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

(11) EP 2 840 346 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
25.02.2015 Bulletin 2015/09

(51) Int Cl.:
F28F 3/10 *(2006.01)* *F28D 9/00* *(2006.01)*

(21) Application number: **14178382.9**

(22) Date of filing: **24.07.2014**

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

(30) Priority: **01.08.2013 US 201313957011**

(71) Applicant: **Hamilton Sundstrand Corporation**
Windsor Locks, CT 06096-1010 (US)

(72) Inventor: **Graham, James R.**
Granby, MA 01033 (US)

(74) Representative: **Hull, James Edward**
Dehns
St. Bride's House
10 Salisbury Square
London
EC4Y 8JD (GB)

(54) High-pressure plate heat exchanger

(57) A heat exchanger plate (10b) has multiple structures thereon. A heat transfer portion has a plurality of ribs arranged in a rib pattern (12b). A fluid ingress structure (14a) is arranged near a first corner of the heat exchanger plate. The structure includes a first open fluid aperture defined in the heat exchanger plate, and a first platform arranged between the first open fluid aperture and the first corner. The first platform is connected to a rib of the rib pattern. A fluid bypass structure is arranged near a second corner. The fluid bypass structure includes a closed fluid aperture defined in the heat exchanger plate, a second platform completely surrounding the closed fluid aperture, and a first corner rib arranged between the second platform and the second corner. The first corner rib is connected to a rib of the rib pattern.

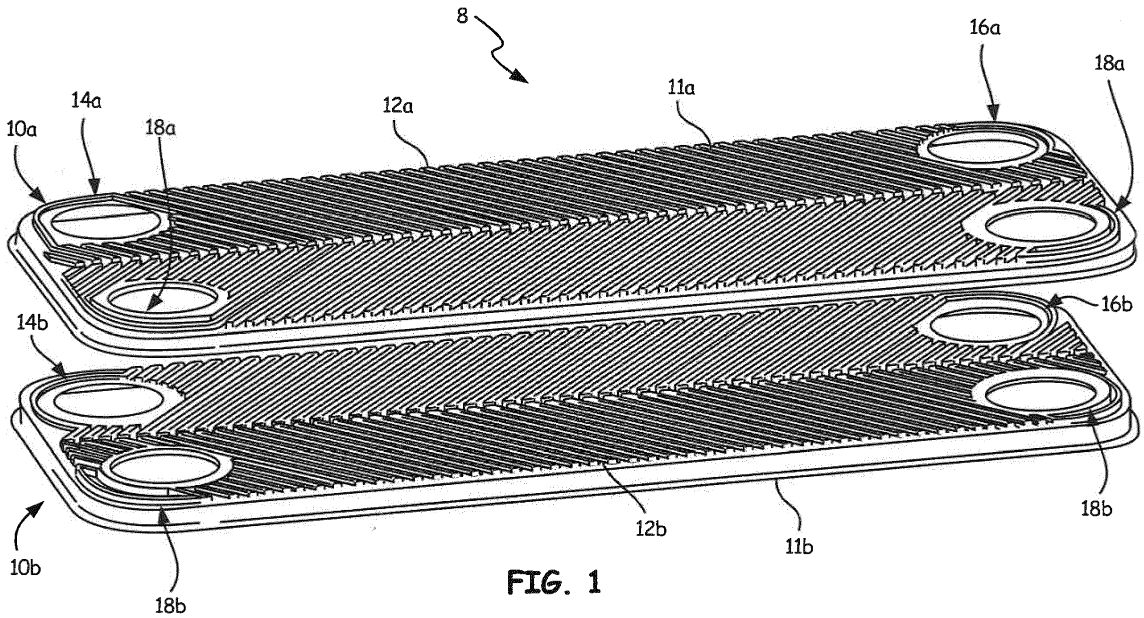

FIG. 1

Printed by Jouve, 75001 PARIS (FR)

Description

BACKGROUND

[0001] Heat exchangers are used to transfer heat between fluids in various technological areas. Typical heat exchangers include a stack of plates with fluid passing between them. In many heat exchangers, the layers alternate between hot and cold, and stacks of 50 or more layers are used to efficiently transfer heat. These stacked layers maximize the so-called "first surface" surface area, which is the surface area of the plates across which heat may conductively pass.

[0002] In some heat exchangers, pins, fins, posts, or ridges are employed to increase the surface area through which heat is transferred. Protrusions from the first surface, such as pins, fins, and posts, form so-called "second surfaces". Second surfaces are often generated by etching a relatively thick plate, while leaving the second surface protrusions un-etched. These second surfaces not only facilitate heat transfer between the first surface and the fluid, but also may be used to reinforce the stack and maintain a desired distance between adjacent heat exchange plates in the stack.

[0003] Another type of heat exchange plate defines ridges, as opposed to protrusions. This type of heat exchange plate is advantageous because it may be stamped out of a single piece of material, without requiring etching, reducing cost and complexity. One commonly used ridge pattern is a herringbone pattern, in which a large number of nested V-shaped ridges are stamped into the plate. The Vs of alternating plates are typically oriented in opposite directions. Thus, any two adjacent plates will touch each other at each location where the ridges of the bottom plate are at a peak and the ridges of the top plate are at a trough. These locations approximate a grid of contact points, which results in good reinforcement of the stack. The plates are kept at a desired distance from one another by brazing each adjacent pair of plates at the grid of contact points.

[0004] As heat exchangers have been incorporated into aerospace technology, size and weight have become greater concerns. Thus, heat exchanger plates have generally become thinner, more lightweight, and more compact. Aerospace heat exchangers are often exposed to high temperature differential, high flow rate and high pressure working fluids. These goals must be accomplished without sacrificing heat exchange performance or structural integrity of the heat exchanger. One problem introduced by the thinning of the heat exchanger plates is that the corners of the heat exchangers may not have sufficient structural integrity, and may bow outwards. Such bowing is undesirable for many reasons, such as the potential for intermixing of the working fluids or other failures related to rupture of the heat exchange plates at the corners.

SUMMARY

[0005] A heat exchanger is disclosed. The plates of the heat exchanger have structures thereon at each of the fluid bypass apertures, fluid ingress apertures, and fluid egress apertures. A heat exchanger plate has a heat transfer portion with a plurality of ribs arranged in a rib pattern. The heat exchanger also has a fluid ingress structure arranged near a first corner of the heat exchanger plate. The structure has a first open fluid aperture defined in the heat exchanger plate, and a first platform arranged between the first open fluid aperture and the first corner, wherein the first platform is connected to a rib of the rib pattern. A fluid bypass structure near a second corner, the structure including a closed fluid aperture defined in the heat exchanger plate, a second platform completely surrounding the closed fluid aperture, and a first corner rib arranged between the second platform and the second corner, wherein the first corner rib is connected to a rib of the rib pattern.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

Fig. 1 is an exploded view of two heat exchanger plates in stacked configuration.

Fig. 2a is a plan view of the fluid ingress structure of a heat exchanger plate.

Fig. 2b is a plan view of the fluid bypass structure of a heat exchanger plate.

DETAILED DESCRIPTION

[0007] The heat exchanger plates described herein prevent corner deformation of the heat exchanger plates. Bypass apertures in the heat exchanger plate are reinforced with a corner rib, which is tied into the main herringbone pattern of the heat exchange plate. Ingress/egress apertures are also supported, first by moving the corner platform inwardly towards the apertures, and second by tying the corner platform into the main herringbone pattern of the heat exchanger plate. All of these changes combine to reduce the size of unsupported corner tangencies.

[0008] Fig. 1 is an exploded view of two heat exchanger plates in stacked configuration. Heat exchanger plate pair 8 includes upper heat exchange plate 10a and lower heat exchange plate 10b, which are included as part of a much larger stack of heat exchanger plates (not shown in this view). For example, heat exchanger plate pair 8 may be a part of a heat exchanger stack having more than 50 heat exchange plates similar to upper heat exchange plate 10a and lower heat exchange plate 10b. Often, these plates will be arranged in alternating fashion; for example, a complete heat exchanger stack could be constructed by stacking copies of heat exchanger plate pair 8 one on top of the other to reach the desired stack height, and adding appropriate end caps (not shown) on the top and bottom of the stack.

[0009] Upper heat exchange plate 10a includes upper plate herringbone ridge pattern 12a, fluid ingress structure 14a, fluid egress structure 16a, and fluid bypass structures 18a. Lower heat exchange plate 10b includes lower plate herringbone ridge pattern 12b, fluid ingress structure 14b, fluid egress structure 16b, and fluid bypass structures 18b.

[0010] In the embodiment shown in Fig. 1, upper heat exchange plate 10a is a stamped metal plate. By selecting a desired stamp or pattern, various contours may be impressed into upper heat exchange plate 10a. In aerospace applications, heat exchange plates, such as upper heat exchange plate 10a, are thinner than those used in industrial heat exchange applications. As shown in Fig. 1, upper heat exchange plate 10a includes upper plate herringbone rib pattern 12a, which includes a group of V-shaped ribs, the point of each V facing towards the right-hand side of the page.

[0011] Upper heat exchange plate 10a defines four structures for handling fluids incident thereon. Fluid ingress structure 14a is one of a series of structures that transmits and selectively admits a fluid to cavities between select pairs of adjacent heat exchange plates. Fluid egress structure 16a is one of a series of structures that takes up fluid admitted to the cavities between those select pairs of adjacent heat exchange plates by fluid ingress structure 14a. Hot fluid provided at fluid ingress structure 14a is communicated via the cavity formed between the select pairs of adjacent heat exchange plates (such as upper heat exchange plate 10a and lower heat exchange plate 10b) and exits via fluid egress structure 16a. Fluid bypass structures 18a are capable of transferring a second fluid, but prevents the second fluid from being admitted to the same cavities that receive the first fluid. Fluid passing through fluid bypass structures 18a may be in fluid communication with fluid ingress and egress structures in other plates within a stack containing upper heat exchange plate 10a. In one embodiment, the first fluid is a hot fluid and the second fluid is a relatively cold fluid.

[0012] Lower heat exchange plate 10b also defines four structures for handling fluids incident thereon. Fluid ingress structure 14b is one of a series of structures that transmits and selectively admits a second, relatively colder fluid to cavities defined between a second select set of pairs of adjacent heat exchange plates. Fluid egress structure 16b is one of a series of structures that transmits the second, relatively cold fluid, and takes up fluid admitted to the cavities between pairs of adjacent heat exchange plates by fluid ingress structure 14b. Relatively colder fluid provided at fluid ingress structure 14b is communicated via the cavities formed between the second select pair of adjacent heat exchange plates, and exits via fluid egress structure 16b. Fluid bypass structures 18b are capable of transferring the first, relatively hot fluid. Fluid passing through fluid bypass structures 18b may be in fluid communication with fluid ingress and egress structures in other plates within a stack containing lower heat exchange plate 10b. For example, hot fluid passing through fluid bypass structures 18b may be in fluid communication with fluid ingress structure 14a and fluid egress structure 16a.

[0013] In operation, lower heat exchange plate 10b is in contact with upper heat exchange plate 10a to define a cavity therebetween. Often, lower heat exchange plate 10b and upper heat exchange plate 10a are brazed together. Due to the opposite directions of upper plate herringbone pattern 12a and lower plate herringbone pattern 12b, the points of contact, at which brazing may occur, approximates a grid. Around these braze contact points, a first fluid (e.g. a cool fluid) may flow unconstructed from fluid ingress structure 14b to fluid egress structure 16b. Likewise, the flow of hot fluid admitted by fluid ingress structure 14a is constrained to a cavity defined by a surface of upper heat exchange plate 10a and a face of an adjacent heat exchange plate (not shown) arranged thereon. Hot fluid that is routed through this cavity may exit via fluid egress structure 16a.

[0014] Heat exchanger pair 8 is part of a larger heat exchanger that transfers heat between two fluids without intermixing those fluids. Thus, it is desirable to have the relatively cold fluid pass to heat exchange plates adjacent to upper heat exchange plate 10a, without mixing with fluid from fluid ingress structure 14a. Thus, fluid bypass structures 18a are included to allow relatively colder fluid to pass by upper heat exchange plate 10a to one or more other heat exchange plates, such as lower heat exchange plate 10b. Likewise, it is desirable to have the relatively hot fluid pass to heat exchange plates adjacent to lower heat exchange plate 10b, without mixing with fluid from fluid ingress structure 14b. Fluid bypass structures 18b are included to allow relatively hot fluid to pass by lower heat exchange plate 10b to one or more other heat exchange plates, such as upper heat exchange plate 10a.

[0015] The embodiment shown in Fig. 1 has structural enhancements on fluid ingress structure 14a, fluid egress structure 16a, and fluid bypass structures 18a. These structural enhancements, which will be described in more detail with respect to Fig. 2, prevent deformation and/or failure of the heat exchanger, in particular at the corners of the plates, which is more prone to failure than most other parts of the heat exchanger.

[0016] Fig. 2a shows fluid ingress structure 14b of Fig. 1. Fluid ingress structure 14b includes ingress aperture 20, ingress platform 22, and ingress corner space 24.

[0017] Lower heat exchange plate 10b is used to transfer heat between relatively hot and cold fluids. Thus, as referred to with respect to Figs. 2a-2b, lower heat exchange plate 10b defines the lower boundary of a first cavity, between lower heat exchange plate 10b and upper heat exchange plate 10a, as well as a second cavity, between lower heat exchange plate 10b and another heat exchange plate (not shown) positioned underneath lower heat exchange plate 10b with respect to the orientation shown in Fig. 1. Lower heat exchange plate 10b also has edges 11b, which are the portions of lower heat exchange plate 10b which do not define any part of the cavities referred to previously, at the top and left with respect to the orientation shown in Fig. 2a. Edges 11b may have any variety of structures to prevent fluid from escaping the stack of heat exchange plates, none of which are shown.

[0018] Ingress aperture 20 is positioned nearby one of the corners of lower heat exchange plate 10b. Ingress aperture 20 is an aperture defined by heat exchange plate 10b, and fluid passing through ingress aperture 20 is in fluid communication with a series of other ingress apertures in other plates of the heat exchange stack, as well as a series of fluid bypass structures. Ingress platform 22 is a long rib that extends to at least partially surround ingress aperture 20, and connects to ribs of lower plate herringbone pattern 12b at each of its ends. Ingress platform 22 may have different dimensions than the ribs of lower plate herringbone pattern 12b. For example, ingress platform 22 may be wider than the ribs of lower plate herringbone pattern 12b, and, as shown, may be curved to follow the contours of ingress aperture 20 and/or edge 11b of lower heat exchange plate 10b.

[0019] Ingress corner space 24 is defined between edge 11b of lower heat exchange plate 10b and ingress platform 22. Ingress platform 22 is located approximately halfway between ingress aperture 20 and edge 11b of lower heat exchanger plate 10b, such that the distance from ingress aperture 20 to ingress platform 22 is approximately equal to the distance from ingress platform 22 to edge 11b of lower heat exchange plate 10b. In alternative embodiments, the ratio of these two distances may be between 0.5 and 2.0.

[0020] Fluid passing through ingress aperture 20 also passes through the cavity defined by lower heat exchange plate 10b and upper heat exchange plate 10a, as described previously with respect to Fig. 1. Fluid that enters the cavity between lower heat exchange plate 10b and upper heat exchange plate 10a first passes through ingress aperture 20, then flows across lower plate herringbone pattern 12b before being taken up by fluid egress structure 16b (Fig. 1).

[0021] The proximity of ingress platform 22 to ingress aperture 20 minimizes the amount of space on either side of ingress platform 22 that is unsupported by a rib and/or platform. Additionally, tying inlet platform 22 to lower plate herringbone pattern 12b adds structural support to inlet platform 22. These structures in the orientation illustrated in Fig. 2a give the corners of lower plate 10b substantial support to oppose deformation.

[0022] A similar configuration is present at fluid egress structure 16b. Those skilled in the art will readily appreciate that the same modifications may be made at fluid egress structure 16b, including the positioning of an egress platform between an egress aperture and edge 11b of lower heat exchange plate 10b to minimize the extent of unsupported space, as well as tying such egress platform to lower plate herringbone pattern 12b. The same benefits accrue at the corner adjacent fluid egress structure 16b due to these modifications.

[0023] Fig. 2b is a plan view of fluid bypass structure 18b of lower heat exchange plate 10b, illustrating bypass aperture 26, bypass platform 28, and bypass rib 30.

[0024] Bypass aperture 26 is positioned near a corner of edge 11b of lower heat exchange plate 10b. Bypass platform 28 completely surrounds bypass aperture 26. Bypass platform 28 is configured to prevent fluid communication between fluid flowing within bypass aperture 26 and the cavity defined by lower heat exchange plate 10b and upper heat exchange plate 10a, as described in more detail with respect to Fig. 1. As shown in Fig. 1, bypass platform 28 is a raised pedestal that sits in contact with the bottom surface of fluid ingress structure 14a. Thus, hot fluid may be routed to fluid ingress structure 14a of Fig. 1, passing through lower heat exchange plate 10b without intermixing with the cold fluid that passes through the cavity defined by lower heat exchange plate 10b and upper heat exchange plate 10a.

[0025] Bypass rib 30 is positioned between edge 11b of lower heat exchange plate 10b and bypass platform 28. Bypass rib 30 is unlike the ribs of lower plate herringbone pattern 12b in that it has a curved shape and follows the contours of bypass platform 28 and/or edge 11b of lower heat exchange plate 10b. Bypass rib 30 is connected at each of its ends to a rib that is a part of lower plate herringbone pattern 12b. Bypass rib bisects the region between bypass platform 28 and a corner of edge 11b. In doing so, the corner area gains significant structural support, and is less likely to suffer from deformation and/or failure due to the pressure and temperature of the fluids incident thereon.

[0026] Analogous features are present at each additional bypass structure in the heat exchange stack, including the second fluid bypass structure 18a as shown in Fig. 1, as well as fluid bypass structures 18a of upper heat exchange plate 10a, as shown in Fig. 1.

Discussion of Possible Embodiments

[0027] A heat exchanger plate includes a heat transfer portion having a plurality of ribs arranged in a rib pattern. It further includes a fluid ingress structure arranged near a first corner of the heat exchanger plate. That structure includes a first open fluid aperture defined in the heat exchanger plate and a first platform arranged between the first open fluid aperture and the first corner, wherein the first platform is connected to a rib of the rib pattern. The heat exchanger has a fluid bypass structure near a second corner. That structure includes a closed fluid aperture defined in the heat exchanger plate, a second platform completely surrounding the closed fluid aperture, and a first corner rib arranged between the second platform and the second corner, wherein the first corner rib is connected to a rib of the rib pattern.

[0028] The heat exchanger plate may also include a fluid egress aperture structure near a third corner. That structure includes a second open fluid aperture defined in the heat exchanger plate, and a third platform arranged between the second open fluid aperture and the third corner, wherein the third platform is connected to at least one rib of the rib pattern. The heat exchanger plate may also include a second fluid bypass structure near a fourth corner. That structure includes a second closed fluid aperture defined in the heat exchanger plate, a fourth platform completely surrounding the second closed fluid aperture, and a second corner rib arranged between the fourth platform and the fourth corner, wherein the second corner rib is connected to at least one rib of the rib pattern. The heat exchanger plate may also have a second platform that is configured to cooperate with an adjacent component to prevent fluid flow between the closed fluid aperture and the heat transfer portion. The heat exchanger plate may be a hot fluid plate and the adjacent component may be a cold fluid plate. The first platform may be connected to a first rib of the rib pattern and the corner rib may be connected to a second rib of the rib pattern. The rib pattern may be a herringbone pattern. The distance between the fluid ingress aperture and the first platform may be less than the distance between the second platform and the closed fluid aperture. The first platform may be connected to at least two ribs of the rib pattern. The corner rib may be connected to at least two ribs of the rib pattern. The first platform may be connected to a first rib of the rib pattern, the third platform connected to a second rib of the rib pattern, the first corner rib connected to a third rib of the rib pattern, and the second corner rib connected to a fourth rib of the rib pattern. The second platform may be connected to a rib of the rib pattern. The fourth platform may be connected to a rib of the rib pattern.

[0029] A heat exchange system includes a first heat exchange plate. The first heat exchange plate includes a first heat exchange portion including a plurality of ribs arranged in a first rib pattern. It also includes a hot fluid ingress aperture defined by the first heat exchange plate. The heat exchange plate includes a hot fluid egress aperture defined by the first heat exchange plate, a first platform circumscribing a first closed fluid aperture, and a second platform circumscribing a second closed fluid aperture. The first heat exchange plate has a first corner rib arranged between the first platform and a first corner of the first heat exchange plate that is closest to the first platform, and a second corner rib arranged between the second platform and a second corner of the first heat exchange plate that is closes to the second platform. The heat exchange system also has a second heat exchange plate arranged adjacent to the first heat exchange plate. The second heat exchange plate has a second heat exchange portion including a plurality of ribs arranged in a second rib pattern. The second heat exchange plate has a cold fluid ingress aperture arranged adjacent to the first closed fluid apertures of the first heat exchange plate, and a cold fluid egress aperture arranged adjacent to the second closed fluid apertures of the first heat exchange plate.

[0030] The heat exchange system described above may also have a first platform that is connected to a first rib of the first rib pattern and the second platform is connected to a second rib of the first rib pattern. The first rib pattern and the second rib pattern may both be herringbone patterns. The first corner rib may be connected to a third rib of the first rib pattern and the second corner rib may be connected to a fourth rib of the first rib pattern. The first heat exchange plate and the second heat exchange plate may define a cavity therebetween. The heat exchange system may also include a plurality of cavities defined by a plurality of additional heat exchange plates. The first set of the plurality of cavities may be configured to route hot fluid and a second set of the plurality of cavities may be configured to route cold fluid.

[0031] While the invention has been described with reference to an exemplary embodiment(s), it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment(s) disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

Claims

1. A heat exchanger plate (10b), comprising:

a heat transfer portion having a plurality of ribs arranged in a rib pattern (12b);
a fluid ingress structure (14b) arranged near a first corner of the heat exchanger plate (106), the fluid ingress structure (14b) comprising:

a first open fluid aperture (20) defined in the heat exchanger plate (10b); and
a first platform (22) arranged between the first open fluid aperture (20) and the first corner, wherein the first platform (22) is connected to the rib pattern (12b); and

a fluid bypass structure (18b) near a second corner, the fluid bypass structure (18b) comprising:

a closed fluid aperture (26) defined in the heat exchanger plate (10b);
a second platform (28) completely surrounding the closed fluid aperture (26); and
a first corner rib (30) arranged between the second platform (28) and the second cor-

ner, wherein the first corner rib (30) is connected the rib pattern (12b).

2. The heat exchanger plate (10b) of claim 1, wherein:

a first distance is defined between an edge of the first corner and the first platform (22); and
a second distance is defined between the first platform (22) and the first open fluid aperture (20); and
a ratio of the first distance to the second distance is between 0.5 and 2.0, and optionally approximately 1.

3. The heat exchanger plate (10b) of claim 1 or 2, and further comprising a fluid egress structure (14b) near a third corner, the fluid egress structure (14b) comprising:

a second open fluid aperture defined in the heat exchanger plate (10b); and
a third platform arranged between the second open fluid aperture and the third corner, wherein the third platform is connected to the rib pattern (12b).

4. The heat exchanger plate (10b) of claim 3, further comprising a second fluid bypass structure (18) near a fourth corner, the second fluid bypass structure (18) comprising:

a second closed fluid aperture defined in the heat exchanger plate (10);
a fourth platform completely surrounding the second closed fluid aperture; and
a second corner rib arranged between the fourth platform and the fourth corner, wherein the second corner rib is connected to the rib pattern (12).

5. The heat exchanger plate (10b) of claim 4, wherein:

the first platform (22) is connected to a first rib of the rib pattern (12b);
the third platform is connected to a second rib of the rib pattern (12b);
the first corner rib (30) is connected to a third rib of the rib pattern (12b); and
the second corner rib is connected to a fourth rib of the rib pattern (12b).

6. The heat exchanger plate (10b) of any preceding claim, wherein the second platform (28) is configured to cooperate with an adjacent component to prevent fluid flow between the closed fluid aperture (26) and the heat transfer portion.

7. The heat exchanger plate (10b) of any preceding claim, wherein the first platform (22) is connected to:

a first rib of the rib pattern (12b) and the first corner rib (30) is connected to a second rib of the rib pattern; and/or
at least two ribs of the rib pattern (12).

8. The heat exchanger plate (10b) of any preceding claim, wherein a distance between the fluid ingress open fluid aperture (20) and the first platform (22) is less than a distance between the second platform (28) and the closed fluid aperture (26).

9. The heat exchanger plate (10b) of any preceding claim, wherein the second platform (28) is connected to the rib pattern (12b).

10. A heat exchange system (8) comprising a plurality of heat exchange plates (10b) of any preceding claims.

11. The heat exchange system (8) of claim 10, wherein the first platform (22) and the second platform (28) of each of the plurality of heat exchange plates (10b) are connected to the rib pattern (12b).

12. The heat exchange system (8) of claim 10 or 11, wherein adjacent panels of the plurality of heat exchange plates (10b) define cavities therebetween.

13. The heat exchange system (8) of claim 12, wherein the fluid ingress structures (14b) of the plurality of heat exchange plates (10b) are capable of selectively admitting the hot fluid to the first subset of cavities and the fluid egress structures (18b) of the plurality of heat exchange plates (10b) are capable of selectively taking up the hot fluid from the first subset of cavities.

14. The heat exchange system (8) of claim 12 or 13, and further comprising:

a first subset of the cavities are configured to route a hot fluid; and
a second subset of the cavities are configured to route a relatively cooler fluid.

15. The heat exchange system (8) of claim 14, wherein the fluid ingress structures (14b) of the plurality of heat exchanger plates (10b) are capable of selectively admitting the cooler fluid to the second subset of cavities and the fluid egress structures (18b) of the plurality of heat exchanger plates (10b) are capable of selectively taking up the cooler fluid from the second subset of cavities.

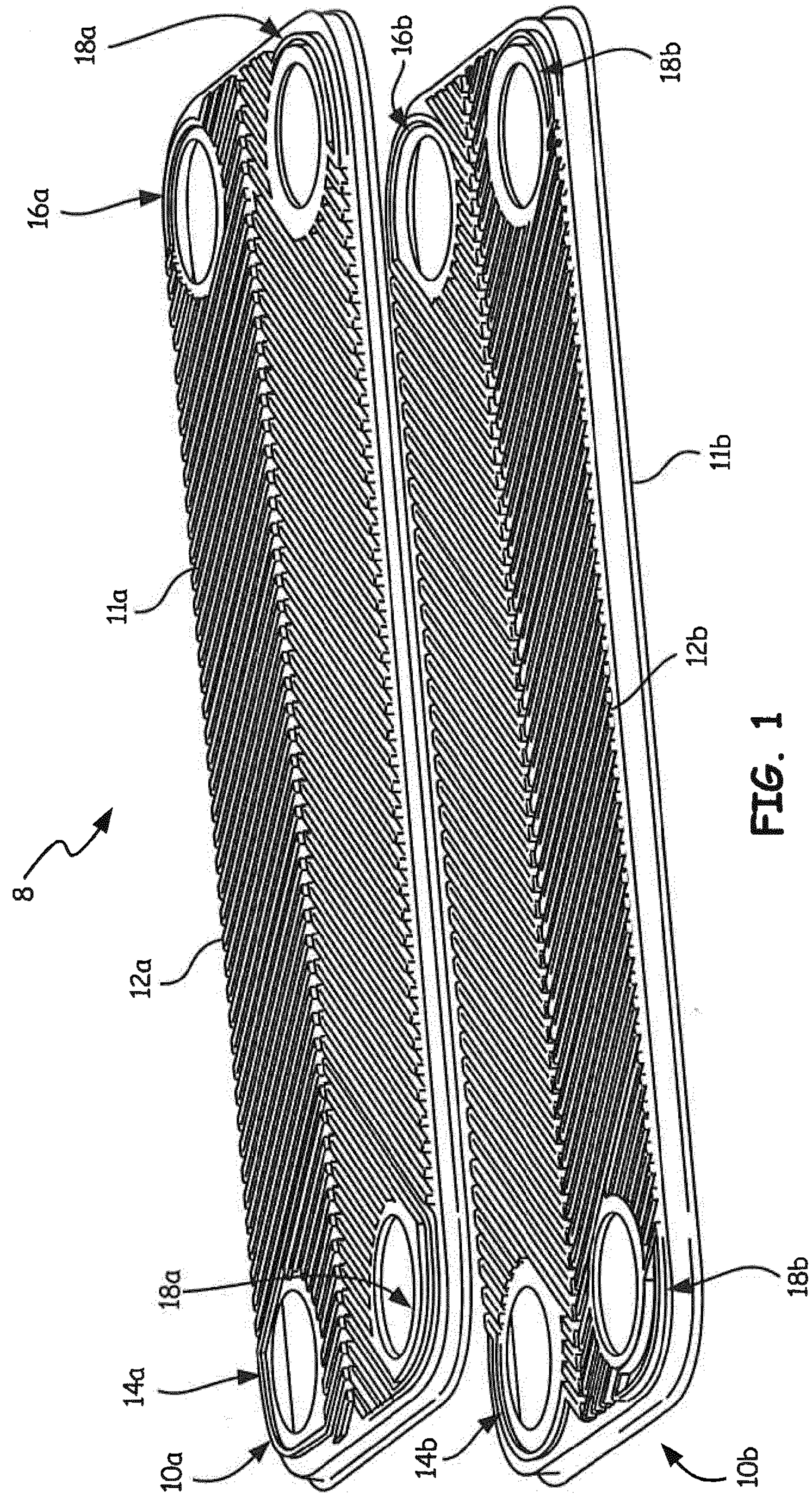

FIG. 1

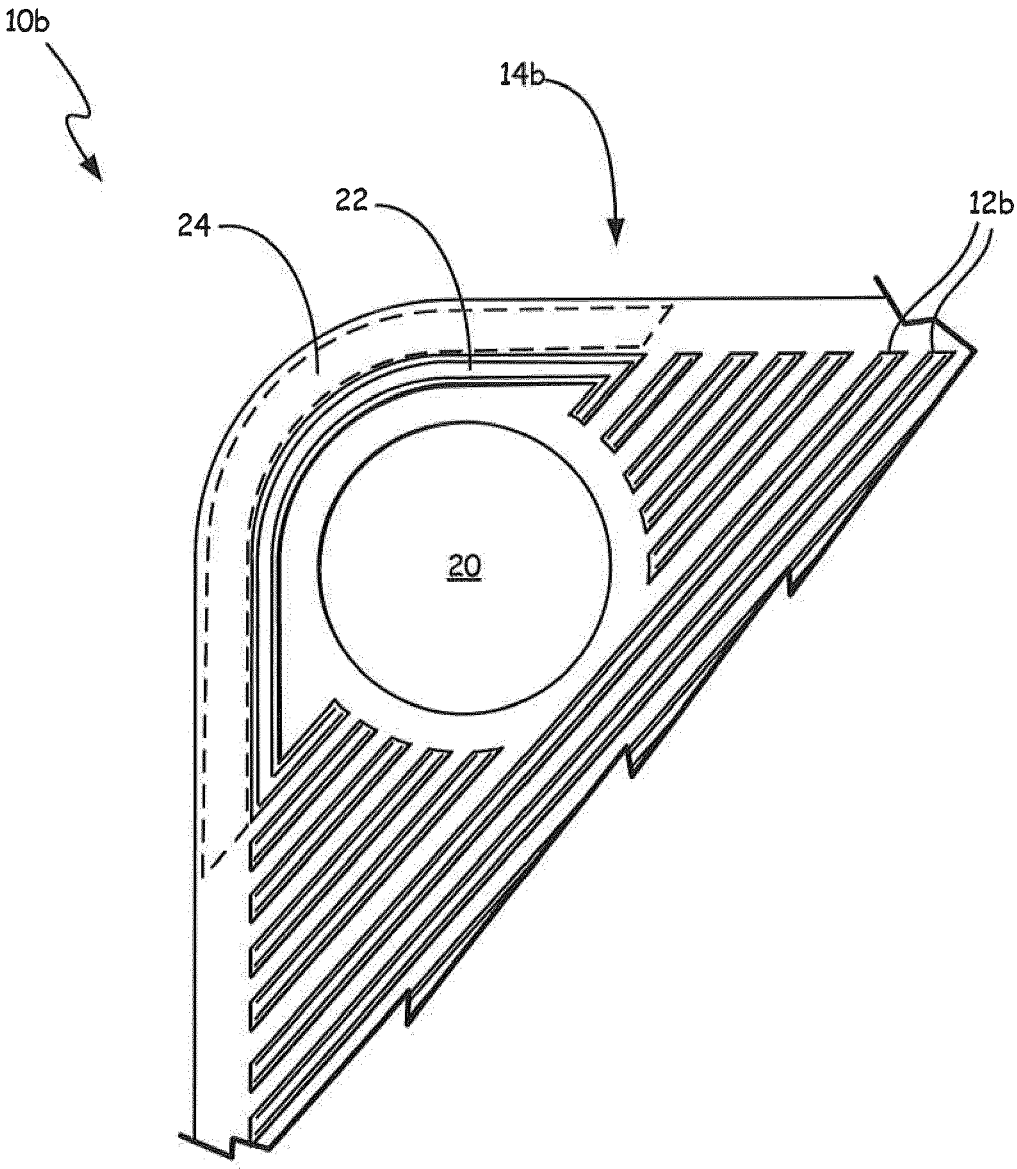

FIG. 2A

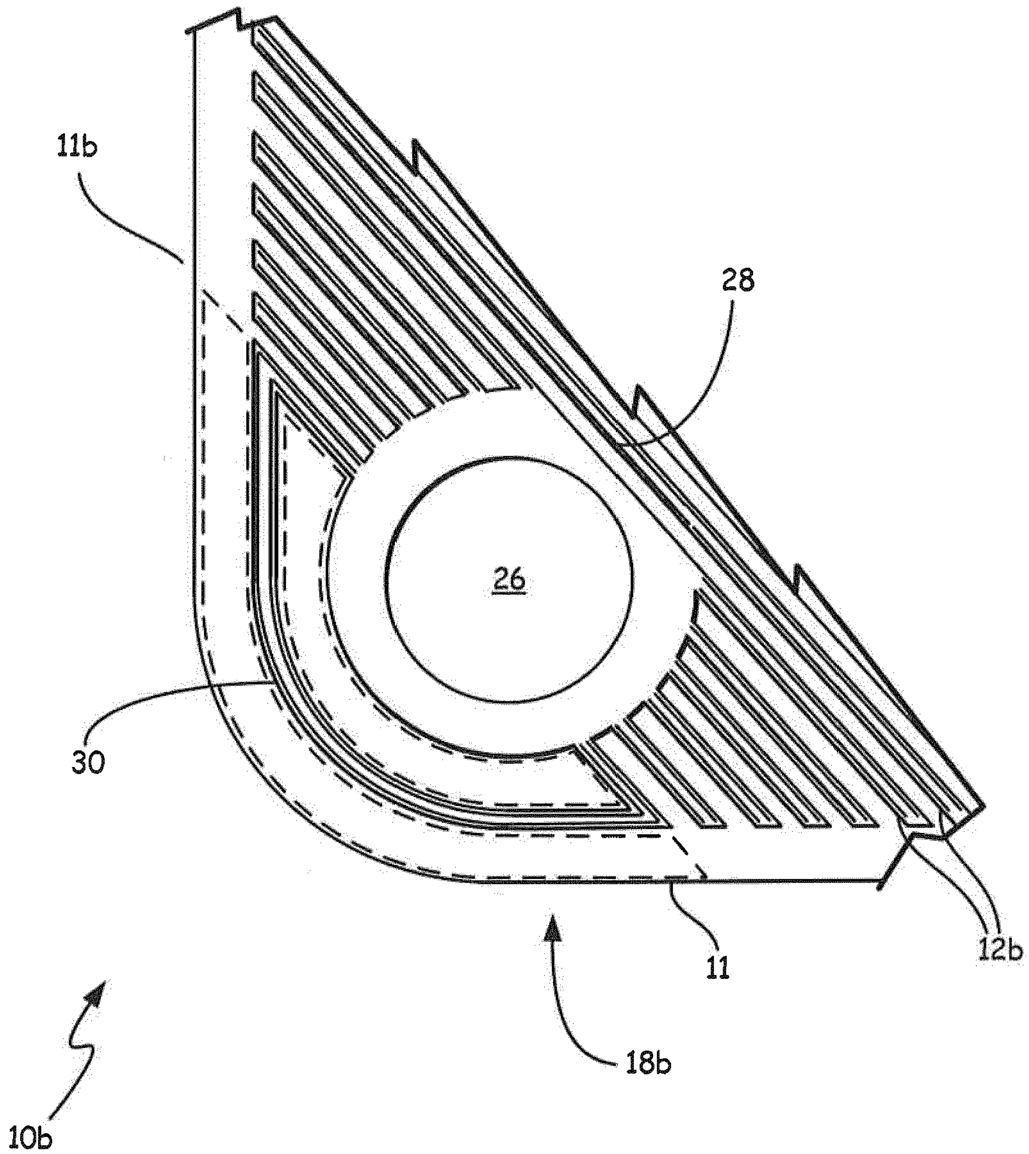

FIG. 2B

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 14 17 8382

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2010/069874 A1 (SWEP INT AB [SE]; ANDERSSON SVEN [SE]; HOBERG SVANTE [SE]; DAHLBERG TO) 24 June 2010 (2010-06-24) * figure 1 * -----	1-15	INV. F28F3/10 ADD. F28D9/00
A	WO 2010/069873 A1 (SWEP INT AB [SE]; ANDERSSON SVEN [SE]; HOBERG SVANTE [SE]; DAHLBERG TO) 24 June 2010 (2010-06-24) * figure 1 * -----	1-15	
A	US 2011/083833 A1 (ZORZIN ALVARO [IT] ET AL) 14 April 2011 (2011-04-14) * figure 2 * -----	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

F28F
F28D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	21 January 2015	Vassoille, Bruno

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 14 17 8382

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

21-01-2015

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2010069874 A1	24-06-2010	CN 102245992 A	16-11-2011
		EP 2370773 A1	05-10-2011
		JP 2012512381 A	31-05-2012
		KR 20110116133 A	25-10-2011
		US 2011290461 A1	01-12-2011
		WO 2010069874 A1	24-06-2010
WO 2010069873 A1	24-06-2010	CN 102245991 A	16-11-2011
		EP 2370772 A1	05-10-2011
		JP 5563592 B2	30-07-2014
		JP 2012512380 A	31-05-2012
		US 2011290462 A1	01-12-2011
		WO 2010069873 A1	24-06-2010
US 2011083833 A1	14-04-2011	CN 102084203 A	01-06-2011
		EP 2307842 A1	13-04-2011
		JP 5553828 B2	16-07-2014
		JP 2011523025 A	04-08-2011
		KR 20110005913 A	19-01-2011
		US 2011083833 A1	14-04-2011
		WO 2009151399 A1	17-12-2009

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82