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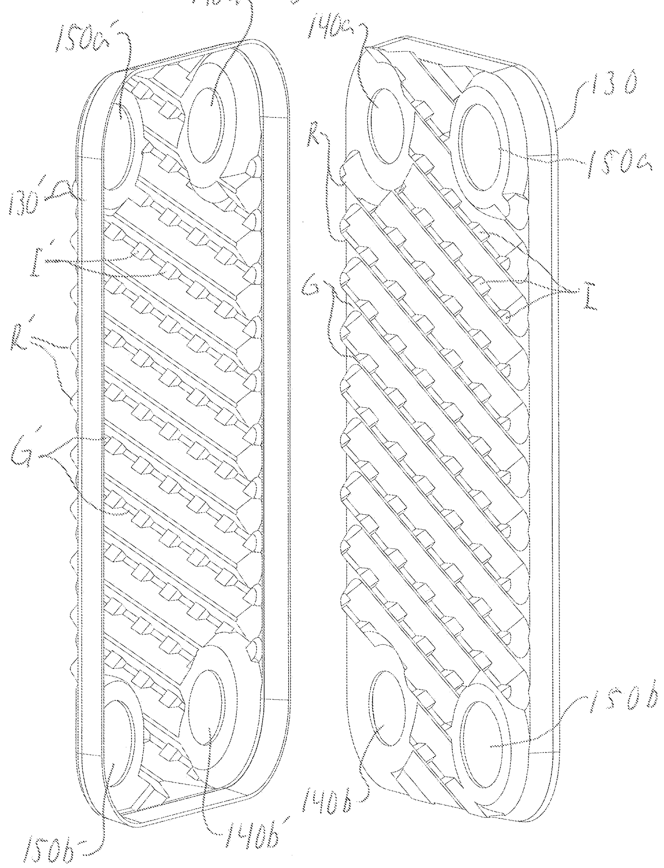
(54) **Asymmetric heat exchanger**

(57) A plate heat exchanger (100) comprises a start plate (110), an end plate (120), and at least two heat exchanger plates (130, 130') placed there between and being provided with a pressed pattern of ridges (R) and grooves (G) adapted to keep the plates on a distance from one another, such that flow channels (N,W) are formed between the plates. Either, or both, of the ridges (R) and grooves (G) are provided with indentations (I, I') adapted for housing a ridge (R) or groove (G) of a neighboring plate.

Fig. 4



EP 2 267 391 A2

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a plate heat exchanger comprising a start plate, an end plate, and at least two heat exchanger plates placed there between. The heat exchanger plates are provided with a pressed pattern of ridges and grooves adapted to keep the plates on a distance from one another, such that flow channels (N,W) are formed between the plates.

PRIOR ART

[0002] Brazed heat exchangers generally comprise a number of heat exchanger plates provided with a pressed pattern of ridges and grooves, said ridges and grooves of neighboring plates cooperating to form flow channels between neighboring plates. Port openings are provided for achieving communication with some of the flow channels and for sealing off other flow channels.

[0003] In the art of heat exchangers, there is a long felt need for "asymmetric" heat exchangers, i.e. heat exchangers wherein different flow channels of the heat exchanger exhibit different features concerning flow resistance, volume and capability to withstand internal pressure.

[0004] A prior art method for achieving asymmetric heat exchangers is to provide plates with a pressed pattern of ridges and grooves, where e.g. every other ridge has a smaller press depth than the other ridges. By combining such a plate with an ordinary heat exchanger plate, i.e. a heat exchanger plate with identical press depths of the ridges and grooves or a plate where the grooves have a smaller press depth, a heat exchanger having asymmetric properties, both in terms of flow resistance and pressure handling capabilities for the media to exchange heat is achieved.

[0005] However, such a design does not give improved pressure handling capabilities as compared to an ordinary heat exchanger; the small channel will exhibit the same pressure handling capability as an "ordinary", i.e. symmetric, heat exchanger, and the large channel will have decreased pressure handling capabilities.

[0006] One example of a heat exchanger exhibiting an asymmetry concerning the different media to exchange heat is disclosed in US 4 423 772. This document does, however, only concern "packed" heat exchangers, i.e. heat exchangers being provided with gaskets, the heat exchanger plates being held together with external elements, e.g. nuts and bolts extending from a start plate to an end plate. Such heat exchangers are not dependent on the contact point between the plates for their pressure handling capabilities; rather, their strength emanates from the nuts and bolts keeping the plate package together.

[0007] The object of the present invention is to provide a brazed asymmetric heat exchanger having improved pressure handling capability as compared to an ordinary brazed heat exchanger for the small flow channel, and similar pressure handling capability as an ordinary heat exchanger for the large channels.

SUMMARY OF THE INVENTION

[0008] The above object is solved by a heat exchanger where the ridges or grooves are provided with indentations adapted for housing a ridge or groove of a neighboring plate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Hereinafter, the invention will be described with reference to the appended drawings, wherein:

Fig. 1 is a schematic perspective view showing a heat exchanger according to the present invention,
Fig. 2 is a schematic top view of a heat exchanger plate comprised in the heat exchanger of Fig. 1,
Figs. 3a-3d are schematic section views taken along section cuts A-A, B-B, C-C and D-D of Fig. 2,
Fig. 4 is an opened perspective view showing two heat exchanger plates forming a narrow channel, and
Fig. 5 is an opened perspective view showing two heat exchanger plates forming a wide channel.

DESRIPTION OF EMBODIMENTS

[0010] In Fig. 1, an asymmetric heat exchanger 100 according to the present invention is shown. The heat exchanger 100 comprises a start plate 110 (not visible in Fig 1), an end plate 120 and a number of heat exchanger plates 130, 130'. The heat exchanger 100 is also provided with four port openings 140a, 140b, 150a, 150b. As can be noted in Fig. 1, the port openings 140a, 140b are significantly smaller than the port openings 150a, 150b. The reason for this difference in size will b explained later.

[0011] In Fig. 2, a heat exchanger plate 130, 130' is shown schematically. Also, section cuts A-A, B-B, C-C and D-D are shown. The sections taken along these lines are shown in Figs. 3a-3d. The size difference between the port openings 140a, 140', 140b140b' and 150a, 150b' and 150b, 150b' is more clearly visible in Fig. 2 as compared to Fig. 1.

[0012] In Fig. 3a, which is a section cut along the line D-D in Fig. 2, eight heat exchanger plates 130, 130' delimiting four wide channels W and three narrow channels N are placed between the start plate 110 and the end plate 120. It can be clearly seen that the narrow channels N are delimited by two neighboring plates 130, 130', having a small distance to one another, whereas the wide channels W are formed by two heat exchanger plates 130', 130 having a large distance to one another. The reason for this difference will be explained later.

[0013] In Fig. 3b, which is a section taken along the line A-A of Fig. 2, the port openings 140a, 150a are shown. As can be seen, the port opening 140a communicates with the narrow channels N, whereas the port opening 150a communicates with the wide channels W.

[0014] In Fig. 3c, which is a section view along the line B-B in Fig. 2, the port openings 140a, 140b, the eight heat exchanger plates 130, 130' and their corresponding channels N and W are shown. The port openings 140a, 140b will communicate through the narrow channels N.

[0015] Fig. 3d, finally, is a section view taken along the line C-C of Fig. 2, and shows the port openings 150a, 150b in communication with each other via the wide channels W.

[0016] Fig. 4 shows two heat exchanger plates 130, 130' which, when stacked onto one another in this order will form a narrow flow channel N. In order to achieve this narrow channel, the plates 130, 130' differ slightly from one another:

> First, the plate 130 will be described. The plate 130 comprises four port openings 140a, 140b, 150a, 150b, an area surrounding the port openings 140a, 140b being provided on a low level and an area surrounding the port openings 150 being provided in an intermediate level as compared to a mean level of the heat exchanger plate. Moreover, the plate is provided with a pressed pattern of ridges R provided on a high level and grooves G located there between on the low level. The ridges R are interrupted by indentations I being placed on the intermediate level. The ridges R and grooves G of the heat exchanger plate extend along straight lines running with an angle as compared to an axis of the plate 130. It should, however, be appreciated that other configurations, e.g. a herringbone pattern, also could be used.

[0017] The plate 130' is provided with two port openings 140a', 140b' provided on a high level, two port openings 150a' and 150b' placed on an intermediate level, ridges R' provided on a high level and grooves G' provided on a low level. The grooves G' are provided with indentations I' on the intermediate level.

[0018] When stacked onto one another, the plates 130, 130' as shown in Fig. 4 will contact one another to form a narrow flow channel as follows:

> The upper areas surrounding the port openings 150a, 150b will contact the lower areas surrounding the port openings 150a', 150b'. Hence, a sealing connection between these areas will be formed.

[0019] The indentations I will contact the indentations I', and the resulting contact point will be very strong; in a way, the contact will resemble a handshake. Also, there will be large contact points between the plates, which will give a high strength to the narrow channel N.

[0020] It should be noted that the areas surrounding the port openings 140a, 140b, 140a' and 140b' will not contact one another, hence leaving a communication between the port openings 140a, 140b, 140a' and 140b to the narrow channel N.

[0021] In Fig. 5, the plates 130, 130' are oppositely placed as compared to Fig. 4. This means that there will be no interaction between the grooves I and I'. Rather, the ridges R' of the plate 130'will contact the grooves G of the plate 130. Consequently, the distance between the plates 130, 130' placed according to Fig. 5 will be larger than when they are placed according to Fig. 4.

[0022] The areas surrounding the port openings 140a', 140b' will contact the areas surrounding the port openings 140a and 140b in the same way the port openings 150a, 150b contact the port openings 150a' and 150b' when the heat exchanger plates are placed according to Fig. 4.

[0023] By placing a number of heat exchanger plates 130, 130 in a stack, wherein every other plate is a plate 130 and the plates placed there between are plates 130', a heat exchanger exhibiting asymmetrical properties regarding both flow resistance and capability to withstand pressure is obtained.

[0024] The asymmetrical property concerning flow resistance comes from the fact that every other channel will be a narrow channel N, and the rest of the cannels will be wide channels W. The wide channels W will exhibit a lower flow resistance (i.e. pressure drop) for a fluid to exchange heat than the narrow channels N.

[0025] The asymmetrical property concerning the capability to withstand an internal pressure emanates from the fact that the contact points between the indentations I and I' (occurs in a narrow channel N) are significantly larger than the contact points between the ridges R' and the grooves G (which occurs in a wide channel W).

[0026] As mentioned earlier, the port openings 140 and 150 are of different size in the described embodiment. There are at least three reasons that the port openings may have different sizes:

> Firstly, it is unnecessary to provide a large port opening if the pressure drop over the flow channels is high. Secondly, a small port makes the flow channel more capable of withstanding higher pressure; a pressure applied to the fluid to be heat exchanged will affect the area of the port, and the force generated by the pressure on this area must be transferred through the plate package (and ultimately the contact points between the indentations I and I' (for the port openings 140) and the ridges R' and the grooves G (for the port openings 150)).
> Thirdly, by reducing the size of the port openings, heat exchanging area can be increased.

[0027] A typical use of a heat exchanger according to the present invention may be in a heat pump for domestic heating. Such a heat pump generally extracts low temperature heat from a low temperature source, often a brine (e.g. a mixture of water and alcohol), which is under a relatively low pressure, by exchanging heat between the brine and a refrigerant (which generally has a high pressure), whereupon the heat absorbed by the refrigerant is made transformed into high temperature heat by a general cooling cycle. Typical temperatures in the heat exchanger for exchanging heat between the brine and the refrigerant may be 0-5 degrees C for the brine and -5 to -20 degrees C for the refrigerant.

[0028] In the embodiment shown in Fig. 3, four plates 130 and four plates 130' form seven channels, three narrow channels N and four wide channels W. As can be seen in this figure, the wide channels W are placed closest to the start- and end endplates 110, 120, respectively. If the order of the heat exchanger plates 130, 130' would be different, a heat exchanger exhibiting four narrow channels would be achieved, but there is a certain benefit with the shown configuration, namely that the medium flowing in the wide channels generally have a temperature more similar to the ambient temperature. By arranging the wide channels closest to the start- and endplates 110, 120, problems concerning condense (in the case of cool media exchanging heat) or heat losses (in the case of hot media exchanging heat) may be minimized.

[0029] The heat exchanger according to the present invention is brazed. Brazing of heat exchanger is a method well known by persons skilled in the art, and shall hence not be describe in more detail.

[0030] It should be noted that the described embodiment is exemplary only. Many modifications of the embodiment can be made without departing from the scope of invention, such as defined in the appended claims.

[0031] One such modification may e.g. be to arrange more port openings in the heat exchanger plates, and allow selective communication with different flow channels for these ports. The selective communication can be achieved in several different ways, arranging rings having an inner diameter equaling the diameter of the port opening and a thickness equaling the distance between two neighboring plates is one way of sealing off communication between a port and a flow channel.

Claims

1. A brazed plate heat exchanger (100) comprising a start plate (110), an end plate (120), and at least two heat exchanger plates (130,130') placed there between and being provided with a pressed pattern of ridges (R) and grooves (G) adapted to keep the plates on a distance from one another, such that flow channels (N,W) are formed between the plates, wherein contact points are formed between the ridges and grooves of neighboring plates, said contact points being adapted to provide brazing points for holding the plates together, **characterized in that** at either, or both, of the ridges (R) and grooves (G) are provided with indentations (I, I') adapted for housing a ridge (R) or groove (G) of a neighboring plate.

2. The brazed plate heat exchanger of claim 1, wherein the ridges (R) and grooves (G) of the neighboring plates are provided with indentations facing one another and being aligned, such that the indentations of the neighboring plates contact one another.

3. The brazed plate heat exchanger of claim 1 or 2, wherein four port openings (140a, 140a', 150b, 150b') are arranged to selectively communicate with flow channels (N,W) formed by the heat exchanger plates (130, 130').

Fig. 1

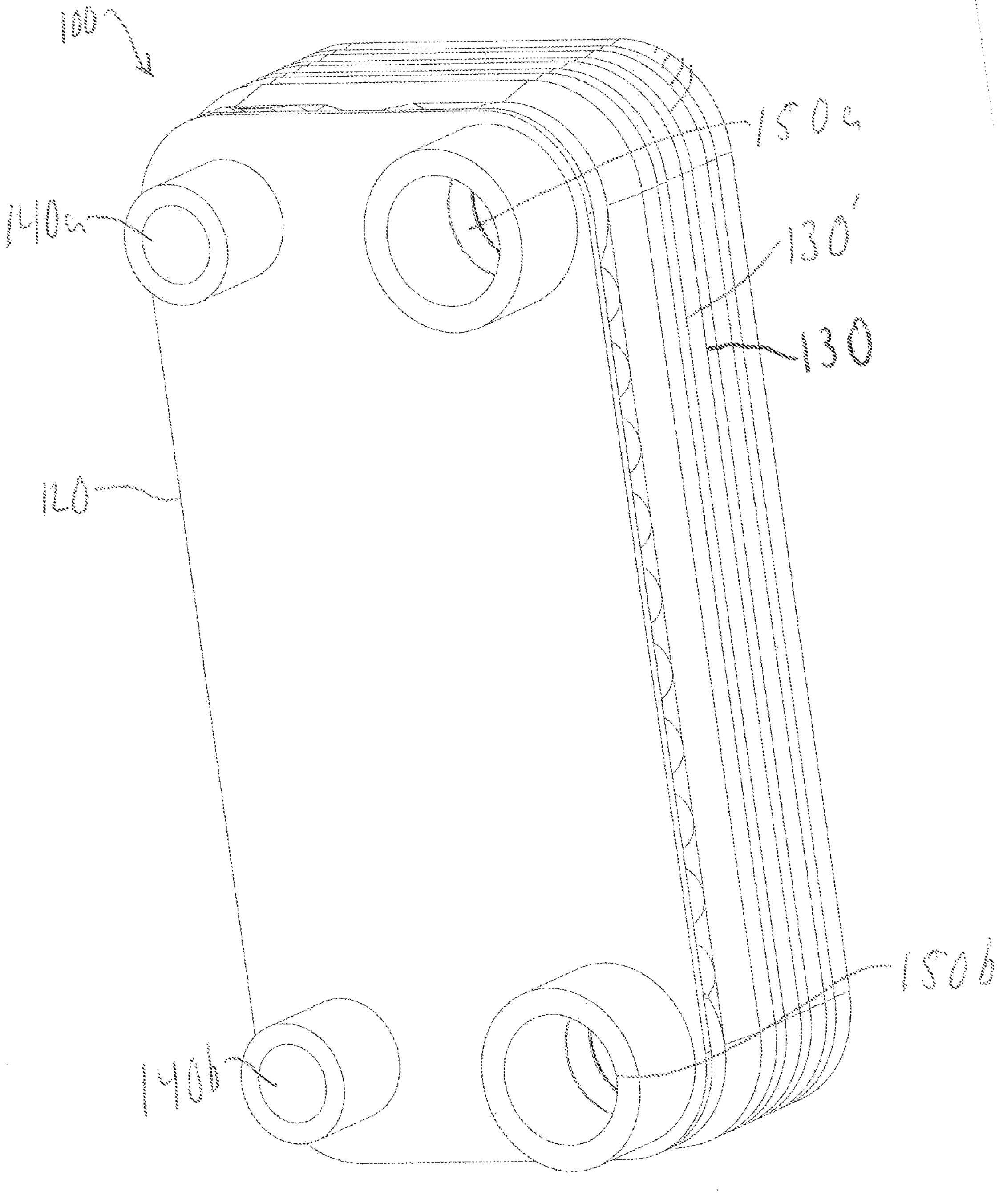
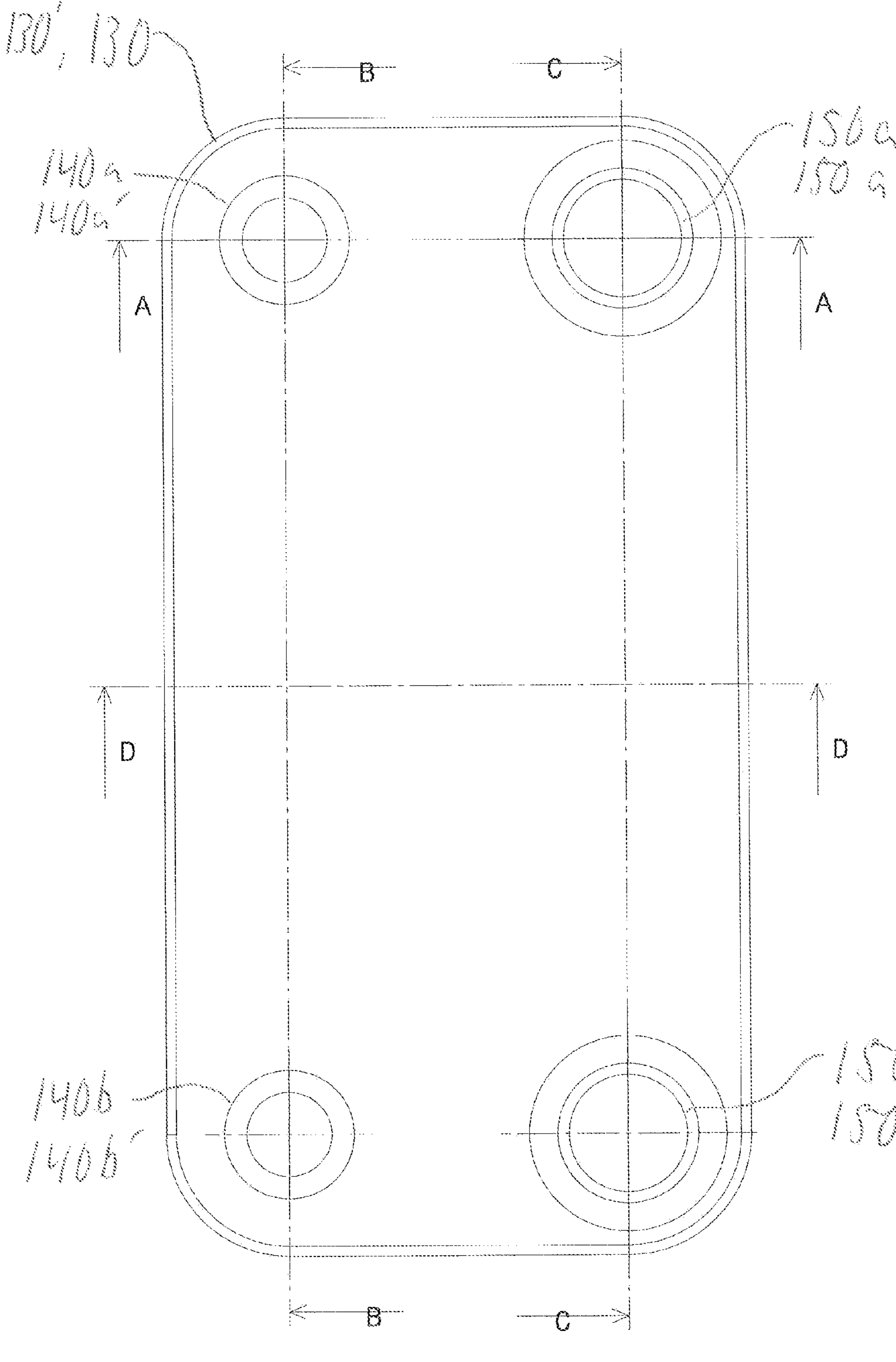
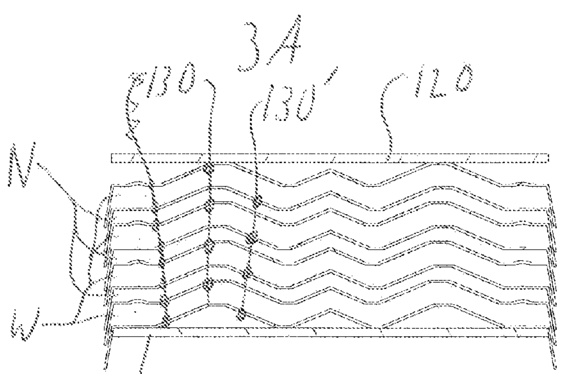
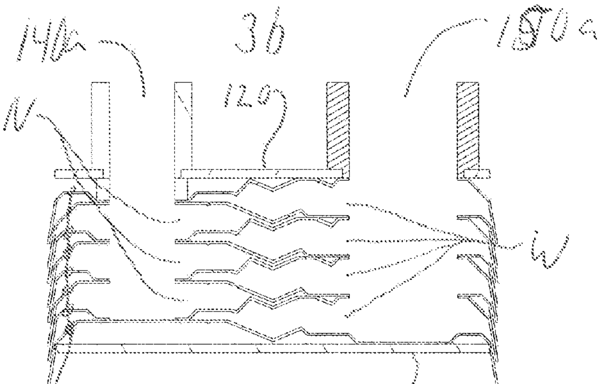


Fig. 2



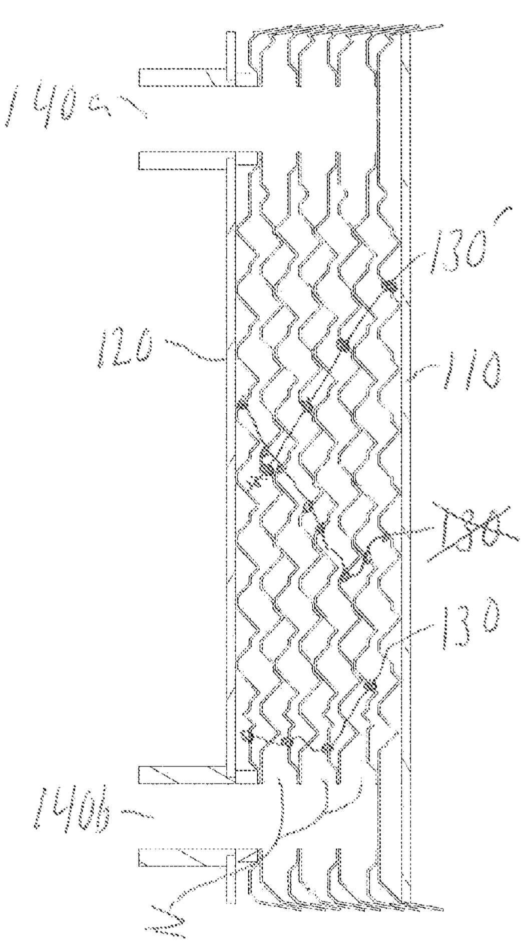


Section cut D-D
Scale: 3:4



Section cut A-A
Scale: 3:4

3c



3d

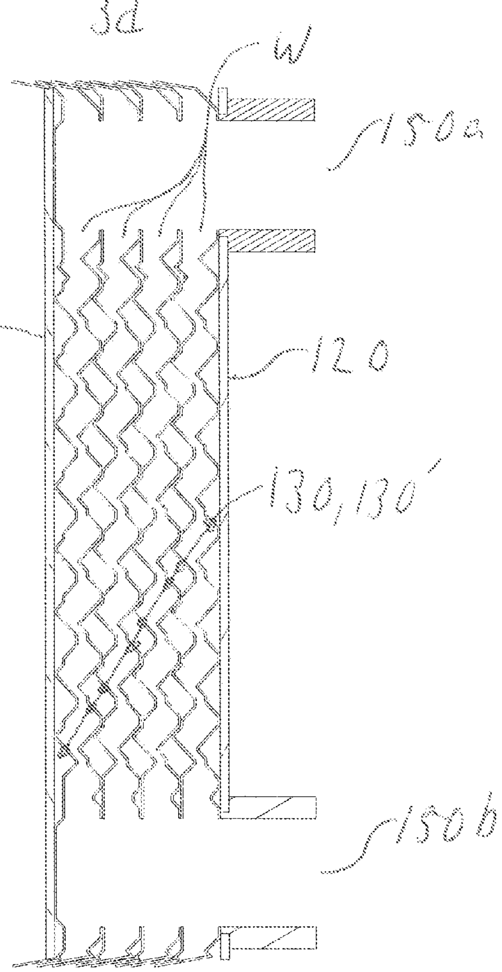


Fig. 4

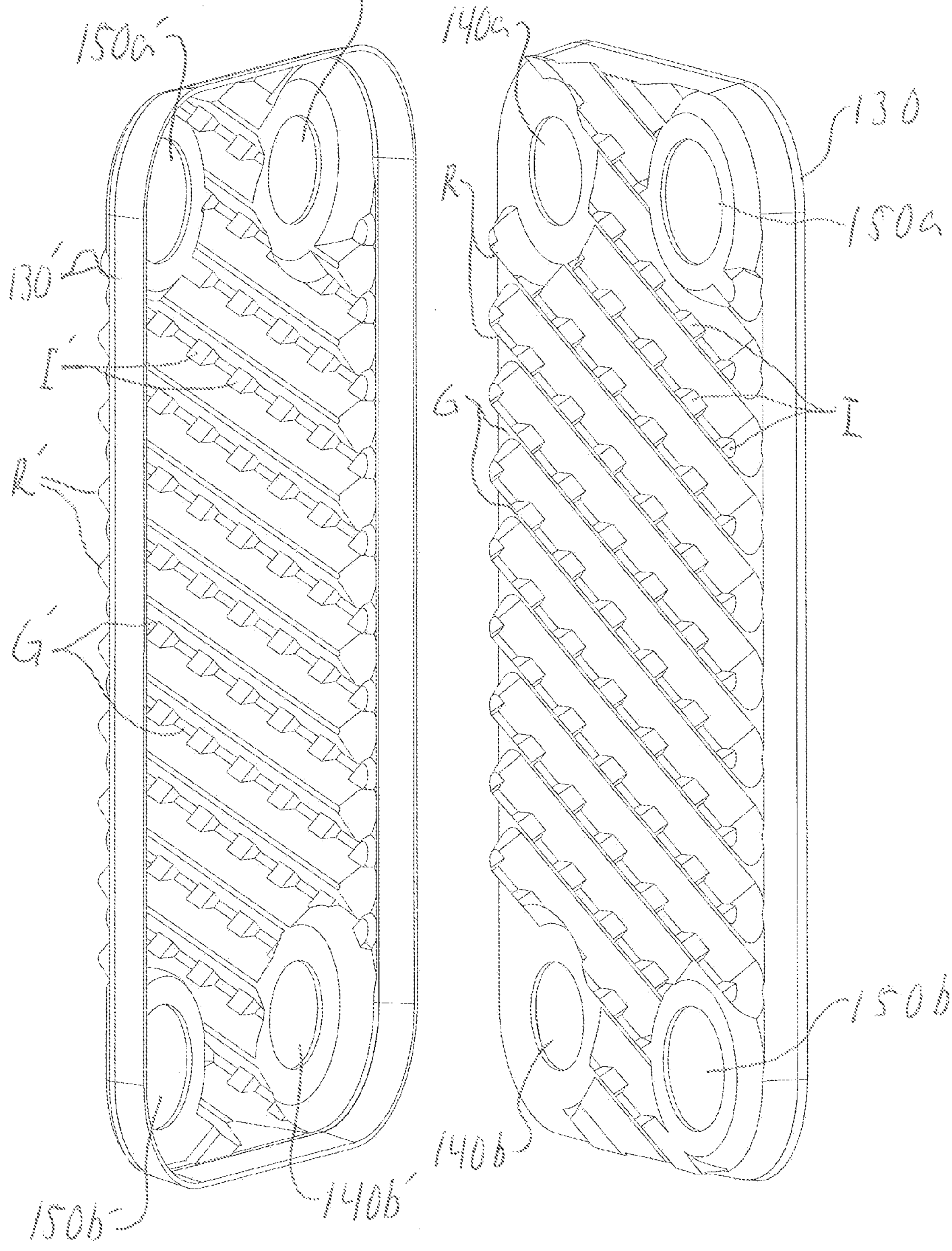
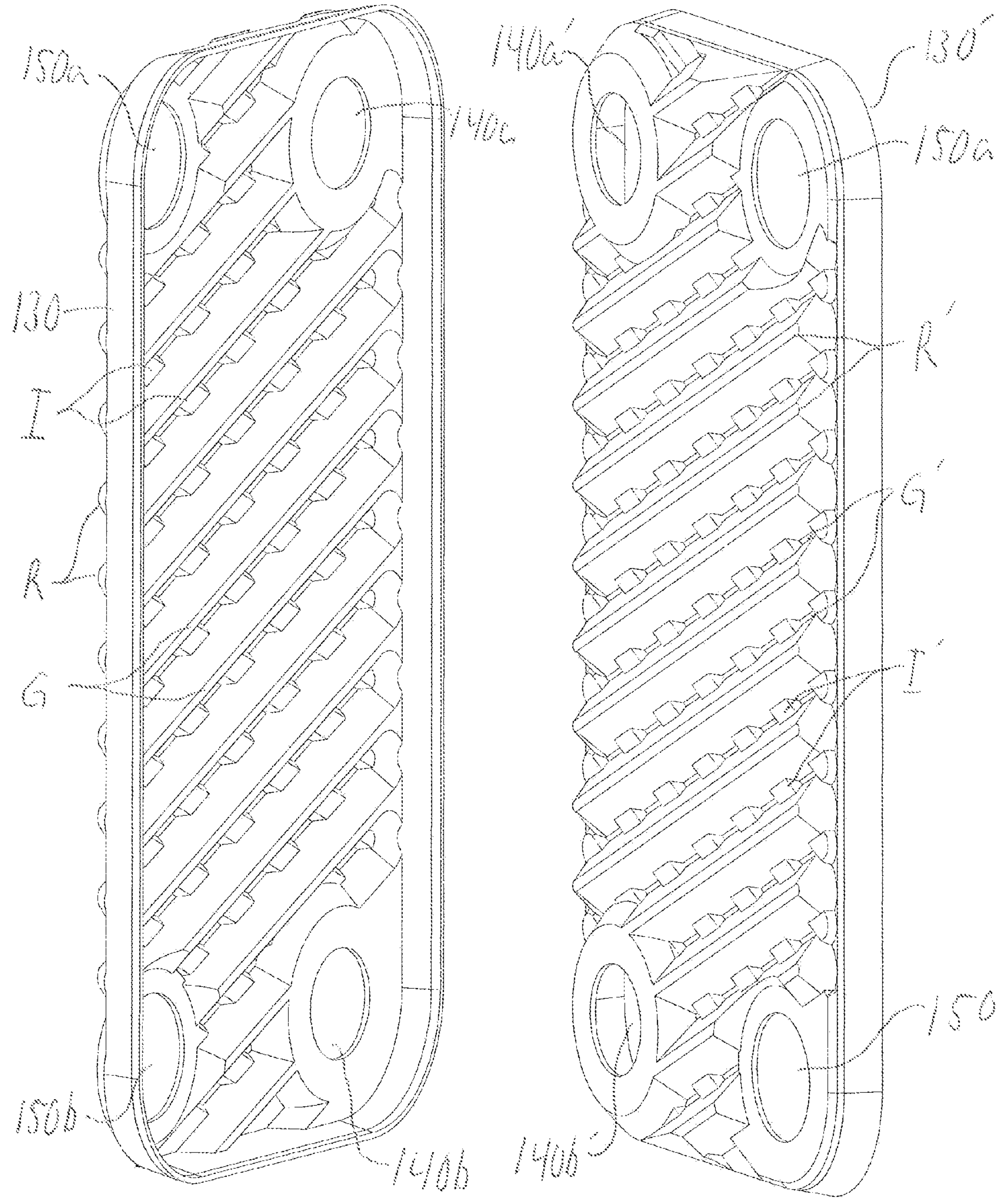


Fig. 5



REFERENCES CITED IN THE DESCRIPTION

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