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(54) ASYMMETRICAL EXCHANGER WITH ANCILLARY CHANNELS FOR CONNECTING TURNS

ASYMMETRISCHER WANDLER MIT ZUSÄTZLICHEN KANÄLEN ZUM VERBINDEN VON WINDUNGEN

ECHANGEUR ASYMÉTRIQUE COMPORTANT DES CANAUX AUXILIAIRES POUR RELIER DES COURBURES

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Description

[0001] This patent relates to plate heat exchangers and in particular to a new asymmetrical plate heat exchanger with ancillary connection channels. It relates, in particular, to a plate-type heat exchanger corresponding to the preamble of claim 1, as disclosed in EP 2 267 391 A1.

[0002] Prior art includes plate heat exchangers comprising at least two separate circuits respectively for the circulation of a primary fluid and a secondary fluid, where those paths are defined by a plurality of exchange plates with facing surfaces, featuring ridges and hollows, generally distributed in a herringbone pattern.

[0003] Prior art heat exchangers are made by stacking the plates in question alternating the rotation of every other one by 180° so that the ridges and hollows of one plate are crossed with respect to the ridges and hollows of the adjacent plate.

[0004] Usually the plates are called symmetric when the ridges and hollows are such that the sections of the channels of both paths used by the two fluids are substantially equal, that is, resulting in equal head loss with equal flows. These heat exchangers are commonly used to heat water for domestic use using the hot water of the heating system.

[0005] To achieve the heat transfer, the temperature of the heating system fluid must be much higher than that of the domestic water. Generally the heating water inlet temperature is 75°C and the outlet temperature may be about 60°C. The inlet water temperature for domestic use may be about 10°C and the outlet temperature about 55°C.

[0006] Prior art also includes plates specially shaped in such a way that the section for the heating fluid is wider than the section for the domestic hot water, and therefore the head losses are differentiated.

[0007] For this purpose the prior art includes the so-called asymmetric heat exchangers, that is, formed by plates comprising ridges with a different shape than the hollows, such as, for example, flat ridges to make the section of the channel even wider. With these types of plates, however, the heat exchange surface between the two fluids is reduced.

[0008] Plates having different head losses with equal flows are also known, obtained by increasing the pitch of the ridges, that is, the distance between the ridges of two adjacent channels. This type of heat exchanger is suitable for the exchange between water and cooling fluid, where the water flows through the path having lower head losses.

[0009] In this case, however, the contact area between the plates themselves are relatively large and therefore underutilized for the heat exchange between the fluids, thus reducing the efficiency of the heat exchanger.

[0010] These solutions, however, compromise the rigidity of the plates due to the reduced number of contact points between the plates making the heat exchanger unsuitable for high pressures.

[0011] In addition, the narrowest channels are excessively smaller than the wider channels.

[0012] Heat exchangers with plates where the depth of the secondary hollow is at least 40% and preferably 50% of the depth of the larger hollow are known. Heat exchangers where the depth of the secondary hollows is diversified on different plates are also known.

[0013] Furthermore, exchangers where a single plate has secondary hollows having two different depths used in two different areas of the plate are also known. One drawback is the fact that the pitch of the welding points is not constant and therefore there are areas where the plates may be less rigid, giving rise to localized deformations that impair the functioning and efficiency of the exchanger.

[0014] To overcome all the drawbacks mentioned above, a new type of asymmetric heat exchanger with plates provided with ancillary connection channels between the main channels was designed and constructed.

[0015] The main object of the present invention is to create paths with different head losses, while maintaining symmetrically distributed welding points as in the heat exchangers of the known type, to the benefit of resistance to pressure.

[0016] Another object of the present invention is to increase the turbulence of the flow in at least one path.

[0017] These and other aims, direct and complementary, are achieved by the new type of heat exchanger with asymmetrical plates with ancillary connection channels between the main channels.

[0018] The new asymmetric plate heat exchanger includes in its main parts at least one series of superimposed plates in a pack, brazed together with possible perimeter seals to confine the fluids inside, and passage holes for at least two exchange fluids, these holes also having seals alternately arranged so as to convey the two fluids in the spaces between the plates, following at least two hydraulically isolated paths.

[0019] The heat exchanger therefore comprises at least two separate paths for a primary fluid and a secondary fluid, each of these two paths being defined by a pair of the facing plates, equipped with alternating ridges and hollows arranged substantially in a herringbone pattern, that is, arranged in two directions which intersect with each other, and where those two paths have different head losses.

[0020] The heat exchanger includes, in particular, two different types of plates, arranged alternately in the pack forming the heat exchanger, where the first type of plate comprises ridges and hollows at a constant pitch and constant height or depth.

[0021] The second type of plate also comprises ridges and hollows at a constant pitch and constant height or depth but has a particular shape as hereinafter described and claimed. Considering one side of the plate of the second type, all the hollows of the plate have a constant depth, except for localized raised portions, that is, having a length much shorter than the length of the hollow. One

or more of the elevations are distributed along each hollow and variously distributed. These localized raised portions of one side of the plate correspond, on the opposite side of the plate, to localized lowered portions on the ridges.

[0022] Placing one plate of the first type facing one plate of the second type, so that the hollows and ridges of the two plates are crossed, a flow path of one of the two fluids is created between them.

[0023] In particular, placing one plate of the first type with one plate of the second type on the side with the raised portions, a secondary path is created, with a greater head loss, formed by main channels, along the hollows of the two facing plates, where there are constrictions in the channels created by the raised portions, suited to increase the turbulence of the fluid and increase the head loss.

[0024] In contrast, placing one plate of the first type with one plate of the second type on the side with the lowered portions, a primary path with a lower head loss is created between them, formed by two series of channels, a first series of main channels along the hollows, and a second series of ancillary channels, transverse to the main channels, created by the lowered portions that put the main channels in communication transversely.

[0025] These main channels and the ancillary transverse channels in fact increase the section for the passage of the flow, thus reducing the head loss.

[0026] As noted, these hollows and ridges are arranged in a herringbone pattern, that is, arranged specularly with respect to a central plane, thus creating two directions which intersect each other.

[0027] These raised portions and corresponding lowered portions are distributed preferably aligned along directions not intersecting the direction of the ridges and hollows. In particular, on each of the two halves of the plate, these raised portions and lowered portions are aligned in a direction parallel to the direction of the ridges and hollows of the specular half.

[0028] Since the new heat exchanger is assembled using two types of alternating plates, the assembly procedures are faster and simplified.

[0029] Each type of plate is in fact made on a dedicated line so that, from each line, the plate obtained is already correctly positioned to be superimposed on the plate coming from the second line. Therefore, the need to rotate the plate 180° as in the assembly procedures of the known type of heat exchangers which use plates which are all the same is eliminated.

[0030] The characteristics of the present invention will be better clarified by the following description with reference to the drawings, attached by way of non-limiting example.

Figure 1 shows a side view (A11) of a plate (A) of the first type, with ridges (A2) and hollows (A3) arranged in a herringbone pattern.

Figure 1a shows a side view of the plate (A) of the first type.

Figure 2 shows a side view (B11) of a plate (B) of the second type, with ridges (B2) and hollows (B3) arranged in a herringbone pattern, with lowered portions (B21) located on the ridges (B2), corresponding to raised portions (B31) located in the hollows (B3) of the opposite side (B12).

Figure 3 shows a cross-section of a pack obtained by the superimposition of four plates, where two plates (A) of the first type are alternated with two plates (B) of the second type.

Figure 3a shows a detailed view of the cross-section in Figure 3.

Figure 4 shows a perspective drawing of a plate (A) of the first type and

Figure 5 shows a perspective drawing of a plate (B) of the second type.

[0031] It is appropriate to note that the ridges and hollows on one side of the plate are hollows and ridges on the opposite side. Thus ridges and hollows are relative to the side being observed. Therefore, the raised portions provided for in this patent may be placed on both the hollows and the ridges with an opposite effect on the opposite side of the same plate.

[0032] The main parts of the new asymmetric plate exchanger comprise plates (A, B) superimposed in a pack, brazed together with possible perimeter seals, to confine the fluids inside, and holes (C) for the passage of the exchange fluids, these holes (C) are themselves brazed together at the edges or equipped with seals alternately arranged so as to convey the two fluids in question in the spaces between the plates along at least two hydraulically isolated paths (1, 2) with different head losses.

[0033] Therefore, the heat exchanger comprises at least two paths (1, 2) separated respectively for a primary fluid and a secondary fluid, each of the two paths (1, 2) being defined by a pair (A, B) of the aforementioned facing plates.

[0034] In particular the heat exchanger includes two different types of plates, arranged alternately in the pack making up the heat exchanger, as shown for example in Figure 3.

[0035] The first type of plate (A) comprises a plurality of alternating ridges (A2) and hollows (A3), arranged in a herringbone pattern, that is, arranged specularly with respect to a central plane (A4) according to two directions (X1, X2) intersecting each other.

[0036] Said ridges (A2) and hollows (A3) have a modular or constant pitch (A5) and have a constant height or depth, that is, the distance (A6) between the top of the ridges and the bottom of the hollows is constant.

[0037] The second type of plate (B) comprises a plurality of alternated ridges (B2) and hollows (B3), arranged in a herringbone pattern, that is, arranged specularly with respect to a central plane (B4) according to two directions (X1, X2) intersecting each other.

[0038] Said ridges (B2) and hollows (B3) have a mod-

ular or constant pitch (B5), equal to or different from the pitch (A5) of the first type of plate (A). Considering one side (B12) of the second type of plate (B), all the hollows (B3) of the plate (B) have a constant depth (B6), with the exception of localized raised portions (B31), that is, having a length much shorter than the length of the hollows (B3).

[0039] These localized raised portions (B31) on the side (B12) of the plate (B) correspond, on the opposite side (B11) of the plate (B), with the localized lowered portions (B21) on the ridges (B2).

[0040] These raised portions (B31) or lowered portions (B21) are distributed along each hollow (B3) or ridge (B2), for example, one or more for each hollow (B3) or ridge (B2), at a modular or constant distance.

[0041] Each of these paths (1, 2) of the two fluids is created by placing one plate of the first type (A) with one plate of the second type (B), so that the hollows (A3, B3) and ridges (A2, B2) of the two plates are crossed.

[0042] In particular, the path in which the primary fluid circulates, or the primary path (1) is obtained by placing a plate of the first type (A) with a plate of the second type (B) on the side of the lowered portions (B21) of the ridges (B2). This primary path (1) has a lower head loss and is formed by two series of channels (11, 12). The first series of channels, or the main channels (11) are formed by the hollows (B3, A3) of the two plates (B, A) facing each other, while the second series of channels, or ancillary channels (12) are transverse to the main channels (11) and created by the lowered portions (B21) that put the main channels (11) in communication transversely.

[0043] These main channels (11) and these transverse ancillary channels (12) in fact increase the section for the passage of the flow, thus reducing the head loss.

[0044] In the preferred embodiment, as shown in Figure 2, the raised portions (B31) and corresponding lowered portions (B21) are distributed preferably aligned along directions (Y1, Y2) intersecting the direction of the ridges (B2) and hollows (B3).

[0045] On each of the two specular halves of the plate (B) of the second type, the lowered portions (B21) are aligned in a direction (Y1, Y2) parallel to the direction (X1, X2) of the hollows (B3) of the opposite specular half, and in particular are aligned with the extension of the lowered portion (B3) of the opposite specular half, thereby creating a network of main (11) and crossed secondary (12) channels.

[0046] This path in which the secondary fluid circulates, or the secondary path (2) is obtained by placing the plate of the first type (A) with the plate of the second type (B) on the side of the raised portions (B31) of the hollows (B3). This secondary path (2) has a greater head loss and is formed by a series of channels (21) formed by the hollows (B3, A3) of the two facing plates (B, A), where in the main channels (21) of the secondary path (2) there are narrowed portions (22) created by the raised portions (B31), which reduce the section for the passage of the fluid, increasing the turbulence of the fluid and increasing the head loss.

[0047] Therefore, with reference to the preceding description and the attached drawings the following claims are made.

Claims

1. Asymmetrical plate-type exchanger comprising several stacked plates (A, B) forming a pack, welded and provided with holes (C) for the passage of at least two fluids, a primary fluid and a secondary fluid, said holes (C) being suited to convey said two fluids into the spaces between pairs (A, B) of facing plates following at least two hydraulically insulated paths (1, 2), each one of said plates (A, B) being provided with alternating ridges (A2, B2) and hollows (A3, B3), and wherein said two paths (1, 2) have different flow resistance in the presence of the same flow, **characterized in that** it comprises two types of alternating stacked plates (A, B), wherein:

   - the first type of plate (A) comprises a plurality of said alternating ridges (A2) and hollows (A3) having constant height or depth (A6),
   - the second type of plate (B) comprises a plurality of said alternating ridges (B2) and hollows (B3), wherein said hollows (B3) on one side (B12) of said plate (B) have all constant depth (B6), except for one or more localized raised portions (B31) that are shorter than the hollow (B3), and wherein said localized raised portions (B31) on said side (B12) correspond, on the opposite side (B11) of the same plate (B), to localized lowered portions (B21) in the ridges (B2)

2. Asymmetrical plate-type exchanger according to claim 1, **characterized in that** the raised portions provided can be positioned both on the hollows and on the ridges, with opposite effect on the opposite side of the same plate.

3. Asymmetrical plate-type exchanger according to claim 1 or 2, **characterized in that** one or more of said raised portions (B31) or lowered portions (B21) are distributed along each hollow (B3) or ridge (B2) at a modular or constant distance.

4. Asymmetrical plate-type exchanger according to claim 1, **characterized in that** said ridges (A2) and hollows (A3) of said plate (A) of the first type are positioned at a modular or constant pitch (A5).

5. Asymmetrical plate-type exchanger according to claim 3, **characterized in that** said ridges (B2) and hollows (B3) of said plate (B) of the second type are positioned at a modular or constant pitch (B5), equal to or different from said pitch (A5) present in the plate

(A) of the first type.

6. Asymmetrical plate-type exchanger according to claim 1, **characterized in that** said ridges (A2, B2) and hollows (A3, B3) on said plates (A, B) of the first and second type are arranged according to a fish bone pattern, that is, are arranged specularly with respect to a centre plane (A4, B4) according to two directions (X1, X2) intersecting each other.

7. Asymmetrical plate-type exchanger according to the preceding claims, **characterized in that** the primary path (1) with lower flow resistance, in which said primary fluid circulates, obtained in said plate (A) of the first type, facing said plate (B) of the second type on the side of said lowered portions (B21) in the ridges (B2), is formed by two series of channels, of which a first series of main channels (11) defined by said hollows (A3, B3) in the two facing plates (A, B), and a second series of ancillary channels (12), arranged crosswise to said main channels (11), defined by said lowered portions (B21) that place said main channels (11) in communication crosswise.

8. Asymmetrical plate-type exchanger according to claim 6, **characterized in that** said raised portions (B31) on the plate (B) of the second type are distributed so that they are aligned along directions (Y1, Y2) intersecting the direction (X1, X2) of said ridges (B2) and hollows (B3).

9. Asymmetrical plate-type exchanger according to claim 7, **characterized in that,** on each one of the two specular halves of the plate (B) of the second type, said lowered portions (B21) are aligned according to a direction (Y1, Y2) parallel to and/or coinciding with the extension of the hollow (B3) in the opposite specular half, thus defining a network of said main (11) and secondary (12) crossed channels.

10. Asymmetrical plate-type exchanger according to the preceding claims, **characterized in that** the secondary path (2) with higher flow resistance, in which said secondary fluid circulates, obtained in said plate (A) of the first type, facing said plate (B) of the second type on the side of said raised portions (B31) on the hollows (B3), is formed by a series of main channels (21), defined by said hollows (A3, B3) in the two facing plates (A, B), wherein in said main channels (21) of the secondary path (2) there are narrowed portions (22) defined by said raised portions (B31).

Patentansprüche

1. Asymmetrischer Platten-Austauscher, mehrere gestapelte Platten (A, B) umfassend, die ein verschweißtes und mit Löchern (C) für den Durchgang von wenigstens zwei Flüssigkeiten, einer primären Flüssigkeit und einer sekundären Flüssigkeit, versehenes Paket bilden, wobei die besagten Löcher (C) dazu geeignet sind, über wenigstens zwei hydraulisch isolierte Wege (1, 2) die besagten zwei Flüssigkeiten in die Räume zwischen Paaren (A, B) zueinander gerichteter Platten zu leiten, wobei jede der besagten Platten (A, B) mit alternierenden Erhöhungen (A2, B2) und Vertiefungen (A3, B3) versehen ist, und wobei die besagten zwei Wege (1, 2) bei gleichem Fluss einen unterschiedlichen Flusswiderstand aufweisen,
dadurch gekennzeichnet, dass er zwei Typen alternierender, gestapelter Platten (A, B) umfasst, wobei:

- der erste Plattentyp (A) eine Vielzahl der besagten, alternierenden Erhöhungen (A2) und Vertiefungen (A3) mit konstanter Höhe oder Tiefe (A6) aufweist,
- der zweite Plattentyp (B) eine Vielzahl der besagten, alternierenden Erhöhungen (B2) und Vertiefungen (B3) aufweist, wobei die besagten Vertiefungen (B3) auf einer Seite (B12) der besagten Platte (B) alle eine konstante Tiefe (B6) aufweisen, mit Ausnahme eines oder mehrerer lokalisierter, erhabener Abschnitte (B31), die kürzer sind als die Vertiefungen (B3), und wobei die besagten, lokalisierten erhabenen Abschnitte (B31) auf der besagten Seite (B12) lokalisierten abgesenkten Abschnitten (B21) in den Erhöhungen (B2) auf der entgegengesetzten Seite (B11) derselben Platte (B) entsprechen.

2. Asymmetrischer Platten-Austauscher nach Patentanspruch 1, **dadurch gekennzeichnet, dass** die vorhandenen erhabenen Abschnitte sowohl an den Vertiefungen als auch an den Erhöhungen positioniert sein können, mit umgekehrter Wirkung an der entgegengesetzten Seite derselben Platte.

3. Asymmetrischer Platten-Austauscher nach Patentanspruch 1 oder 2, **dadurch gekennzeichnet, dass** einer oder mehrere der besagten erhabenen Abschnitte (B31) oder der abgesenkten Abschnitte (B21) in einem modularen oder konstanten Abstand entlang jeder Vertiefung (B3) oder Erhöhung (B2) verteilt sind.

4. Asymmetrischer Platten-Austauscher nach Patentanspruch 1, **dadurch gekennzeichnet, dass** die besagten Erhöhungen (A2) und Vertiefungen (A3) der besagten Platte (A) des ersten Typs mit einem modularen oder konstanten Abstand (A5) positioniert sind.

5. Asymmetrischer Platten-Austauscher nach Patentanspruch 3, **dadurch gekennzeichnet, dass** die

besagten Erhöhungen (B2) und Vertiefungen (B3) des zweiten Typs mit einem modularen oder konstanten Abstand (B5) positioniert sind, welcher bezüglich des besagten Abstands (A5) an der Platte (A) des ersten Typs gleich oder unterschiedlich ist.

6. Asymmetrischer Platten-Austauscher nach Patentanspruch 1, **dadurch gekennzeichnet, dass** die besagten Erhöhungen (A2, B2) und Vertiefungen (A3, B3) an den besagten Platten (A, B) des ersten und zweiten Typs nach einem Fischgrätmuster angeordnet sind, das heißt dass sie bezüglich einer mittleren Ebene (A4, B4) spiegelbildlich in zwei sich einander schneidenden Richtungen (X1, X2) angeordnet sind.

7. Asymmetrischer Platten-Austauscher nach vorstehenden Patentansprüchen, **dadurch gekennzeichnet, dass** der primäre Weg (1) mit niedrigerem Flusswiderstand, in dem die besagte primäre Flüssigkeit zirkuliert und der in der besagten Platte (A) des ersten Typs ausgeführt ist, welche an der Seite der besagten abgesenkten Abschnitte (B21) in den Erhöhungen (B2) zu der besagten Platte (B) des zweiten Typs gerichtet ist, durch zwei Reihen von Kanälen gebildet ist, darunter eine erste Reihe mit Hauptkanälen (11), die durch die besagten Vertiefungen (A3, B3) in den zwei zueinander gerichteten Platten (A, B) definiert sind, und eine zweite Reihe von Hilfskanälen (12), die quer zu den besagten, durch die besagten abgesenkten Abschnitte (B21) definierten Hauptkanälen (11) angeordnet sind und die besagten Hauptkanäle (11) quer miteinander in Kommunikation versetzen.

8. Asymmetrischer Platten-Austauscher nach Patentanspruch 6, **dadurch gekennzeichnet, dass** die besagten erhabenen Abschnitte (B31) an der Platte (B) des zweiten Typs so verteilt sind, dass sie in die Richtung (X1, X2) der besagten Erhöhungen (B2) und Vertiefungen (B3) schneidenden Richtungen (Y1, Y2) gefluchtet sind.

9. Asymmetrischer Platten-Austauscher nach Patentanspruch 7, **dadurch gekennzeichnet, dass** an jeder der zwei spiegelbildlichen Hälften der Platte (B) des zweiten Typs die besagten abgesenkten Abschnitte (B21) entlang einer Richtung (Y1, Y2), welche parallel zu und/oder zusammenfallend mit der Verlängerung der Vertiefung (B3) in der entgegengesetzten spiegelbildlichen Hälfte ist, gefluchtet sind und somit ein Netzwerk der besagten, sich kreuzenden Hauptkanäle (11) und sekundären Kanäle (12) definieren.

10. Asymmetrischer Platten-Austauscher nach vorstehenden Patentansprüchen, **dadurch gekennzeichnet, dass** der sekundäre Weg (2) mit höherem Flusswiderstand, in dem die besagte sekundäre Flüssigkeit zirkuliert und der in der besagten Platte (A) des ersten Typs ausgeführt ist, welche an der Seite der besagten erhabenen Abschnitte (B31) an den Vertiefungen (B3) zu der besagten Platte (B) des zweiten Typs gerichtet ist, durch eine Reihe von Hauptkanälen (21) gebildet ist, die durch die besagten Vertiefungen (A3, B3) in den zwei zueinander gerichteten Platten (A, B) definiert ist, wobei in den besagten Hauptkanälen (21) des sekundären Wegs (2) verengte Abschnitte (22) vorhanden sind, die durch die besagten erhabenen Abschnitte (B31) definiert sind.

Revendications

1. Échangeur asymétrique à plaques comprenant plusieurs plaques empilées (A, B) formant un paquet, soudées et dotées de trous (C) pour le passage d'au moins deux fluides, un fluide primaire et un fluide secondaire, lesdits trous (C) étant aptes à transporter lesdits deux fluides dans les espaces entre des couples (A, B) de plaques opposées suivant au moins deux parcours hydrauliquement isolés (1, 2), chacune desdites plaques (A, B) étant dotée de crêtes (A2, B2) et de cavités (A3, B3) alternées et où lesdits deux parcours (1, 2) présentent une résistance à l'écoulement différente en présence du même débit, **caractérisé en ce qu'il** comprend deux types de plaques empilées alternées (A, B), où :

   • le premier type de plaque (A) comprend une pluralité desdites crêtes (A2) et desdites cavités (A3) alternées ayant une hauteur ou une profondeur constante (A6),
   • le deuxième type de plaque (B) comprend une pluralité desdites crêtes (B2) et desdites cavités (B3) alternées, où lesdites cavités (B3) sur un côté (B12) de ladite plaque (B) ont toutes une profondeur constante (B6), à l'exception d'une ou plusieurs portions en relief localisées (B31) qui sont plus courtes que la cavité (B3), et où lesdites portions en relief (B31) localisées sur ledit côté (B12) correspondent, sur le côté opposé (B11) de la même plaque (B), à des portions abaissées (B21) localisées sur les crêtes (B2).

2. Échangeur asymétrique à plaques selon la revendication 1, **caractérisé en ce que** les portions en relief prévues peuvent être positionnées aussi bien sur les cavités que sur les crêtes, avec un effet opposé sur le côté opposé de la même plaque.

3. Échangeur asymétrique à plaques selon la revendication 1 ou 2, **caractérisé en ce qu'une** ou plusieurs desdites portions en relief (B31) ou desdites portions

abaissées (B21) sont distribuées le long de chaque cavité (B3) ou crête (B2) à une distance modulaire ou constante.

4. Échangeur asymétrique à plaques selon la revendication 1, **caractérisé en ce que** lesdites crêtes (A2) et lesdites cavités (A3) de ladite plaque (A) du premier type sont positionnées à un pas (A5) modulaire ou constant.

5. Échangeur asymétrique à plaques selon la revendication 3, **caractérisé en ce que** lesdites crêtes (B2) et lesdites cavités (B3) de ladite plaque (B) du deuxième type sont positionnées à un pas (B5) modulaire ou constant, égal ou différent dudit pas (A5) présent dans de la plaque (A) du premier type.

6. Échangeur asymétrique à plaques selon la revendication 1, **caractérisé en ce que** lesdites crêtes (A2, B2) et lesdites cavités (A3, B3) sur lesdites plaques (A, B) du premier e du deuxième type sont disposées selon un motif à arête de poisson, c'est-à-dire disposées de manière spéculaire par rapport à un plan central (A4, B4) selon deux directions (X1, X2) s'entrecoupant mutuellement.

7. Échangeur asymétrique à plaques selon les revendications précédentes, **caractérisé en ce que** le parcours primaire (1) avec une résistance à l'écoulement inférieure, dans lequel ledit fluide primaire circule, obtenu dans ladite plaque (A) du premier type, tournée vers ladite plaque (B) du deuxième type sur le côté desdites portions abaissées (B21) sur les crêtes (B2), se compose de deux séries de canaux, dont une première série de canaux principaux (11) définis par lesdites cavités (A3, B3) dans les deux plaques (A, B) opposées, et une deuxième série de canaux auxiliaires (12), disposés transversalement auxdits canaux principaux (11), définis par lesdites portions abaissées (B21) qui mettent en communication lesdits canaux principaux (11) transversalement.

8. Échangeur asymétrique à plaques selon la revendication 6, **caractérisé en ce que** lesdites portions en relief (B31) sur la plaque (B) du deuxième type sont distribuées de manière à être alignées le long des directions (Y1, Y2) qui entrecoupent la direction (X1, X2) desdites crêtes (B2) et desdites cavités (B3).

9. Échangeur asymétrique à plaques selon la revendication 7, **caractérisé en ce que,** sur chacune des deux moitiés spéculaires de la plaque (B) du deuxième type, lesdites portions abaissées (B21) sont alignées selon une direction (Y1, Y2) parallèle à et/ou coïncidant avec l'extension de la cavité (B3) dans la moitié spéculaire opposée, définissant de cette manière un réseau desdits canaux croisés principaux (11) et secondaires (12).

10. Échangeur asymétrique à plaques selon les revendications précédentes, **caractérisé en ce que** le parcours secondaire (2) avec une résistance à l'écoulement supérieure, dans lequel ledit fluide secondaire circule, obtenu dans ladite plaque (A) du premier type, tournée vers ladite plaque (B) du deuxième type sur le côté desdites portions en relief (B31) sur les cavités (B3), se compose d'une série de canaux principaux (21), définis par lesdites cavités (A3, B3) dans les deux plaques opposées (A, B), où dans lesdits canaux principaux (21) du parcours secondaire (2) se trouvent des portions rétrécies (22) définies par lesdites portions en relief (B31).

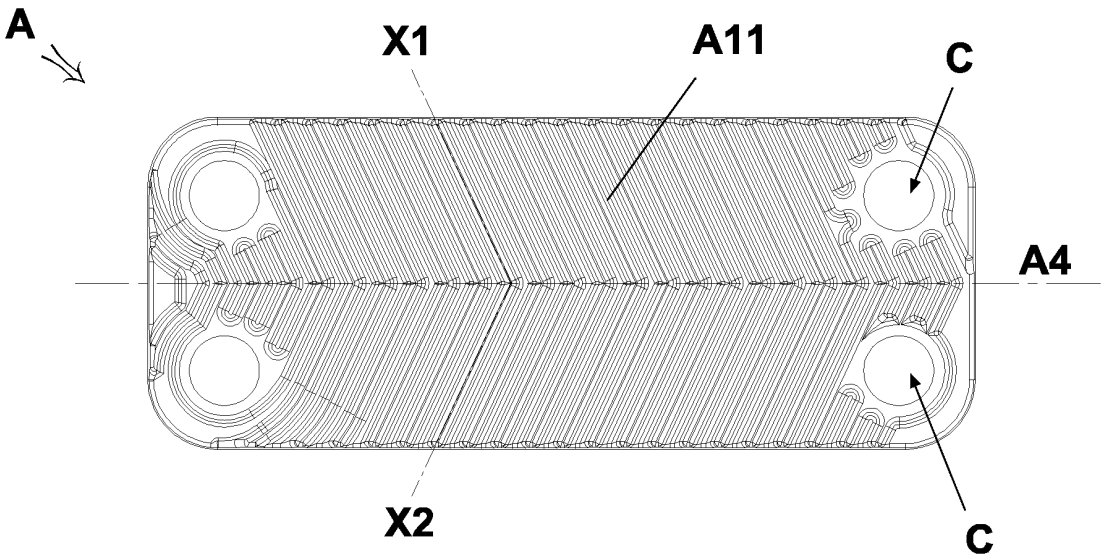


Fig. 1

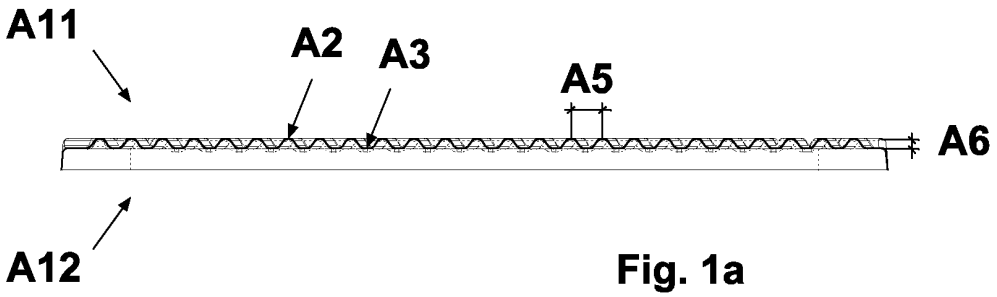


Fig. 1a

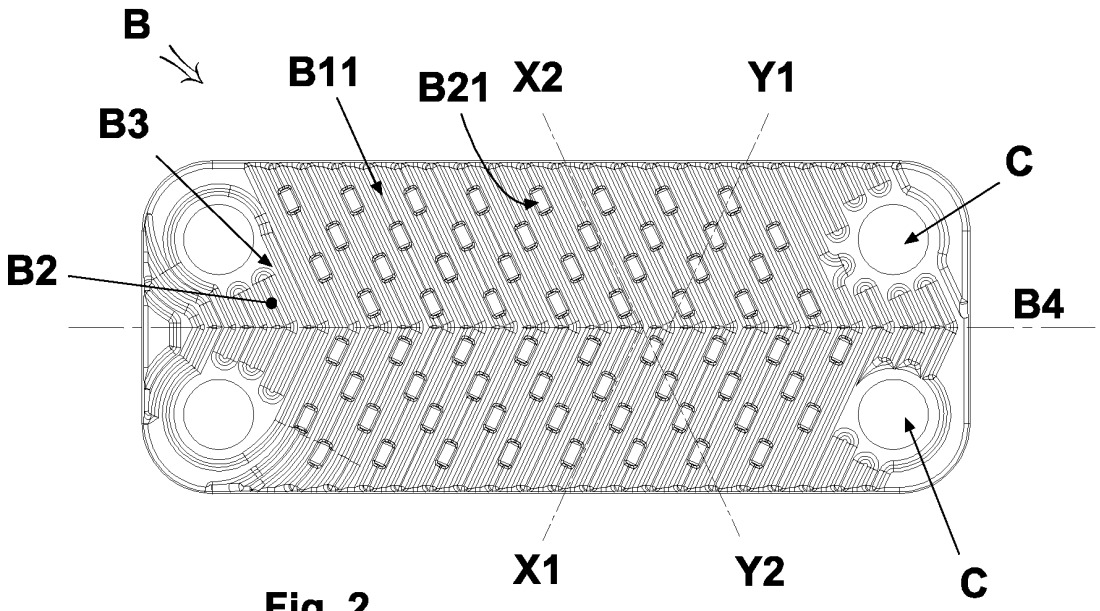
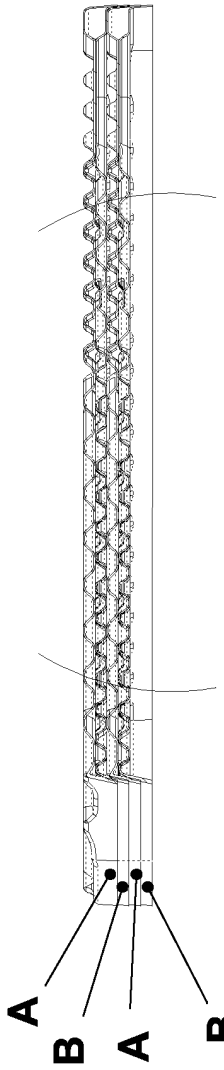


Fig. 2

Fig. 3



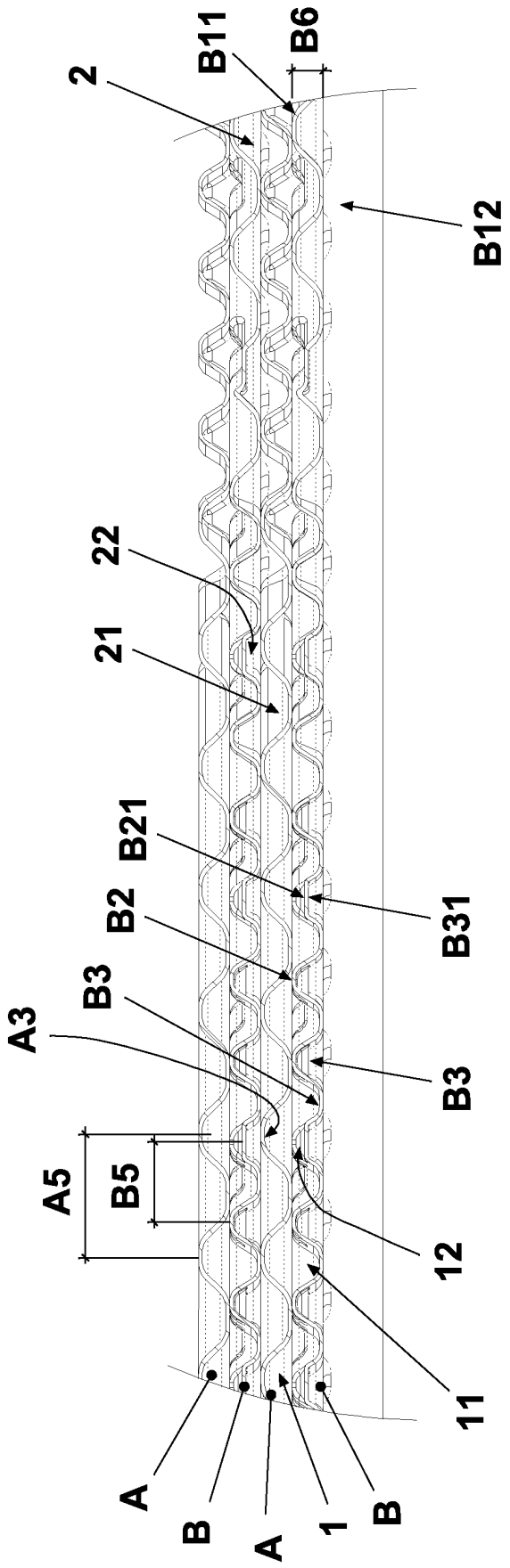


Fig. 3a

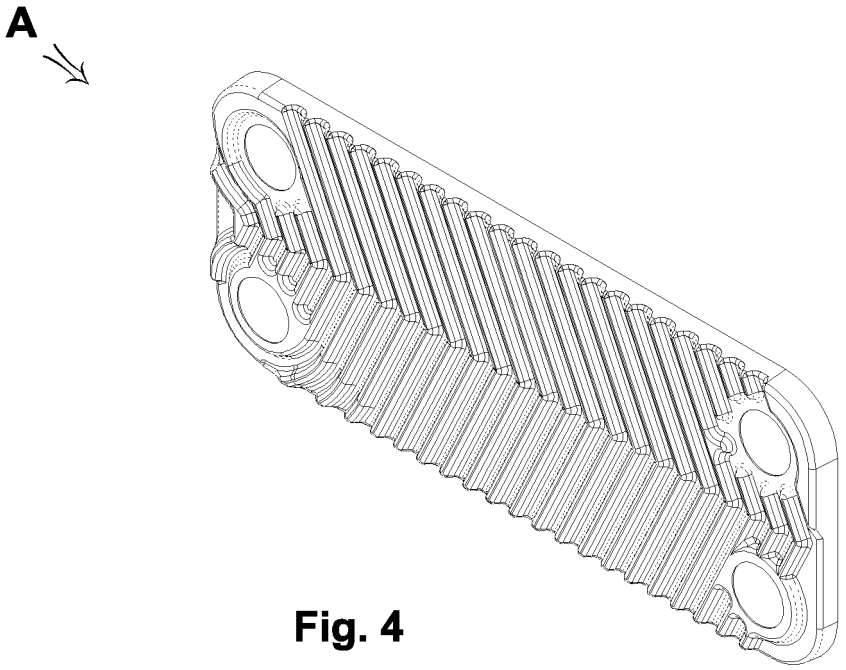


Fig. 4

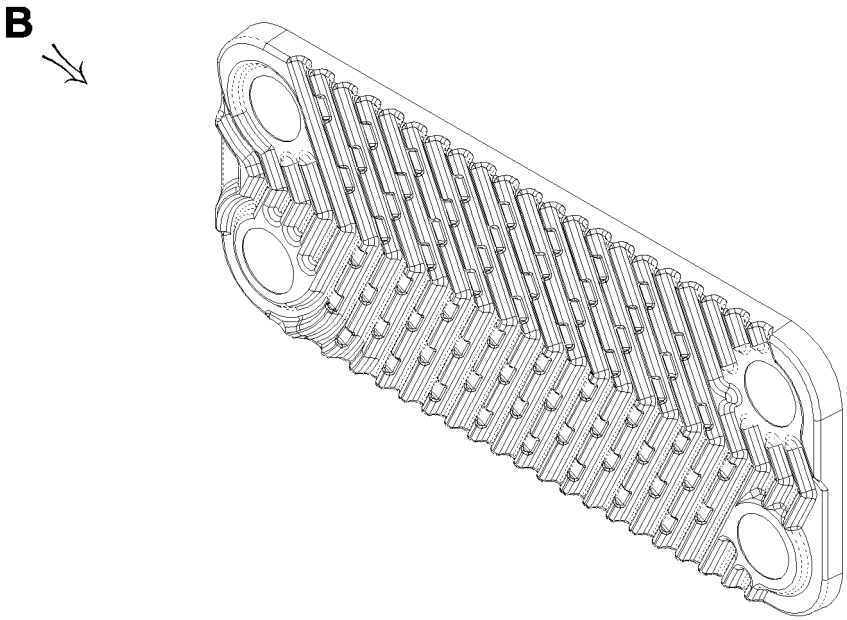


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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