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(54) **METAL BASE PLATE MATERIAL FOR USE IN HEAT EXCHANGE PLATE**

(57) The present invention is a metal base plate material for a heat exchange plate to be built into a plate-type heat exchanger. A surface is provided with a plurality of strip-shaped first regions and a plurality of strip-shaped second regions, which are provided alternately and in parallel. The strip-shaped first regions each have a plurality of first ridges arranged substantially parallel to each other and at substantially equal intervals such that an angle of intersection with a longitudinal direction is greater than or equal to 10° and less than or equal to 25°. The strip-shaped second regions each have a plurality of second ridges arranged substantially parallel to each other and at substantially equal intervals and angled to face the plurality of the first ridges in a crosswise direction. The first regions are separated from the second regions adjacent thereto by gap regions therebetween, respectively, at substantially equal intervals. When one orientation of longitudinal directions of the first regions and the second regions is defined as a downstream direction, first ends on a downstream side of the plurality of the first ridges and second ends on a downstream side of the plurality of the second ridges are positioned differently from each other in the longitudinal directions.

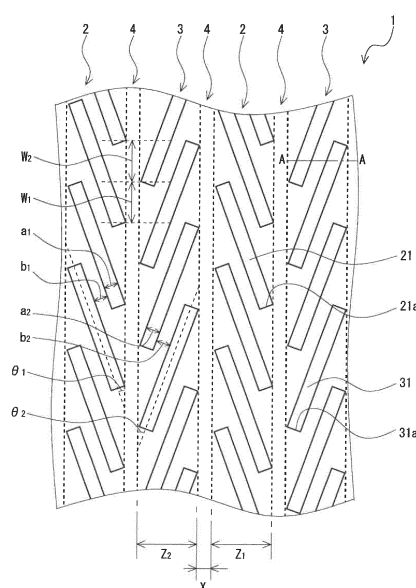


FIG. 1

Description**[TECHNICAL FIELD]**

[0001] The present invention relates to a metal base plate material for a heat exchange plate.

[BACKGROUND ART]

[0002] Plate-type heat exchangers utilizing condensation heat transfer of working media are known. Heat exchange plates to be built into the plate-type heat exchangers are usually formed into complex shapes such as a herringbone shape and the like to improve heat exchange efficiency and/or mechanical durability. In general, such heat exchange plates are manufactured by press forming metal base plate materials.

[0003] To further improve the heat exchange efficiency of a heat exchange plate, a method in which a plurality of minute ridges is provided on a surface of a metal base plate material before press forming has been proposed (Patent Document 1). In Patent Document 1, two kinds of ridges are symmetrically formed on a surface of a metal flat plate material before press forming in such a way as to be angled in a V-shape, and a gap is provided between these two kinds of ridges. This enables agitation of a vapor of a working medium, thereby accelerating condensation of the working medium, and enables a condensate of the working medium to be efficiently discharged.

[0004] Since the two kinds of ridges provided on the surface of the base plate material in Patent Document 1 form the symmetrical V-shape with the gap between the two kinds of ridges, the condensate flowing down on the surface of the base plate material is guided by the two kinds of ridges to be concentrated on a space between the ridges, and the flow slows down when passing the gap between ends on the downstream side of the ridges. Hence, a new approach needs to be devised to properly disperse the condensate on the plate material surface and discharge the condensate more efficiently.

[PRIOR ART DOCUMENTS]**[PATENT DOCUMENTS]**

[0005] Patent Document 1: Japanese Unexamined Patent Application, Publication No. 2015-161449

[SUMMARY OF THE INVENTION]**[PROBLEMS TO BE SOLVED BY THE INVENTION]**

[0006] The present invention has been made in view of the above-described circumstances, and an object of the present invention is to provide a metal base plate material for a heat exchange plate which can properly disperse a condensate of a working medium and effi-

ciently discharge the condensate.

[MEANS FOR SOLVING THE PROBLEMS]

[0007] An aspect of the invention made to solve the above problems is a metal base plate material for a heat exchange plate to be built into a plate-type heat exchanger, wherein at least one surface is provided with a plurality of strip-shaped first regions and a plurality of strip-shaped second regions, which are provided alternately and in parallel; the strip-shaped first regions each have a plurality of first ridges arranged substantially parallel to each other and at substantially equal intervals such that an angle of intersection with a longitudinal direction is greater than or equal to 10° and less than or equal to 25°; the strip-shaped second regions each have a plurality of second ridges arranged substantially parallel to each other and at substantially equal intervals and angled to face the plurality of the first ridges in a crosswise direction; the first regions are separated from the second regions adjacent thereto by gap regions therebetween, respectively, at substantially equal intervals; and when one orientation of longitudinal directions of the first regions and the second regions is defined as a downstream direction, first ends on a downstream side of the plurality of the first ridges and second ends on a downstream side of the plurality of the second ridges are positioned differently from each other in the longitudinal directions.

[0008] Since the metal base plate material has the gap regions between the first regions and the second regions and ends (the first ends and the second ends) of two kinds of ridges (the first ridges and the second ridges) are arranged to be positioned differently from each other in the longitudinal directions of the first regions and the second regions, concentration of a condensate on a space between the ends of the two kinds of ridges can be reduced and the condensate can be properly dispersed. Furthermore, since the two kinds of ridges of the metal base plate material, which are inclined in opposite directions from each other with respect to the longitudinal directions, are arranged such that the angles of intersection with the longitudinal directions of the first regions and the second regions are greater than or equal to 10° and less than or equal to 25°, slowdown of a downward flow of the condensate can be curbed, enabling efficient discharge of the condensate.

[0009] It is preferred that an average distance between the plurality of the first ridges is greater than or equal to 0.1 mm and less than or equal to 1.0 mm, an average distance between the plurality of the second ridges is greater than or equal to 0.1 mm and less than or equal to 1.0 mm, and an average distance between the first regions and the second regions is greater than or equal to 0.2 mm and less than or equal to 4.0 mm. In the metal base plate material, since the average distance between the first ridges, the average distance between the second ridges, and the average distance between the first regions and the second regions are properly adjusted in

this manner, the condensate can be efficiently discharged.

[0010] An amount of positional difference longitudinally between the first ends and the second ends is preferably greater than or equal to 0.1 mm and less than or equal to 5.8 mm. In the metal base plate material, since the amount of positional difference longitudinally between the first ends and the second ends is properly adjusted in this manner, the condensate can be properly dispersed.

[0011] An angle of intersection of the second ridges with the longitudinal direction of the second regions is preferably equal to an absolute value of the angle of intersection of the first ridges. This is because amounts of downward flow of the condensate in the first regions and the second regions are effectively balanced.

[EFFECTS OF THE INVENTION]

[0012] The metal base plate material for a heat exchange plate of the present invention can properly disperse a condensate of a working medium and efficiently discharge the condensate.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0013]

FIG. 1 is a schematic plan view showing a part of a surface of a metal base plate material of an embodiment of the present invention.

FIG. 2 is a schematic perspective cross-sectional view showing a part of a cross-section taken along an A-A line around the surface of the metal base plate material in FIG. 1.

[DESCRIPTION OF EMBODIMENTS]

[0014] Embodiments of the metal base plate material for a heat exchange plate according to the present invention will be described in detail below with reference to the drawings.

Metal base plate material

[0015] A metal base plate material 1 in FIG. 1 is a metal base plate material for a heat exchange plate to be built into a plate-type heat exchanger. A material for the metal base plate material 1 is not particularly limited, but for example, titanium is used. The metal base plate material 1 is a flat plate material serving as a material for manufacturing a heat exchange plate, and when it is to be built into a plate-type heat exchanger, it is formed into the heat exchange plate by press forming. As the metal base plate material 1, a rectangular plate with long sides of 1,200 mm, short sides of 800 mm, and an average thickness of greater than or equal to 0.5 mm and less than or equal to 1.0 mm is used, although there is no particular limita-

tion.

[0016] A plurality of strip-shaped first regions 2 and a plurality of strip-shaped second regions 3 are provided alternately and in parallel on a surface of the metal base plate material 1. It is to be noted that the surface having the first regions 2 and the second regions 3 is at least one surface of the metal base plate material 1, and may be one side of the metal base plate material 1 or both sides of the metal base plate material 1.

First Regions

[0017] The first regions 2 are strip-shaped regions provided on the surface of the metal base plate material 1. The plurality of the first regions 2 is provided such that the first regions 2 are substantially parallel to each other. Each of the first regions 2 has a plurality of first ridges 21 arranged substantially parallel to each other and at substantially equal intervals such that the angle of intersection with a longitudinal direction is θ_1 .

[0018] The lower limit of an average width Z_1 in a crosswise direction of the first regions 2 is preferably 1 mm, more preferably 2 mm, and still more preferably 3 mm. Meanwhile, the upper limit of the average width Z_1 is preferably 20 mm, more preferably 18 mm, and still more preferably 16 mm. If the average width Z_1 is less than the lower limit, agitation of a vapor of a working medium may be insufficient, resulting in failure to accelerate condensation of the working medium. Conversely, if the average width Z_1 is greater than the upper limit, a condensate may be retained in the first regions 2, resulting in inefficient discharge of the condensate. It is to be noted that "average width" refers to an average value of widths at five arbitrarily selected points in one object.

(First ridges)

[0019] In the first regions 2, the plurality of the first ridges 21 is provided such that the first ridges 21 are substantially parallel to each other and at substantially equal intervals. The first ridges 21 are long, thin, rod-shaped ridges in plan view, and each has such a length that both ends reach both side portions of the first region 2, which is strip-shaped. It is to be noted that, although the first ridges 21 in FIG. 1 are substantially rectangular, the first ridges 21 only need to be formed so that two long sides are substantially parallel to each other in plan view; both ends may be curved, for example. Further, a method for forming ridges on the surface of the metal base plate material 1 is not particularly limited, but for example, a method in which protrusions/recessions are transferred during rolling, and the like are employed.

[0020] The angle of intersection θ_1 of the first ridges 21 with the longitudinal direction of the first regions 2 is set to an acute angle to curb slowdown of a downward flow of the condensate. The lower limit of the angle of intersection θ_1 is preferably 10° , more preferably 12° , and still more preferably 13° . Meanwhile, the upper limit

of the angle of intersection θ_1 is preferably 25° , more preferably 22° , and still more preferably 20° . If the angle of intersection θ_1 is less than the lower limit, the condensate may fail to be properly guided along sides of the first ridges 21. Conversely, if the angle of intersection θ_1 is greater than the upper limit, the condensate may be retained in the first regions 2 and inefficiently discharged. It is to be noted that "angle of intersection" refers to an acute angle of two angles formed when two straight lines cross each other.

[0021] The lower limit of an average width a_1 in a crosswise direction of the first ridges 21 is preferably 0.10 mm, more preferably 0.11 mm, and still more preferably 0.12 mm. Meanwhile, the upper limit of the average width a_1 is preferably 1.0 mm, more preferably 0.8 mm, and still more preferably 0.6 mm. If the average width a_1 is less than the lower limit, strength of the first ridges 21 may be insufficient. Conversely, if the average width a_1 is greater than the upper limit, the condensate may flow down on top surfaces of the first ridges 21, resulting in failure to properly guide the condensate along the sides of the first ridges 21.

[0022] The lower limit of an average distance b_1 between two of the first ridges 21 is preferably 0.1 mm, more preferably 0.2 mm, and still more preferably 0.3 mm. Meanwhile, the upper limit of the average distance b_1 is preferably 1.0 mm, more preferably 0.9 mm, and still more preferably 0.8 mm. If the average distance b_1 is less than the lower limit, the condensate may spill over the top surfaces of the first ridges 21, resulting in failure to properly guide the condensate along the sides of the first ridges 21. Conversely, if the average distance b_1 is greater than the upper limit, the condensate may be retained between the first ridges 21 and inefficiently discharged. It is to be noted that "average distance" is an average of distances in the crosswise direction of the ridges, and refers to an average value of five arbitrarily selected five between two ridges.

[0023] The lower limit of an average height h of the first ridges 21 with respect to the surface of the metal base plate material 1 is preferably 0.02 mm, more preferably 0.03 mm, and still more preferably 0.04 mm. Meanwhile, the upper limit of the average height h is preferably 0.10 mm, more preferably 0.09 mm, and still more preferably 0.08 mm. If the average height h is less than the lower limit, agitation of the vapor of the working medium may be insufficient, resulting in failure to accelerate condensation of the working medium. Conversely, if the average height h is greater than the upper limit, processing cost may increase.

Second regions

[0024] Like the first regions 2, the second regions 3 are strip-shaped regions provided on the surface of the metal base plate material 1. The plurality of the second regions 3 is provided such that the second regions 3 are substantially parallel to each other. Each of the second

regions 3 has a plurality of second ridges 31 arranged substantially parallel to each other and at substantially equal intervals, and at an angle θ_2 to face the plurality of the first ridges 21 in a crosswise direction.

[0025] The lower limit of an average width Z_2 in the crosswise direction of the second regions 3 is preferably 1 mm, more preferably 2 mm, and still more preferably 3 mm. Meanwhile, the upper limit of the average width Z_2 is preferably 20 mm, more preferably 18 mm, and still more preferably 16 mm. If the average width Z_2 is less than the lower limit, agitation of the vapor of the working medium may be insufficient, resulting in failure to accelerate condensation of the working medium. Conversely, if the average width Z_2 is greater than the upper limit, the condensate may be retained in the second regions 3, resulting in inefficient discharge of the condensate.

(Second ridges)

[0026] In the second regions 3, the plurality of the second ridges 31 is provided such that the second ridges 31 are substantially parallel to each other and at substantially equal intervals. Similarly to the first ridges 21, the second ridges 31 are long, thin, rod-shaped ridges in plan view, and each has such a length that both ends reach both side portions of the second region 3, which is strip-shaped. Although in FIG. 1, a shape of the second ridges 31 is a substantially rectangular shape similar to that of the first ridges 21, the second ridges 31 only need to be formed so that two long sides are substantially parallel to each other in plan view, similarly to the first ridges 21. In addition, in light of a balance of amounts of downward flow of the condensate, it is preferable that the shape of the second ridges 31 are similar to the first ridges 21 in plan view and that a height of the second ridges 31 with respect to the surface of the metal base plate material 1 is equal to the height h of the first ridges 21 with respect to the surface of the metal base plate material 1 as shown in FIG. 2.

[0027] The second ridges 31 are angled to face the first ridges 21 in the crosswise direction; therefore, when one orientation of the longitudinal directions of the first regions 2 and the second regions 3 is defined as a downstream direction, first ends 21a on a downstream side of the plurality of the first ridges 21 and second ends 31a on a downstream side of the plurality of the second ridges 31 are adjacent to each other with gap regions 4 interposed therebetween.

[0028] An angle of intersection θ_2 of the second ridges 31 with the longitudinal direction of the second regions 3 is set to an acute angle to curb the slowdown of the downward flow of the condensate. The lower limit of the angle of intersection θ_2 is preferably 10° , more preferably 12° , and still more preferably 13° . Meanwhile, the upper limit of the angle of intersection θ_2 is preferably 25° , more preferably 22° , and still more preferably 20° . If the angle of intersection θ_2 is less than the lower limit, the condensate may fail to be properly guided along sides of the

second ridges 31. Conversely, if the angle of intersection θ_2 is greater than the upper limit, the condensate may be retained in the second regions 3 and inefficiently discharged. It is to be noted that in light of the balance of the amounts of downward flow of the condensate, an absolute value of the angle of intersection θ_1 is preferably equal to that of the angle of intersection θ_2 .

[0029] The lower limit of an average width a_2 in the crosswise direction of the second ridges 31 is preferably 0.10 mm, more preferably 0.11 mm, and still more preferably 0.12 mm. Meanwhile, the upper limit of the average width a_2 is preferably 1.0 mm, more preferably 0.8 mm, and still more preferably 0.6 mm. If the average width a_2 is less than the lower limit, the strength of the second ridges 31 may be insufficient. Conversely, if the average width a_2 is greater than the upper limit, the condensate may flow down on top surfaces of the second ridges 31, resulting in failure to properly guide the condensate along the sides of the second ridges 31. It is to be noted that in light of the balance of the amounts of downward flow of the condensate, the average width a_1 is preferably equal to the average width a_2 .

[0030] The lower limit of an average distance b_2 between two of the second ridges 31 is preferably 0.1 mm, more preferably 0.2 mm, and still more preferably 0.3 mm. Meanwhile, the upper limit of the average distance b_2 is preferably 1.0 mm, more preferably 0.9 mm, and still more preferably 0.8 mm. If the average distance b_2 is less than the lower limit, the condensate may spill over the top surfaces of the second ridges 31, resulting in failure to properly guide the condensate along the sides of the second ridges 31. Conversely, if the average distance b_2 is greater than the upper limit, the condensate may be retained between the second ridges 31 and inefficiently discharged. It is to be noted that in light of the balance of the amounts of downward flow of the condensate, the average distance b_1 is preferably equal to the average distance b_2 .

[0031] When one orientation of the longitudinal directions of the first regions 2 and the second regions 3 is defined as the downstream direction, the first ends 21a on the downstream side of the plurality of the first ridges 21 and the second ends 31a on the downstream side of the plurality of the second ridges 31 are positioned differently from each other in the longitudinal directions as shown in FIG. 1. An amount of positional difference longitudinally between the first ends 21a and the second ends 31a includes an amount of positional difference W_1 in a case where the first end 21a is on the downstream side with respect to the second end 31a and an amount of positional difference W_2 in a case where the first end 21a is on the upstream side with respect to the second end 31a. In light of the balance of the amounts of downward flow of the condensate, the amount of positional difference W_1 is preferably equal to the amount of positional difference W_2 ; however, there is no particular limitation, and the amount of positional difference W_1 may be different from the amount of positional difference W_2 .

It is to be noted that "an end on the downstream side of ridges" refers to a downstream terminal on an upstream long side of the ridge.

[0032] The lower limit of the amount of positional difference W_1 longitudinally between the first end 21a and the second end 31a is preferably 0.1 mm, more preferably 0.6 mm, and still more preferably 1.0 mm. Meanwhile, the upper limit of the amount of positional difference W_1 is preferably 5.8 mm, more preferably 4.5 mm, and still more preferably 3.5 mm. If the amount of positional difference W_1 is less than the lower limit, concentration of the condensate on spaces between the first ends 21a and the second ends 31a may fail to be reduced and the condensate may be improperly dispersed. Conversely, if the amount of positional difference W_1 exceeds the upper limit, the condensate may fail to be properly guided along the first ridges 21 and the second ridges 31. It is to be noted that the upper limit and the lower limit of the amount of positional difference W_2 is similar to that of W_1 .

Gap Regions

[0033] The first regions 2 are separated from the second regions 3 adjacent thereto by the gap regions 4 therebetween, respectively, at substantially equal intervals. The gap regions 4 are strip-shaped regions parallel to the longitudinal directions of the first regions 2 and the second regions 3, and the first regions 2 and the second regions 3 are arranged parallel to each other with the gap regions 4 interposed therebetween. Protrusions/recessions such as ridges and the like are not formed in the gap regions 4, and most of the condensate flows down the gap regions 4 in a zigzag manner.

[0034] The lower limit of an average distance X between the first regions 2 and the second regions 3 is preferably 0.2 mm, more preferably 0.3 mm, and still more preferably 0.4 mm. Meanwhile, the upper limit of the average distance X is preferably 4.0 mm, more preferably 3.5 mm, and still more preferably 3.0 mm. If the average distance X is less than the lower limit, the condensate may be inefficiently discharged. Conversely, if the average distance X is greater than the upper limit, the condensate may fail to be properly guided along the first ridges 21 and the second ridges 31.

(Advantages)

[0035] Since the metal base plate material 1 has the gap regions 4 between the first regions 2 and the second regions 3 and ends (the first ends 21a and the second ends 31a) of two kinds of ridges (the first ridges 21 and the second ridges 31) are arranged to be positioned differently from each other in the longitudinal directions of the first regions 2 and the second regions 3, the concentration of the condensate on the spaces between the ends of the two kinds of ridges can be reduced, and the condensate can be properly dispersed. Moreover, in the metal base plate material 1, since the two kinds of ridges are

arranged such that the angles of intersection with the longitudinal directions of the first regions 2 and the second regions 3 is greater than or equal to 10° and less than or equal to 25° , the slowdown of the downward flow of the condensate can be curbed, enabling efficient discharge of the condensate.

[0036] Furthermore, in the metal base plate material 1, the average distance b_1 between the first ridges 21, the average distance b_2 between the second ridges 31, and the average distance X between the first regions 2 and the second regions 3 are properly adjusted, enabling efficient discharge of the condensate.

[0037] Furthermore, in the metal base plate material 1, the amount of positional difference W_1 and W_2 longitudinally between the first ends 21a and the second ends 31a is properly adjusted, enabling the condensate to be properly dispersed.

[OTHER EMBODIMENTS]

[0038] The metal base plate material for a heat exchange plate of the present invention is not limited to the above embodiment.

[0039] In the above embodiment, the metal base plate material 1 having the gap regions 4 between the first regions 2 and the second regions 3 has been described. However, it is only necessary that the gap regions 4 are provided between the first ends 21a and the second ends 31a; it is not necessary that the gap regions 4 be provided between ends on the upstream side of the first ridges 21 and ends on the upstream side of the second ridges 31.

EXAMPLES

[0040] Hereinafter, the present invention will be described in detail by way of Examples; however, the Examples are not construed as limiting the present invention.

[0041] As a test of condensation heat transfer performance, overall heat transfer coefficients were evaluated by using metal base plate materials No. 1 to No. 4. Hydrofluorocarbon (R134a) was used as a working medium to be in contact with surfaces of the metal base plate materials, and cold water was used as a refrigerant to be in contact with rear surfaces of the metal base plate materials to condense the working medium. The working medium, whose inflow temperature was set to 30°C with a heater, was made to flow onto the surfaces of the metal base plate materials at a pressure of 0.68 MPa. Cold water was brought to an inflow temperature of 20°C and made to flow onto the rear surfaces of the metal base plate materials at a flow rate of 3 L/min. Further, a heat transfer area of the metal base plate materials was $17,500\text{ mm}^2$, and a depth W was 2 mm. The overall heat transfer coefficients were calculated using the temperature at which the cold water flowed onto the rear surfaces of the metal base plate materials, the temperature at which the cold water flowed out from the rear surfaces

of the metal base plate materials, the heat transfer area of the metal base plate materials, and the difference between the inflow temperature of the working medium and the inflow temperature of the cold water.

[0042] The surfaces of the metal base plate materials, which were to be in contact with the working medium, are as follows. It is to be noted that the metal base plate materials No. 1 and No. 2 are the metal base plate material 1 of the above embodiment, and the metal base plate material No. 3 is the metal base plate material 1 of the above embodiment wherein the angle of intersection θ of the ridges with the longitudinal directions of regions in which the ridges are provided, and the amount of positional difference W longitudinally between the ends of the ridges are outside ranges of the embodiment. Further, the metal base plate material No. 4 is a flat plate material wherein a surface has no ridge. It is to be noted that the first ridges and the second ridges of the metal base plate materials No. 1 to No. 3 are identical in shape.

Metal base plate material No. 1

[0043] Height h of the ridges: 0.05 mm; width a in the crosswise directions of the ridges: 0.125 mm; distance b between the ridges: 0.6 mm; angle of intersection θ of the ridges with the longitudinal directions of the regions in which the ridges are provided: 15° ; distance X between the regions in which the ridges are provided: 0.98 mm; width Z in the crosswise directions of the regions in which the ridges are provided: 4.88 mm; amount of positional difference W longitudinally between the ends of the ridges: 1.4 mm

Metal base plate material No. 2

[0044] Height h of the ridges: 0.05 mm; width a in the crosswise directions of the ridges: 0.125 mm; distance b between the ridges: 0.6 mm; angle of intersection θ of the ridges with the longitudinal directions of the regions in which the ridges are provided: 15° ; distance X between the regions in which the ridges are provided: 0.49 mm; width Z in the crosswise directions of the regions in which the ridges are provided: 2.44 mm; amount of positional difference W longitudinally between the ends of the ridges: 1.4 mm

Metal base plate material No. 3

[0045] Height h of the ridges: 0.05 mm; width a in the crosswise directions of the ridges: 0.125 mm; distance b between the ridges: 0.6 mm; angle of intersection θ of the ridges with the longitudinal directions of the regions in which the ridges are provided: 45° ; distance X between the regions in which the ridges are provided: 4 mm; width Z in the crosswise directions of the regions in which the ridges are provided: 20 mm; amount of positional difference W longitudinally between the ends of the ridges: 0 mm

[0046] The test results are as follows: the overall heat transfer coefficient of the metal base plate material No. 1 was 3,592 W/m²K, the overall heat transfer coefficient of the metal base plate material No. 2 was 3,436 W/m²K, the overall heat transfer coefficient of the metal base plate material No. 3 was 2,518 W/m²K, and the overall heat transfer coefficient of the metal base plate material No. 4 was 2,305 W/m²K, confirming that the metal base plate materials No. 1 and No. 2 showed high overall heat transfer coefficients. Thus, it can be concluded that the overall heat transfer coefficient of a metal base plate material is improved by properly arranging ridges on a surface of the metal base plate material as in the metal base plate materials No. 1 and No. 2.

[0047] The metal base plate material for a heat exchange plate of the present invention can properly disperse a condensate of a working medium and efficiently discharge the condensate.

[Explanation of the Reference Symbols]

[0048]

- 1 Metal base plate material
- 2 First region
- 3 Second region
- 4 Gap region
- 21 First ridge
- 21a First end
- 31 Second ridge
- 31a Second end

Claims

1. A metal base plate material for a heat exchange plate to be built into a plate-type heat exchanger, wherein at least one surface is provided with a plurality of strip-shaped first regions and a plurality of strip-shaped second regions, which are provided alternately and in parallel, the strip-shaped first regions each comprise a plurality of first ridges arranged substantially parallel to each other and at substantially equal intervals such that an angle of intersection with a longitudinal direction is greater than or equal to 10° and less than or equal to 25°, the strip-shaped second regions each comprise a plurality of second ridges arranged substantially parallel to each other and at substantially equal intervals and angled to face the plurality of the first ridges in a crosswise direction, the first regions are separated from the second regions adjacent thereto by gap regions therebetween, respectively, at substantially equal intervals, and when one orientation of longitudinal directions of the first regions and the second regions is defined as a downstream direction, first ends on a downstream

side of the plurality of the first ridges and second ends on a downstream side of the plurality of the second ridges are positioned differently from each other in the longitudinal directions.

2. The metal base plate material according to claim 1, wherein an average distance between the plurality of the first ridges is greater than or equal to 0.1 mm and less than or equal to 1.0 mm, an average distance between the plurality of the second ridges is greater than or equal to 0.1 mm and less than or equal to 1.0 mm, and an average distance between the first regions and the second regions is greater than or equal to 0.2 mm and less than or equal to 4.0 mm.
3. The metal base plate material according to claim 1 or 2, wherein an amount of positional difference longitudinally between the first ends and the second ends is greater than or equal to 0.1 mm and less than or equal to 5.8 mm.
4. The metal base plate material according to claim 1, wherein an angle of intersection of the second ridges with the longitudinal direction of the second regions is equal to an absolute value of the angle of intersection of the first ridges.

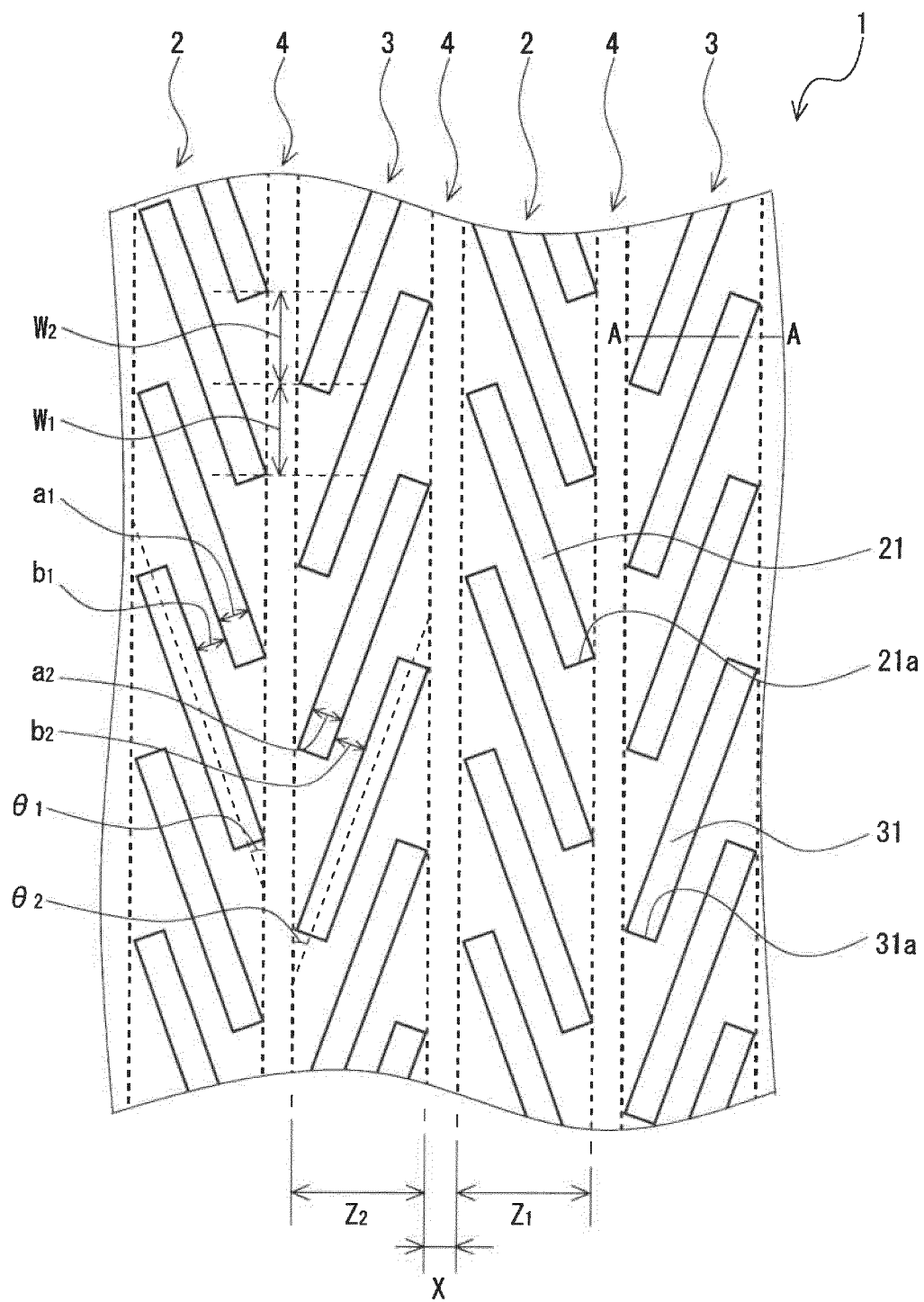


FIG. 1

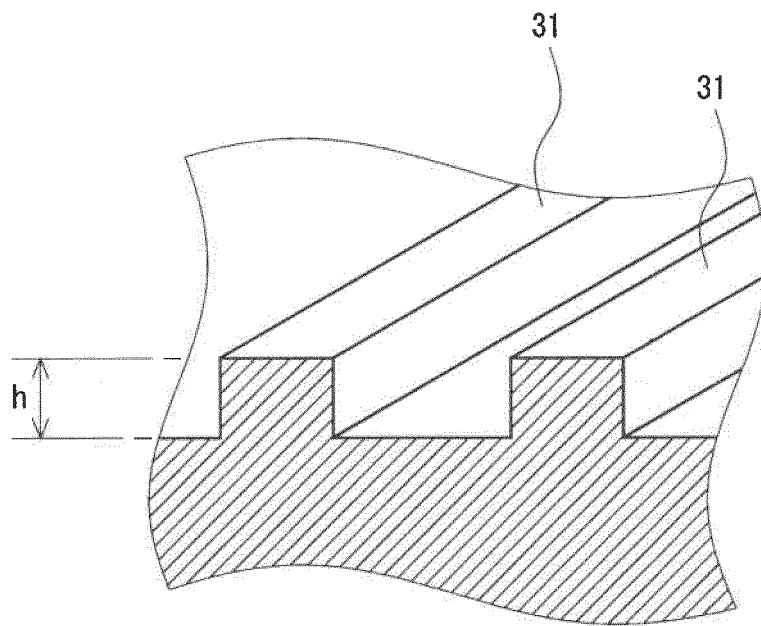


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/035935

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. F28F3/04 (2006.01) i, F28D9/00 (2006.01) i, F28F13/04 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. F28F3/04, F28D9/00, F28F13/04

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2015-161449 A (KOBE STEEL, LTD.) 07 September 2015, paragraphs [0020], [0027], [0028], fig. 1, 4 & US 2016/0363395 A1, fig. 1, 4, paragraphs [0029], [0042]-[0045] & WO 2015/129539 A1 & EP 3104109 A1 & CN 106030234 A & KR 10-2016-0121583 A & RU 2016138147 A	1-4
Y	JP 2007-510122 A (BEHR GMBH & CO. KG) 19 April 2007, fig. 6g & US 2007/011077882 A1, fig. 6g & WO 2005/052490 A1 & EP 2267393 A2 & DE 102004045923 A1 & KR 10-2006-0101481 A & CN 1875240 A & BR PI0415965 A & ES 2496943 T	1-4



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search
03.12.2018Date of mailing of the international search report
11.12.2018Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/035935

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2016/0021784 A1 (CATERPILLAR INC.) 21 January 2016, fig. 5 (Family: none)	1-4
Y	JP 2007-333254 A (CALSONIC KANSEI CORP.) 27 December 2007, fig. 1-4 & US 2007/0287334 A1, fig. 1-4	1-4
A	US 2012/0024510 A1 (KOHL, Michael) 02 February 2012, fig. 7 & WO 2010/089287 A1 & DE 102009007619 A1	1-4
A	US 6938685 B2 (BEHR GMBH & CO.) 06 September 2005, fig. 10, 11 & EP 1256772 A2 & DE 10220532 A1	1-4
A	US 2005/0081379 A1 (BEHR GMBH & CO.) 21 April 2005, fig. 5-7, 9-12 & DE 102004045018 A1	1-4
A	JP 1-184399 A (NIPPONDENSO CO., LTD.) 24 July 1989, fig. 9 (Family: none)	1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2015161449 A [0005]