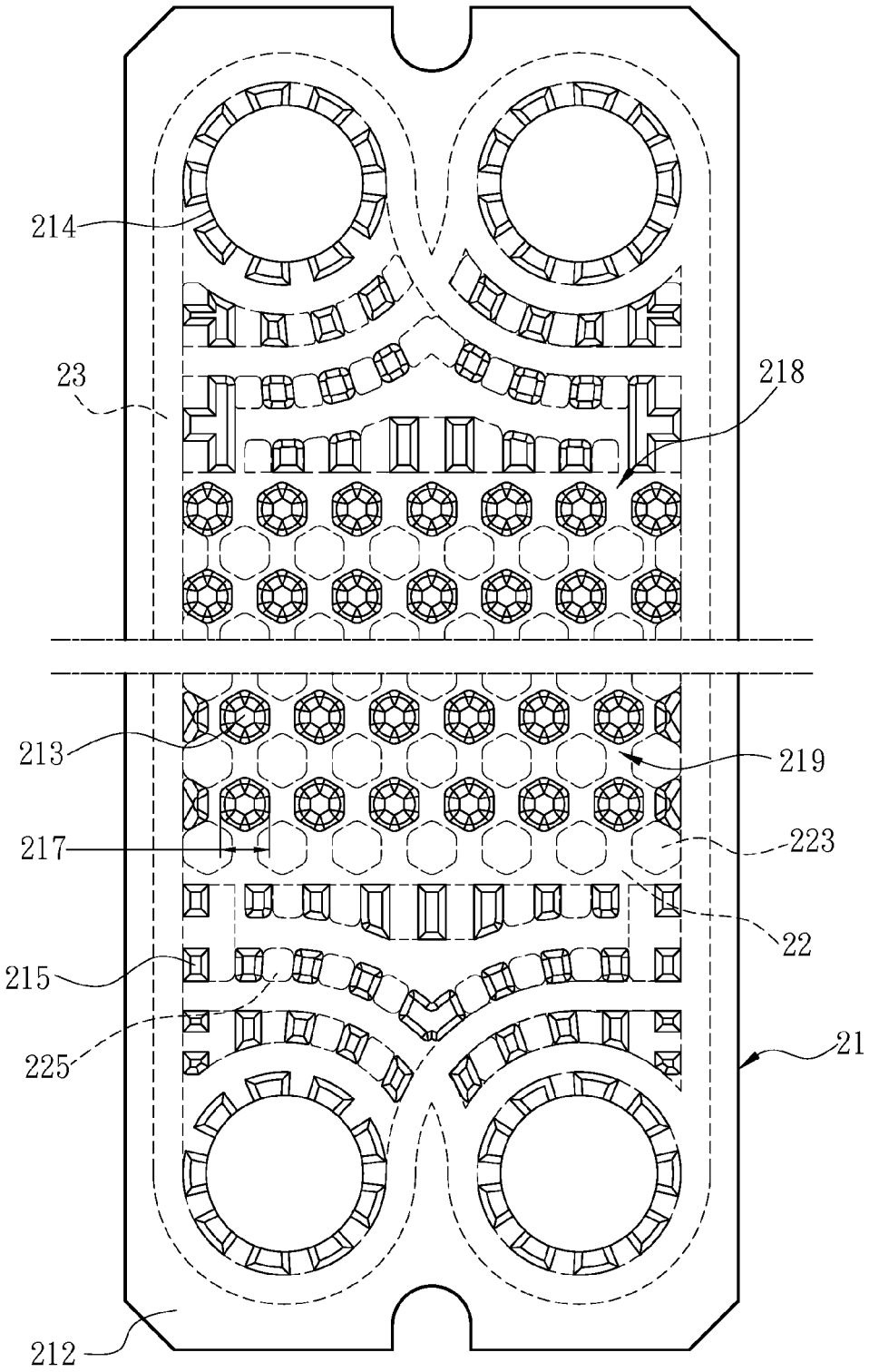

Fig. 4

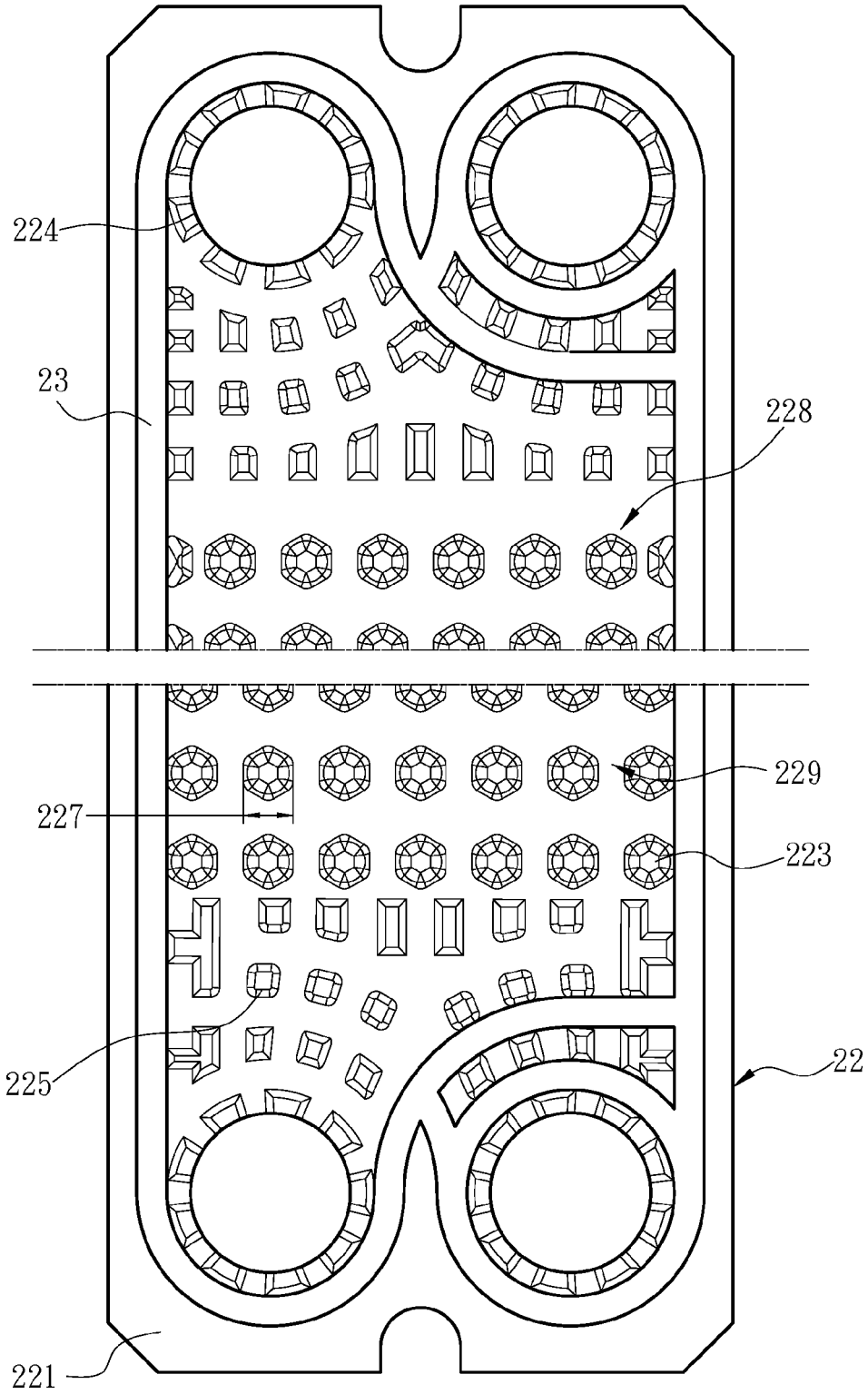

Fig. 5

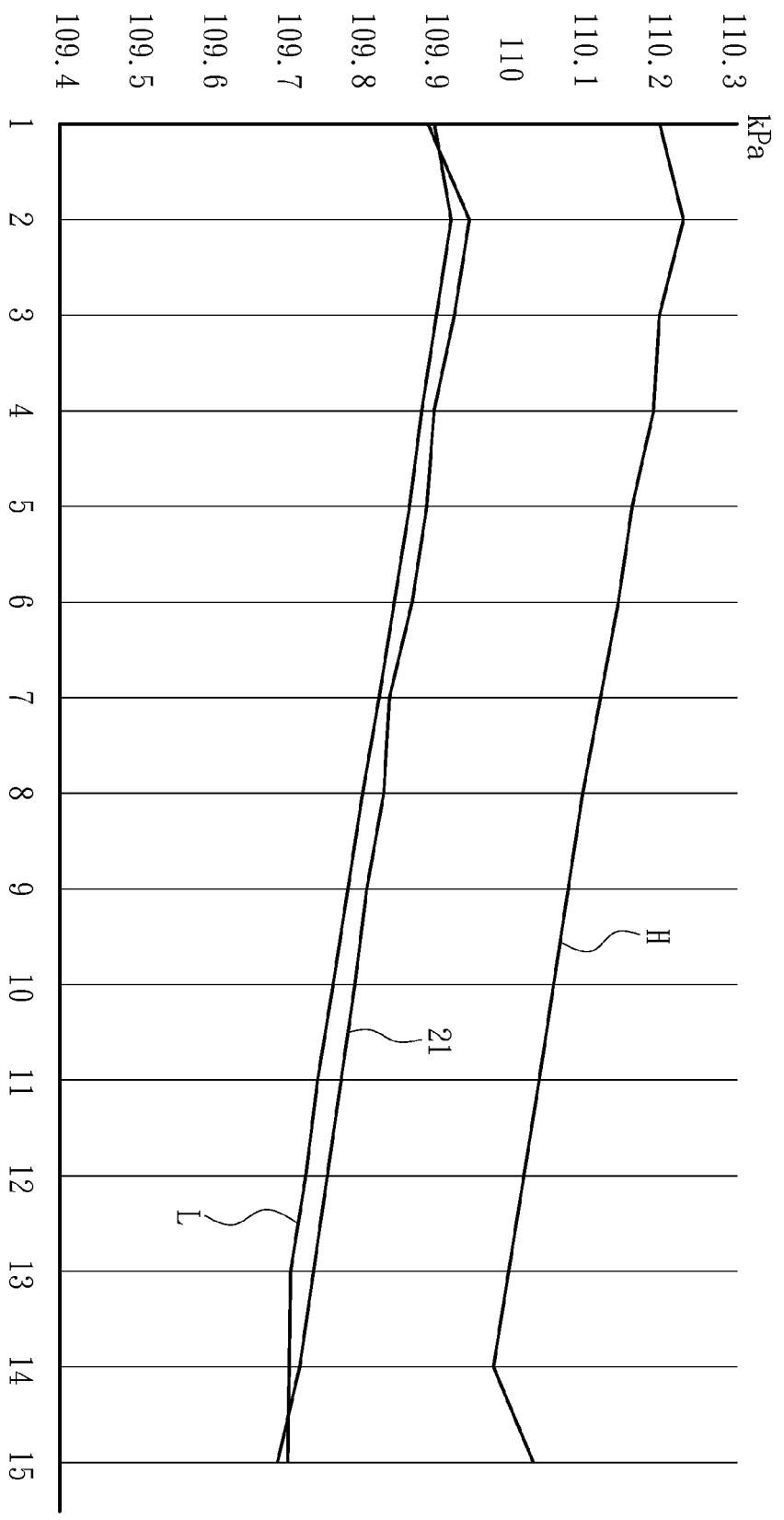
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Fig. 6

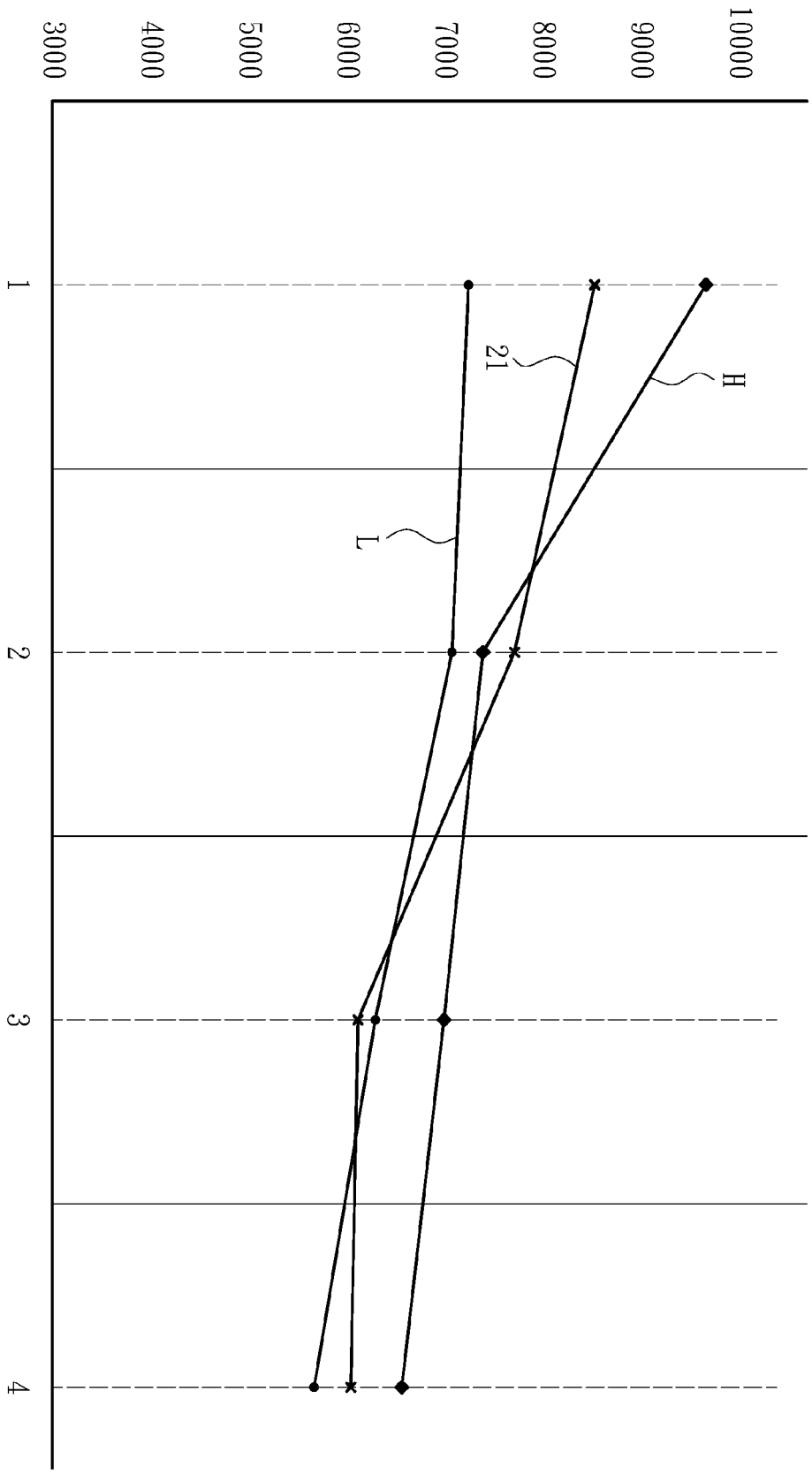

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 14 19 4574

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F28D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 August 2015	Merkt, Andreas

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