Abstract: A plate laminated type heat exchanger includes: a plate laminated body (30) which is formed by laminating a plurality of plates (3); and a heat exchanger body (2) which includes a first header (4) through which fluid (G) flows in from outside of the plate laminated body (30) and a second header (4) through which the fluid (G) flows out to the outside of the plate laminated body (30) which are connected to the plate laminated body (30). Each of the plurality of plates (3) is formed from a flat plate shape having a first surface (38a) and a second surface (38b). The first surface (38a) is provided with a plurality of grooves (39) defined by inner walls (42) through which the fluid flows. The plurality of plates (3) are connected each other so that the first surface (38a) of one of the plurality of plates (3) is brazed to the second surface (38b) of the other one of the plurality of plates (3).
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[Description]

[Title of Invention]
PLATE LAMINATED TYPE HEAT EXCHANGER

[Technical Field]
[0001]
The present invention relates to a plate laminated type heat exchanger.

[Background Art]
[0002]
There is a conventional plate laminated type heat exchanger that includes a plurality of waveform plates which are laminated and bonded to each other. Each waveform plate has a plurality of recessed portion as flow channels of fluid on a surface thereof (For example, see Japanese Unexamined Patent Application Publication No. 2002-62085). In addition, there is a conventional plate laminated type heat exchanger formed from flat plates bonded to each other by diffusion bonding (For example, Japanese Unexamined Patent Application Publication No. Sho 61-62795 and Japanese Unexamined Patent Application Publication (Translation of PCT Application) No. 2008-535261).

[Summary of Invention]

[Technical Problem]
[0003]
When the waveform plates are used in the plate laminated type heat exchanger, a rigidity of the plates may not be sufficiently obtained. In addition, when the plates are bonded to each other by brazing, a bonding force between each plate may not be sufficiently obtained. Further, when a bonding portion to be brazed to an adjacent plate is large, a brazing material may not be sufficiently spread all over the bonding portion, that is, a middle portion in the bonding portion may not be covered by the brazing material and the bonding force between each plate may not be sufficiently obtained. Therefore, in the conventional plate laminated type heat exchange, the plates may be sloughed off or damaged when a pressure in the flow channel becomes equal to or higher than 100 bar during operation.

For this reason, in some of the conventional plate laminated type heat exchanger, each plate is bonded to the adjacent plate by diffusion bonding to obtain the sufficient bonding force therebetween. However, a production cost may increase to produce the plate laminated type heat exchanger by using the diffusion bonding.

[Solution to Problem]
[0004]
According to a first aspect of the present invention, a plate laminated type heat exchanger including: a plate laminated body which is formed by laminating a plurality of plates; and a heat exchanger body which includes a first header through which fluid flows in from outside of the plate laminated body and a second header through which the fluid flows out to the outside of the plate laminated body which are connected to the plate laminated body. Each of the plurality of plates is formed in a flat plate shape having a first surface and a second surface. The first surface of at least one of the plurality of plates is provided with a plurality of grooves defined by inner walls through which the fluid flows. The plurality of plates are bonded each other by brazing so that the first surface of one of the plurality of plates is brazed to the second surface of the other one of the plurality of plates.

[0005]
According to this configuration, since the plurality of grooves are formed on the plate formed in the flat plate shape, each plate can obtain a sufficient rigidity compared with using a waveform plate. Accordingly, the plate laminated type heat exchanger can prevent from being damaged even if a pressure inside the plate laminated type heat exchanger becomes high. Therefore, the plate laminated type heat exchanger can be used under a high pressure environment.

Furthermore, since each of the plurality of plates is bonded to each other by brazing, the plate laminated type heat exchanger can be produced at low cost.

[0006]
According to a second aspect of the present invention, in the plate laminated type heat exchanger according to the first aspect, the plurality of grooves includes at least two groove groups of a first groove group and a second groove group which has a groove width narrower than a groove width of the first groove group.

[0007]
According to this configuration, the number of the grooves and the inner walls formed in the second groove group increases. Accordingly, since portions of the first surface at which the inner walls are formed are used as bonding portions to be bonded to an adjacent plate, the plurality of plates are more strongly bonded each other as the number of the inner walls formed in the second groove group increases. In addition, since each bonding portion at which the inner walls are formed is narrow, each bonding portion can be sufficiently covered by a brazing material. Therefore, defects in bonding caused by lacking of the brazing material can be prevented from occurring.

Further, when the pressure inside the plate laminated type heat exchanger becomes high, stress applied to each plate is increased and the plurality of plate may be sloughed
off by the stress. However, since the groove width of the second groove group is narrow, the stress is distributed to each groove in the second groove group and the stress applied to the plate decreased. Accordingly, the plurality of plates can be prevented from being sloughed off by the stress even if each plate is bonded by the brazing.

As a result, the plate laminated type heat exchanger can be used under a high pressure environment.

[0008] According to a third aspect of the present invention, in the plate laminated type heat exchanger according to the first or second aspect, a merging portion is provided between the first groove group and the second groove group, and at least two inner walls are provided at positions with respect to both sides of the second groove group in a direction intersecting with a flow direction of the fluid.

[0009] Accordingly, the fluid can flow smoothly and uniformly in each of the plurality of grooves. As a result, a pressure loss in the plate laminated type heat exchanger can be prevented and efficiency of the heat exchange can be improved.

[0010] According to a fourth aspect of the present invention, in the plate laminated type heat exchanger according to the second or third aspect, when the groove width of the second groove group is W, the width W is set to from 2 mm to 4 mm. A thickness of at least one of the plurality of plate is set to less than the width W.

[0011] Accordingly, the speed of the heat exchange can be increased and efficiency of the heat exchange can be improved. In addition, according to this configuration, since the thickness of at least on the plate is set to less than the width W, the plate laminated type heat exchanger can be manufactured in compact and in low cost to reduce materials to form the plate.

[0012] Accordingly to the fifth aspect of the present invention, in the plate laminated type heat exchanger according to any one of the first to fourth aspect, at least one of the plurality of plates includes a bonding portion formed around the plurality of grooves to
bond to the second surface of the other one of the plurality of plates, and the bonding portion includes an auxiliary bonding portion.

According to a sixth aspect of the present invention, in the plate laminated type heat exchanger according to the fifth aspect, the auxiliary bonding portion is formed in groove shape.

According to this configuration, since the auxiliary bonding portion is formed in the bonding portion, a flat area in the bonding portion is divided by the auxiliary bonding portion. Therefore, a brazing material can be sufficiently spread all over the flat area in the bonding portion to be brazed without reducing the total area of the flat area in the bonding portion. Accordingly, each of the plurality of plates is capable of bonding with the strong bonding force and the defects of the plate laminated type heat exchanger can be prevented from occurring.

According to the seventh aspect of the present invention, in the plate laminated type heat exchanger according to fifth aspect, when the groove width of the second groove group is W, a distance from a first end of the plate in a direction orthogonal to the second groove group to an outermost groove in the second groove group closer to the first end of the plate is set to 10 times or less than the width W.

According to this configuration, the bonding portion formed around the plurality of grooves can be reduced and an effective area of the second groove group can be sufficiently large. Accordingly, the speed of the heat exchange can be increased and the efficiency of the heat exchange can be improved.

[Advantageous Effects of Invention]

According to the above-mentioned plate laminated type heat exchanger, the defects can be prevented from occurring even if the plate laminated type heat exchanger is used under the high pressure environment. Further, the production cost of the plate laminated type heat exchanger can be reduced.

[Brief Description of Drawings]

Fig. 1 is a perspective view which shows a plate laminated type heat exchanger according to an embodiment of the present invention.
[Fig. 2]
Fig. 2 is a side view which shows the plate laminated type heat exchanger according to the embodiment of the present invention.

[Fig. 3]
Fig. 3 is an exploded perspective view of a plate laminated body.

[Fig. 4]
Fig. 4 is a top view which shows a pattern of a flow channel formed on a plate according to the embodiment of the present invention.

[Fig. 5]
Fig. 5 is an enlarged view of a portion A of Fig. 4.

[Fig. 6]
Fig. 6 is a cross-sectional view taken along line VI-VI' of Fig. 4.

[Fig. 7]
Fig. 7 is a cross-sectional view taken along line VII-VII" of Fig. 5.

[Fig. 8]
Fig. 8 is a cross-sectional view taken along line VIII-VIII'-V" of Fig. 5.

[Description of Embodiments]

[0019]
(Configuration of a plate laminated type heat exchanger)
Hereinafter, a plate laminated type heat exchanger 1 according to an embodiment of the present invention will be described with reference to the drawings.

[0020]
Fig. 1 is a perspective view which shows a plate laminated type heat exchanger 1.
Fig. 2 is a side view which shows the plate laminated type heat exchanger 1.
Fig. 3 is an exploded perspective view of the plate laminated body 30 according to the embodiment of the present invention.

[0021]
As shown in Fig. 1, a plate laminated type heat exchanger 1 includes a heat exchanger body 2 which is configured from a plate laminated body 30 and a header 4.

[0022]
As shown in Fig. 3, the plate laminated body 30 is formed by alternately laminating a first plate 3a having a high temperature fluid flow channel 39a to flow high temperature fluid G1 and a second plate 3b having a low temperature fluid flow channel 39b to flow low temperature fluid G2. Hereinafter, the first plate 3a and the second plate 3b will be collectively referred to as a plate 3. The high temperature fluid flow channel 39a and the low temperature fluid flow channel 39b will be collectively referred
to as a flow channel 39. The high temperature fluid G1 and the low temperature fluid G2 will be collectively referred to as fluid G.

The plate 3 has two directions of a width direction and a longitudinal direction. The width direction corresponds to a direction in which the high temperature fluid G1 flows in and out of the high temperature fluid flow channel 39a in Fig. 3.

In the following description, the width direction of the plate 3 is referred to as a X direction. The longitudinal direction of the plate 3 is referred to as a Y direction. A lamination direction of the plate 3 is referred to as a Z direction.

As shown in Fig. 2, the plate 3 has four side surfaces of a first side surface 38c which is positioned in one side in the X direction (-X direction), a second side surface 38d which is positioned in the other side in the X direction (+X direction), third side surface 38e which is positioned in one side in the Y direction (+Y direction), and a fourth side surface 38f in the other side in the Y direction (-Y direction).

Four side surfaces of the plate laminated body 30 formed by laminating the plate 3 will be referred to by the same names of the first side surface 38c, the second side surface 38d, the third side surface 38e and the fourth side surface 38f of the plate 3.

[0023]

In this embodiment, as shown in Fig. 2, the header 4 is configured from four headers of a first inlet header 4a, second inlet header 4b, first outlet header 4c, and second outlet header 4d.

As shown in Fig. 2, the first inlet header 4a is disposed on a first side surface 38c of the plate laminated body 30 closer to a third side surface 38e. The first inlet header 4a has a first inlet 4e through which the high temperature fluid G1 flows in from an outside of the plate laminated body 30.

The second inlet header 4b is disposed on a second side surface 38d of the plate laminated body 30 closer to the third side surface 38e. The second inlet header 4b has a second inlet 4f through which the low temperature fluid G2 flows in from the outside of the plate laminated body 30.

The first outlet header 4c is disposed on a second side surface 38d of the plate laminated body 30 closer to a fourth side surface 38f. The first outlet header 4c has a first outlet 4g through which the high temperature fluid G1 flows out to the outside of the plate laminated body 30.

The second outlet header 4d is disposed on the first side surface 38c of the plate laminated body 30 closer to the fourth side surface 38f. The second outlet header 4d has a second outlet 4h through which the low temperature fluid G2 flows out to the outside of the plate laminated body 30.
As shown in Fig. 3, the plate 3 is formed in a flat plate shape and having a first surface 38a and a second surface 38b.

As shown in Fig. 3, the high temperature fluid flow channel 39a, through which the high temperature fluid G1 flows, is formed in a groove shape on a first surface 38a of the first plate 3a by etching. The low temperature fluid flow channel 39b, through which the low temperature fluid G2 flows, is formed in a groove shape on a first surface 38a of the second plate 3b by etching.

Fig. 4 is a top view which shows a pattern of a high temperature fluid flow channel 39a formed on the first surface 38a of the first plate 3a (plate 3).

Fig. 5 is an enlarged view of a portion A of Fig. 4.

Fig. 6 is a cross-sectional view taken along line VI-VI' of Fig. 4.

As shown in Figs. 3 and 4, the high temperature fluid flow channel 39a have four portions of a first inlet channel 31a, a first intermediate channel 33a, a main channel 34a, a second intermediate channel 33b and a first outlet channel 32a. The low temperature fluid flow channel 39b have four portions of a second inlet channel 31b, a first intermediate channel 33a, a main channel 34b, a second intermediate channel 33b and a second outlet channel 32b.

The first inlet channel 31a and the second inlet channel 31b will be collectively referred to as an inlet channel 31. The first intermediate channel 33a and the second intermediate channel 33b will be collectively referred to as an intermediate channel 33. The a main channel 34a and the main channel 34b will be collectively referred to as a main channel 34. The first outlet channel 32a and the second outlet channel 32b will be collectively referred to as an outlet channel 32. In addition, the inlet channel 31, the intermediate channel 33 and the outlet channel will be collectively referred to as a first groove group. The main channel 34 will be referred to as a second groove group.

Since basic configuration is the same, the following description will be given based on the high temperature fluid flow channel 39a of the first plate 3a.

As shown in Fig. 4, the first inlet channel 31a is configured from a plurality of grooves having a linear groove shape in a plan view (viewing from the +Z direction) and formed in a range L3 (shown in Fig. 5) in the Y direction so that the plurality of grooves are aligned in the Y direction.

The first inlet channel 31a has a first inlet opening 40a opening to the first side surface 38c of the first plate 3a (to the -X direction) at a position apart from the third
side surface 38e of the first plate 3a.

The first inlet channel 31a extends toward the second side surface 38d side (toward the +X direction) of the first plate 3a in parallel with third side surface 38e of the first plate 3a to a position having a predetermined distance disposed between the first inlet channel 31a and the second side surface 38d of the first plate 3a.

In addition, the first inlet channel 31a is formed such that a length in the X direction becoming shorter as approaching to the fourth side surface 38f side of the first plate 3a.

[0027]

As shown in Fig. 4, the first intermediate channel 33a is configured from a plurality of grooves having a linear groove shape in the plan view (viewing from the +Z direction).

The first intermediate channel 33a is formed in a range L2 (shown in Fig. 5) from an outermost groove of the first intermediate channel 33a arranged near the first side surface 38c to an outermost groove of the first intermediate channel 33a arranged near the second side surface 38d, in a range L3 in the Y direction and in a range LI in the X direction.

The first intermediate channel 33a is formed from a portion close to an end part of the first inlet channel 31a near the second side surface 38d (in the +X direction) interposing a merging portion 37 (to be described later) formed therebetween.

The first intermediate channel 33a extends and inclines toward the fourth side surface 38f of the first plate 3a to a same position in the Y direction as a position of an outermost groove of the first inlet channel 31a arranged near the fourth side surface 38f (in the -Y direction).

[0028]

As shown in Fig. 4, the main channel 34a is formed of a plurality of grooves having waved shapes in the plan view (viewing from the +Z direction) and formed in a range LI (shown in Fig. 5) in the X direction so that the plurality of grooves are aligned in the X direction.

The main channel 34a is formed from a portion close to an end part of the first intermediate channel 33a near the fourth side surface 38f (in the -Y direction) interposing the merging portion 37 formed therebetween, while an outermost groove of the main channel 34a arranged near the first side surface 38c (in the -X direction) is connected to an end part close to the second side surface 38d (in the +X direction) on the outermost groove of the first inlet channel 31a arranged near the fourth side surface 38f (in the -Y direction).

The main channel 34a is arranged at a substantially center of the first plate 3a.
having predetermined a width $W_4$ (shown in Fig. 6) on both sides of the main channel 34a in the X direction.

The main channel 34a extends toward the fourth side surface 38f (toward the -Y direction) in parallel with the first side surface 38c of the first plate 3a.

Configuration of the intermediate channel 33b is similar to that of the intermediate channel 33a. That is, as shown in Fig.3, the second intermediate channel 33b is configured from a plurality of grooves.

The second intermediate channel 33b is formed from a portion close to an end part of the main channel 34a near the fourth side surface 38f (in the -Y direction) interposing the merging portion 37 formed therebetween.

The second intermediate channel 33b extends and inclines toward the second side surface 38d of the first plate 3a.

Configuration of the first outlet channel 32a is similar to that of the first inlet channel 31a. That is, as shown in Fig.4, the first outlet channel 32a is configured from a plurality of grooves so that the plurality of grooves are aligned in the Y direction.

The first outlet channel 32a is formed from a portion close to an end part of the second intermediate channel 33b near the second side surface 38d (in the +X direction) interposing the merging portion 37 formed therebetween while an outermost groove of the first outlet channel 32a arranged near the third side surface 38e (in the +Y direction) is connected to an end part close to the fourth side surface 38f (in the -Y direction) on an outermost groove of the main channel 34a arranged near the second side surface 38d (in the +X direction).

The first outlet channel 32a extends toward the second side surface 38d of the first plate 3a (toward the +X direction) in parallel with the fourth side surface 38f of the first plate 3a.

The first outlet channel 32a has a first outlet opening 41a opening to the second side surface 38d (to the +X direction) of the first plate 3a at a position apart from the fourth side surface 38f of the first plate 3a.

As shown in Fig. 5, the main channel 34a has a groove width $W_1$, the first intermediate channel 33a has a groove width $W_2$, and the first inlet channel 31a has a groove width $W_3$. The second intermediate channel 33b has a same groove width as the first intermediate channel 33a and the first outlet channel 32a has a same groove width as the first inlet channel 31a.
The groove width W1 to W3 satisfy following relation:
\[ W_1 < W_2 < W_3 \]

[0032]

In this embodiment, as shown in Fig. 6, the groove width W1 of the main channel 34a is set to 2 mm to 4 mm. More preferably, the groove width W1 is set to 3 mm.

A thickness T of the plate 3 is preferably set to less than the width W1. More preferably, the thickness of the plate 3 is set to 2 mm or less.

A groove depth D of the first inlet channel 31a, the intermediate channel 33, the main channel 34a and the first outlet channel 32a is preferably set to approximately 1.5 mm.

[0033]

Furthermore, the range L1 to L3 satisfy following relation:
\[ L_3 < L_2 < L_1 \]

In addition, the number of the grooves in the main channel 34a is larger than the intermediate channel 33, and the number of the grooves in the intermediate channel 33 is larger than the first inlet channel 31a and the first outlet channel 32a.

[0034]

Fig. 7 is a cross-sectional view taken along line VII-VH'-VH" of Fig. 5.

Fig. 8 is a cross-sectional view taken along line VIII-VIIr-VIIr'-VIH" of Fig. 5.

In Fig. 7, the first intermediate channel 33a is indicated by a region between VII-VII', and the merging portion 37 is indicated by a region between VII'-VII".

As shown in Fig. 7, the merging portion 37 between the first intermediate channel 33a and the main channel 34a, for example, is configured to have one groove having a groove width wider than that of the first intermediate channel 33a.

More specifically, the first intermediate channel 33a is provided with the plurality of grooves defined by inner walls 42 at an interval of the width W2, as shown in the region between VII-VII' in Fig. 7. Accordingly, the high temperature fluid G1 separately flows in each groove in the first intermediate channel 33a.

However, the merging portion 37 between the first intermediate channel 33a and the main channel 34a has two inner walls 42 provided at both sides of the range L1 in the x direction, as shown in the region between VII'-VH" in Fig. 7. One of two inner walls 42 of the merging portion 37 is a portion at which the outermost grooves of the first intermediate channel 33a and the main channel 34a arranged near the first side surface 38c are connected. The other of two inner walls 42 of merging portion 37 is a portion at which the outermost grooves of the first intermediate channel 33a and the main channel 34a arranged near the second side surface 38d are connected.
Accordingly, the high temperature fluid G_l flowing from the first intermediate channel 33a is merged at the merging portion.

[0035]

In Fig. 8, the first intermediate channel 33a is indicated by a region between VIII-VIII'-VIII", and the merging portion 37 is indicated by a region between VIII"-VIII"'.

As shown in Fig. 8, the merging portion 37 between the first inlet channel 31a and the first intermediate channel 33a, for example, is configured to have a plurality of grooves.

More specifically, the merging portion 37 between the first inlet channel 31a and the first intermediate channel 33a provided with the plurality of grooves defined by the inner walls 42 at an interval wider than the width W2 of intermediate channel 33 including two inner walls 42 provided at both sides of the range L2, as shown in the region between VIII"-VIII" in Fig. 8. With this configuration, the high temperature fluid G_l flowing from the first inlet channel 31a can still be merged at the merging portion 37.

[0036]

In this embodiment, two type of the merging portion 37, a first type in which the merging portion 37 having one groove and a second type in which the merging portion 37 having the plurality of grooves, are described. However, the merging portion 37 between the first intermediate channel 33a and the main channel 34a may be formed in the second type. The merging portion 37 between the first inlet channel 31a and the first intermediate channel 33a may be formed in the first type.

The merging portion 37 between the main channel 34a and the second intermediate channel 33b, and between the second intermediate channel 33b and the first outlet channel 32a are also formed in any one of the first type and the second type.

[0037]

As shown in Fig. 4, a bonding portion 35 is formed around the high temperature fluid flow channel 39a of the first plate 3a which is configured to bond to the second surface 38b of the second plate 3b to form the plate laminated body 30.

As shown in Fig. 6, the bonding portion 35 has the width W4 in the X direction from an end edge of the first surface 38a closer to the first side surface 38c to the outermost groove of the main channel 34a near the first side surface 38c.

In this embodiment, the width W4 is preferably set to 10 times or less of the width W1 of the main channel 34a.

[0038]
A shown in Fig. 4, the bonding portion 35 has an auxiliary bonding portion 36 formed at two positions at a side the first intermediate channel 33a in the +X direction with a predetermined space and at a side of the second intermediate channel 33b in the -X direction with a predetermined space.

In this embodiment, the auxiliary bonding portion 36 formed at the side of the first intermediate channel 33a, for example, has a right triangle shape having a first side arranged on a same position in the X direction as a position of the outermost groove of the first inlet channel 31a arranged near the third side surface 38e, a second side arranged on a same position in the Y direction as a position of the outermost groove of the main channel 34a arranged near the second side surface 38d, and third side parallel to an outermost groove of the first intermediate channel 33a arranged near the second side surface 38d interposing a predetermined space therebetween.

A plurality of grooves are formed inside the auxiliary bonding portion 36. In this embodiment, the plurality of grooves of the auxiliary bonding portion 36 are formed at a predetermined interval so that the plurality of grooves extend in the X direction. The plurality of grooves of the auxiliary bonding portion 36 may formed to extend to the other direction, for example, in the Y direction, or the like.

[0039]

In this embodiment, the low temperature fluid flow channel 39b of the second plate 3b has a similar shape to the high temperature fluid flow channel 39a of the first plate 3a. However, the low temperature fluid flow channel 39b is formed to have a laterally reversed shape of the high temperature fluid flow channel 39a in the X direction.

The following description will be given of only differences between the low temperature fluid flow channel 39b of the second plate 3b and the high temperature fluid flow channel 39a of the first plate 3a.

[0040]

As shown in Fig. 3, a second inlet channel 31b has a second inlet opening 40b opening to the second side surface 38d of the second plate 3b (to the +X direction) at a position apart from the third side surface 38e of the second plate 3b. The second inlet channel 31b extends toward the first side surface 38c side (toward the -X direction) of the second plate 3b in parallel with the third side surface 38e of the second plate 3b to a position having a predetermined distance disposed between the second inlet channel 31b and the first side surface 38c of the second plate 3b.

[0041]

As shown in Fig. 3, a first intermediate channel 33a is formed from a portion close to an end part of the second inlet channel 31b near the first side surface 38c (in the -X
direction) interposing a merging portion 37 formed therebetween.

The first intermediate channel 33a extends and inclines toward the fourth side surface 38f of the second plate 3b to a same position in the Y direction as a position of an outermost groove of the second inlet channel 31b arranged near the fourth side surface 38f (in the -Y direction).

[0042]

As shown in Fig. 3, a main channel 34b is formed from a portion close to an end part of the first intermediate channel 33a near the fourth side surface 38f (in the -Y direction) interposing the merging portion 37 formed therebetween, while an outermost groove of the main channel 34b arranged near the second side surface 38d (in the +X direction) is connected to an end part close to the first side surface 38c (in the -X direction) on the outermost groove of the first inlet channel 31a arranged near the fourth side surface 38f (in the -Y direction).

In this embodiment, the main channel 34b is arranged in a same direction to the main channel 34a (in the Y direction).

[0043]

As shown in Fig. 3, a second intermediate channel 33b is formed from a portion close to an end part of the main channel 34b near the fourth side surface 38f (in the -Y direction) interposing the merging portion 37 formed therebetween.

The second intermediate channel 33b extends and inclines toward the first side surface 38c of the second plate 3b.

[0044]

As shown in Fig. 3, a second outlet channel 32b is formed from a portion close to an end part of the second intermediate channel 33b near the first side surface 38c side (in the -X direction) interposing the merging portion 37 formed therebetween while an outermost groove of the second outlet channel 32b arranged near the third side surface 38e (in the +Y direction) is connected to an end part close to the fourth side surface 38f (in the -Y direction) on an outermost groove of the main channel 34a arranged near the first side surface 38c (in the -X direction).

The second outlet channel 32b extends toward the first side surface 38c of the first plate 3a (toward the -X direction) in parallel with the fourth side surface 38f of the second plate 3b.

The second outlet channel 32b has a second outlet opening 41b opening to the first side surface 38c (to the -X direction) of the second plate 3b at a position apart from the fourth side surface 38f of the second plate 3b.

[0045]
A shown in Fig. 4, a bonding portion 35 of the second plate 3b which is configured to bond to the second surface 38b of the first plate 3a to form the plate laminated body 30. The bonding portion 35 has an auxiliary bonding portion 36 formed at two positions at a side the first intermediate channel 33 in the -X direction and at a side of the second intermediate channel 33b in the +X direction.

(Assembly method of the plate laminated type heat exchanger)

Next, an assembly method of the plate laminated type heat exchanger 1 will be described with reference to Figs. 1 to 3.

First, as shown in Fig. 3, the first plate 3a and the second plate 3b are alternately arranged so that the first surface 38a of the first plate 3a and the second plate 3b face the same direction (+Z direction in Fig. 3), and the first inlet opening 40a is positioned in an opposite side of the second inlet opening 40b of the second inlet channel 31b formed on the second plate 3b in the X direction.

Then, the bonding portion of the first plate 3a and the second plate 3b are coated by brazing material and are brazed to the second surface 38b of the first plate 3a and the second plate 3b respectively to form the plate laminated body 30.

Next, as shown in Fig. 2, the first inlet header 4a is attached on the third side surface 38e side of the first side surface 38c of the plate laminated body 30 so that the first inlet 4e is arranged with respect to the first inlet opening 40a of the first inlet channel 31a.

The second inlet header 4b is attached on the third side surface 38e side of the second side surface 38d of the plate laminated body 30 so that the second inlet 4f is arranged with respect to the second inlet opening 40b of the second inlet channel 31b.

The first outlet header 4c is attached on the fourth side surface 38f of the second side surface 38d of the plate laminated body 30 so that the first outlet 4g is arranged with respect to the first outlet opening 41a of the first outlet channel 32a.

The second outlet header 4d is attached on the fourth side surface 38f of the first side surface 38c of the plate laminated body 30 so that the second outlet 4h is arranged with respect to the second outlet opening 41b of the second outlet channel 32b.

In this way, the first inlet header 4a, the second inlet header 4b, the first outlet header 4c, and the second outlet header 4d are attached to the plate laminated body 30 to form the heat exchanger body 2 (shown in Fig. 1).
After that, pipes (not shown) to supply the high temperature fluid G1 and the low temperature fluid G2 into the heat exchanger body 2 are connected to the first inlet 4e and the second inlet 4f respectively. In addition, pipes (not shown) which exhaust the high temperature fluid G1 and the low temperature fluid G2 from the heat exchanger body 2 are connected to the first outlet 4g and the second outlet 4h respectively.

Accordingly, assembly of the plate laminated type heat exchanger 1 is completed.

[0050]
(Operating of the plate laminated type heat exchanger)

Next, operation of the plate laminated type heat exchanger 1 will be described with reference to Fig. 2 and 3.

First, as shown in Fig. 2, the high temperature fluid G1 is supplied to the first inlet 4e of the first inlet header 4a from the outside of the heat exchanger body 2. As shown in Fig 3, the high temperature fluid G1 flows into the first inlet channel 31a of the high temperature fluid flow channel 39a through the first inlet opening 40a from the first inlet header 4a. In the first inlet channel 31a, the high temperature fluid G1 flows in the +X direction along an extending direction of the first inlet channel 31a.

Then, the high temperature fluid G1 flows into the merging portion 37 from the first inlet channel 31a. The high temperature fluid G1 flown from the first inlet channel 31a is merged at the merging portion 37. After that, the high temperature fluid G1 is separated to flow into the first intermediate channel 33a.

In the first intermediate channel 33a, the high temperature fluid G1 flows in a direction along an inclination of the first intermediate channel 33a.

Then, the high temperature fluid G1 flows into the merging portion 37 from the first intermediate channel 33a. The high temperature fluid G1 flown from the first intermediate channel 33a is merged at the merging portion 37. After that, the high temperature fluid G1 is separated to flow into the main channel 34a.

In the main channel 34a, the high temperature fluid G1 in the -Y direction along an extending direction of the main channel 34a.

Then, the high temperature fluid G1 flows into the merging portion 37 from the main channel 34a. The high temperature fluid G1 flown from the main channel 34a is merged at the merging portion 37. After that, the high temperature fluid G1 is separated to flow into the second intermediate channel 33b.

In the second intermediate channel 33b, the high temperature fluid G1 flows in a direction along an inclination of the second intermediate channel 33b.

Then, the high temperature fluid G1 flows into the merging portion 37 from the second intermediate channel 33b. The high temperature fluid G1 flown from the
second intermediate channel 33b is merged at the merging portion 37. After that, the high temperature fluid G1 is separated to flow into the first outlet channel 32a.

In the first outlet channel 32a, the high temperature fluid G1 in the +X direction along an extending direction of the first outlet channel 32a. The high temperature fluid G1 flows from the first outlet channel 32a to the first outlet header 4c through the first outlet opening 41a.

Then, as shown in Fig. 2, the high temperature fluid G1 is exhausted to the outside of the heat exchanger body 2 through the first outlet 4g of the first outlet header 4c. [0051]

Furthermore, as shown in Fig. 2, the low temperature fluid G2 is supplied to the second inlet 4f of the second inlet header 4b from the outside of the heat exchanger body 2.

As shown in Fig. 3, the low temperature fluid G2 flows into the second inlet channel 31b of the low temperature fluid flow channel 39b through the second inlet opening 40b from the second inlet header 4b. In the second inlet channel 31b, the low temperature fluid G2 flows in the -X direction along an extending direction of the the second inlet channel 31b.

Then, the low temperature fluid G2 flows into the merging portion 37 from the second inlet channel 31b. The low temperature fluid G2 flown from the second inlet channel 31b is merged at the merging portion 37. After that, the low temperature fluid G2 is separated to flow into the first intermediate channel 33a.

In the first intermediate channel 33a, the low temperature fluid G2 flows in a direction along an inclination of the first intermediate channel 33a.

Then, the low temperature fluid G2 flows into the merging portion 37 from the first intermediate channel 33a. The low temperature fluid G2 flown from the first intermediate channel 33a is merged at the merging portion 37. After that, the low temperature fluid G2 is separated to flow into the main channel 34b.

In the main channel 34b, the low temperature fluid G2 in the -Y direction along an extending direction of the main channel 34b.

Then, the low temperature fluid G2 flows into the merging portion 37 from the main channel 34b. The low temperature fluid G2 flown from the main channel 34b is merged at the merging portion 37. After that, the low temperature fluid G2 is separated to flow into the second intermediate channel 33b.

In the second intermediate channel 33b, the low temperature fluid G2 flows in a direction along an inclination of the second intermediate channel 33b.

Then, the low temperature fluid G2 flows into the merging portion 37 from the
second intermediate channel 33b. The low temperature fluid G2 flown from the second intermediate channel 33b is merged at the merging portion 37. After that, the high temperature fluid G1 is separated to flow into the second outlet channel 32b.

In the second outlet channel 32b, the low temperature fluid G2 in the -X direction along an extending direction of the second outlet channel 32b.

The low temperature fluid G2 flows to the second outlet header 4d through the second outlet opening 41b.

Then, as shown in Fig. 2, the low temperature fluid G2 is exhausted to the outside of the heat exchanger body 2 through the second outlet 4h of the second outlet header 4d.

[0052]

In this way, the high temperature fluid G1 flowing through the main channel 34a and the low temperature fluid G2 flowing through the main channel 34b flow in the same direction (-Y direction in Fig. 3).

At this time, heat of the high temperature fluid G1 is transferred to the low temperature fluid G2 and heat exchange therebetween is performed.

[0053]

(Effects)
In this way, in the embodiment mentioned above, since the flow channel 39 is formed so that the groove width W1 of the main channel 34, the groove width W2 of the intermediate channel 33 and the groove width W3 of the inlet channel 31 and the outlet channel 32 satisfy the relation W1 < W2 < W3, the number of the grooves and the inner walls 42 formed in the main channel 34 increases. Since portions of the first surface 38a at which the inner walls 42 are formed are used as the bonding portions to be bonded to an adjacent plate 3, the plates 3 are more strongly bonded each other as the number of the inner walls 42 formed in the main channel 34 increases. Moreover, since each bonding portion at which the inner walls 42 are formed is narrow, each bonding portion can be sufficiently covered by a brazing material. Therefore, defects in bonding caused by lacking of the brazing material can be prevented from occurring.

In addition, when the pressure inside the plate laminated type heat exchanger 1 becomes high, stress applied to each plate 3 is increased and the plurality of plates 3 may be sloughed off by the stress. However, since the groove width W1 of the main channel 34 is narrow, the stress is distributed to each groove in the main channel 34 and the stress applied to the plate 3 decreased. Accordingly, the plurality of plates 3 can be prevented from being sloughed off.

As a result, the plate laminated type heat exchanger 1 can be used under a high
pressure environment, for example, in which the pressure is higher than 100 bar.

Since bonding force between each plate 3 is increased with the configuration mentioned above, each plate 3 is capable of being bonded each other by brazing even if the plate laminated type heat exchanger 1 is used under the high pressure environment. Further, since each plate 3 is bonded by brazing, the plate laminated type heat exchanger 1 can be produced at low cost.

In addition, since the width W1 of the main channel 34 is set to 2 mm to 4 mm, the pressure of fluid G is further increased in the main channel 34, the speed of the heat exchange between the high temperature fluid G1 and the low temperature fluid G2 can be increased and efficiency of the heat exchange can be improved.

Further, since the thickness T of the plate 3 is set to less than the width W1 of the main channel 34, a thin plate can be used to form the plate 3. Accordingly, the plate laminated type heat exchanger 1 can be manufactured in compact and in low cost to reduce materials to form the plate 3.

In addition, since the flow channel 39 is formed in a groove shape by etching on the first surface 38a of the plate 3 having flat plate shape, the groove width W1 of the main channel 34 is capable of being narrowed and the plate 3 can obtain a sufficient rigidity compared with using a waveform plate although the plate 3 is formed from the thin plate. Accordingly, the plate laminated type heat exchanger 1 can prevent from being damaged even if a pressure inside the plate laminated type heat exchanger 1 becomes higher than 100 bar. Therefore, the plate laminated type heat exchanger 1 can be used under a high pressure environment.

Further, since the flow channel 39 is formed so that the range L1 in which the main channel 34 is formed, the range L2 in which the intermediate channel 33 is formed and the range L3 in which the inlet channel 31 and the outlet channel 32 are formed satisfy the relation L3 < L2 < L1, an effective area of the main channel 34, in which the heat exchange is performed, can increase while areas of the intermediate channel 33, the inlet channel 31 and the outlet channel 32 decreased. Accordingly, the heat exchange can be effectively performed.

In addition, since the merging portion 37 is formed between the inlet channel 31 and the intermediate channel 33, between the intermediate channel 33 and the main
channel 34, between the main channel 34 and the intermediate channel 33 and between the intermediate channel 33 and the outlet channel 32, the fluid G flowing from the inlet channel 31 is merged at the merging portion 37 and uniformly separated into the intermediate channel 33, the fluid G flowing from the intermediate channel 33 is merged at the merging portion 37 and uniformly separated into the main channel 34, the fluid G flowing from the main channel 34 is merged at the merging portion 37 and uniformly separated into intermediate channel 33, and the fluid G flowing from the intermediate channel 33 is merged at the merging portion 37 and uniformly separated into the outlet channel 32.

With the configuration mentioned above, although the number of the grooves formed in the inlet channel 31 and the outlet channel 32, the number of the grooves formed in the intermediate channel 33 and the number of the grooves formed in the main channel 34 are different, the fluid G can be merged at each merging portion 37 and uniformly separated into each channel. Accordingly, the fluid G can flow smoothly and uniformly into each channel of the flow channel 39. As a result, a pressure loss in the plate laminated type heat exchanger 1 can be prevented and efficiency of the heat exchange can be improved.

[0059]

When a total area of the bonding portion to be brazed is small, a bonding force between each plate may not be sufficiently obtained. In addition, when the bonding portion has a large flat area to be brazed, the brazing material may not be sufficiently spread all over the flat area in the bonding portion and a middle of the flat area in the bonding portion may not be covered by the brazing material. As a result, the bonding force between each plate may be weakened and the defects of the plate laminated type heat exchanger may occur.

However, in the embodiment mentioned above, since the auxiliary bonding portion 36 is formed in the bonding portion 35, the bonding portion 35 becomes large and the flat area in the bonding portion 35 is divided by the auxiliary bonding portion 36. Therefore, the brazing material can be sufficiently spread all over the flat area in the bonding portion 35 to be brazed without reducing the total area of the bonding portion 35. Accordingly, each plate 3 is capable of bonding with the strong bonding force and the defects of the plate laminated type heat exchanger can be prevented from occurring.

Further, since the effective area of the main channel 34, in which the heat exchange is performed, can increase while the areas of the intermediate channel 33, the inlet channel 31 and the outlet channel 32 decreased, as mentioned above, the main channel 34 is capable of having sufficient effective area even if the area of the bonding portion
35 increased to form the auxiliary bonding portion 36.

[0060] Although the shape or combination of each component has been illustratively described in the above embodiment, specific configurations are not limited thereto and a design modification may be made appropriately without departing from the principles and spirit of the invention.

[0061] Although the configuration that the high temperature fluid G1 flowing through the main channel 34a and the low temperature fluid G2 flowing through the main channel 34b flow in the same direction (-Y direction in Fig. 3) has been described in the above embodiment, the present invention is not limited thereto.

   The high temperature fluid G1 flowing through the main channel 34a may flow in a direction opposite to the low temperature fluid G2 flowing through the main channel 34b, or in a direction perpendicular to the low temperature fluid G2 flowing through the main channel 34b. In this configuration, the heat exchange can be sufficiently performed.

   However, in this case, the grooves formed in the high temperature fluid flow channel 39a and the low temperature fluid flow channel 39b are needed to be appropriately arranged based on the direction to which the high temperature fluid G1 and the low temperature fluid G2 is to be flown.

[0062] Although the configuration that the flow channel 39 is formed in the groove shape on the first surface 38a of the plate 3 having the flat plate shape by etching has been described in the above embodiment, the present invention is not limited thereto.

   The flow channel 39 may be formed in the groove shape by machining.

[0063] Although the configuration that the intermediate channel 33, the inlet channel 31 and the outlet channel 32 are formed in the linear groove shape while the main channel 34 is formed in the waved shape has been described in the above embodiment, the present invention is not limited thereto.

   The main channel 34 may be formed in the linear groove shape. Since the effective area of the main channel 34 is sufficiently large, the heat exchange can be effectively performed in the main channel 34.

   The intermediate channel 33, the inlet channel 31 and the outlet channel 32 may be formed in the waved shape. Accordingly, the heat exchange efficiency can increase at the intermediate channel 33, the inlet channel 31 and the outlet channel 32.
Although the configuration that the auxiliary bonding portion 36 is formed in the right triangle shape has been described in the above embodiment, the present invention is not limited thereto.

The auxiliary bonding portion 36 may be formed in any shape other than the right triangle shape when the flat area in the bonding portion 35 can be divided.

In addition, the auxiliary bonding portion 36 is not limited to have the plurality of grooves. The auxiliary bonding portion 36 may have an emboss pattern or a knurling pattern. The bonding force can be sufficiently obtained with these configurations.

[Industrial Applicability]

According to the present invention, the defects can be prevented from occurring even if the plate laminated type heat exchanger is used under the high pressure environment. Further, the production cost of the plate laminated type heat exchanger can be reduced.

[Reference Signs List]

1 plate laminated type heat exchanger
2 heat exchanger body
3 plate
4 header
4a first inlet header (inlet header)
4b second inlet header (inlet header)
4c first outlet header (outlet header)
4d second outlet header (outlet header)
4e first inlet (inlet)
4f second inlet (inlet)
4g first outlet (outlet)
4h second outlet (outlet)
30 plate laminated body
3a first plate (plate)
3b second plate (plate)
31 inlet channel (first groove group)
31a first inlet channel (inlet channel)
31b second inlet channel (inlet channel)
32 outlet channel (first groove group)
32a  first outlet channel (outlet channel)
32b  second outlet channel (outlet channel)
33  intermediate channel (first groove group)
33a  first intermediate channel (intermediate channel)
33b  second intermediate channel (intermediate channel)
34  main channel (second groove group)
35  bonding portion
36  auxiliary bonding portion
37  merging portion
38a  first surface
38b  second surface
38c  first side surface
38d  second side surface
38e  third side surface
38f  fourth side surface
39  flow channel
39a  high temperature fluid flow channel (flow channel)
39b  low temperature fluid flow channel (flow channel)
40  inlet opening
40a  first inlet opening
40b  second inlet opening
41  outlet opening
41a  first outlet opening
41b  second outlet opening
42  inner wall
G  fluid
G1  high temperature fluid
G2  low temperature fluid
W1, W2, W3  groove width
W4  width of the bonding portion
T  plate thickness
D  groove depth
L1, L2, L3  range in which the flow channel is formed

[Citation List]
[Patent Literature]
[0067]
[PTL 1]

[PTL 2]

[PTL 3]
[CLAIMS]

[Claim 1]
A plate laminated type heat exchanger comprising:
a plate laminated body which is formed by laminating a plurality of plates; and
a heat exchanger body which includes a first header through which fluid flows in from outside of the plate laminated body and a second header through which the fluid flows out to the outside of the plate laminated body which are connected to the plate laminated body,
wherein each of the plurality of plates is formed in a flat plate shape having a first surface and a second surface,
the first surface of at least one of the plurality of plates is provided with a plurality of grooves defined by inner walls through which the fluid flows, and
the plurality of plates are bonded each other by brazing so that the first surface of one of the plurality of plates is brazed to the second surface of the other one of the plurality of plates.

[Claim 2]
The plate laminated type heat exchanger according to claim 1,
wherein the plurality of grooves includes at least two groove groups of a first groove group and a second groove group which has a groove width narrower than a groove width of the first groove group.

[Claim 3]
The plate laminated type heat exchanger according to claim 1 or 2,
wherein a merging portion is provided between the first groove group and the second groove group, and
at least two inner walls are provided at positions with respect to both sides of the second groove group in a direction intersecting with a flow direction of the fluid.

[Claim 4]
The plate laminated type heat exchanger according to claim 2 or 3,
wherein when the groove width of the second groove group is W,
the width W is set to from 2 mm to 4 mm, and
a thickness of at least one of the plurality of plate is set to less than the width W.

[Claim 5]
The plate laminated type heat exchanger according to any one of claims 1 to 4,
wherein at least one of the plurality of plates includes a bonding portion formed around the plurality of grooves to bond to the second surface of the other one of the plurality of plates, and
the bonding portion includes an auxiliary bonding portion.

[Claim 6]
The plate laminated type heat exchanger according to claim 5, wherein the auxiliary bonding portion is formed in groove shape.

[Claim 7]
The plate laminated type heat exchanger according to claim 5, wherein when the groove width of the second groove group is $W$, a distance from a first end of the plate in a direction orthogonal to the second groove group to an outermost groove in the second groove group closer to the first end of the plate is set to 10 times or less than the width $W$. 
FIG. 1
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. F28D9/00
ADD.

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)
F28D

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Relevant to claim No.</th>
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<td>X</td>
<td>US 4 347 896 A (ROSMAN IRWIN E ET AL) 7 September 1982 (1982-09-07) col umn 2, l i n e 12 - l i n e 54 col umn 5, l i n e 60 - col umn 7, l i n e 5 f i gures 6a-6d, 7, 8</td>
<td>1-7</td>
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<tr>
<td>X</td>
<td>EP 0 183 007 Al (ROCKWELL INTERNATIONAL CORP [US]) 4 June 1986 (1986-06-04) page 2, l i n e 19 - page 5; f i gures 1-3</td>
<td>1, 5</td>
</tr>
<tr>
<td>X</td>
<td>US 1 662 870 A (STANCLIFFE CECIL W) 20 March 1928 (1928-03-20) page 1, l i n e 59 - page 2, l i n e 81; f i gures 4, 5, 6, 7</td>
<td>1</td>
</tr>
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Date of the actual completion of the international search 10 July 2015

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<table>
<thead>
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<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
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<tr>
<td>US 4347896 A</td>
<td>07-09-1982</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0183007 A1</td>
<td>04-06-1986</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP S61110880 A</td>
<td>29-05-1986</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NO 854327 A</td>
<td>02-05-1986</td>
</tr>
<tr>
<td>US 1662870 A</td>
<td>20-03-1928</td>
<td>NONE</td>
<td></td>
</tr>
</tbody>
</table>