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(54) A PLATE HEAT EXCHANGER

(57) The present invention provides a heat exchanger for heat exchange between a first fluid and a second fluid. The heat exchanger includes a stack of corrugated plates forming at least one first channel for the first fluid and at least one second channel for the second fluid. In that, the cross-section of the first channel is different from the cross-section of the second channel. Further, the corrugated plates further comprising corrugations having crest ridges and trough ridges formed along the extension of the plates and the undulating profile of crest ridges is different from the undulating profile of trough ridges.

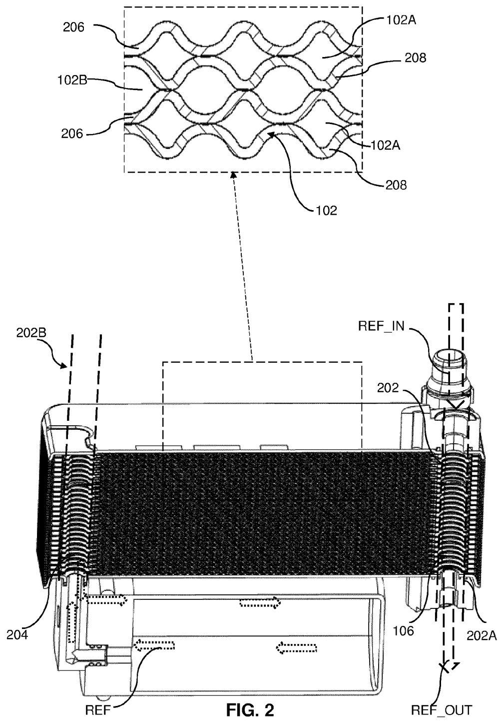

FIG. 2

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Description

[0001] The present invention generally relates to a plate heat exchanger.

[0002] Plate-type heat exchangers may include a plurality of plates stacked together to form two fluid channels. The two fluid channels are fluidically isolated from each other, yet thermal coupled with each other. In one example, adjacent plates of the stacked plates delimit the paths for the fluid channels. Each plate may include openings for enabling fluid flow into the respective fluid channels. The openings provided in the stack of plates form conduits that transfers the fluid to the respective fluid channels. The openings forming the conduits act as a manifold to enable fluid flow into the respective channels. Further, the openings may include collars to fluidically connect the conduits with the respective fluid channels. The two fluid channels can be a refrigerant channel and a coolant channel. Both the channels are in heat-exchange configuration to enable heat exchange between fluids in the refrigerant channel and the coolant channel.

[0003] Generally, the plates in the heat exchanger alternately form the refrigerant channel and the coolant channel. Here, cross-section of the refrigerant channel and coolant channel may be same and such channels may carry homogenous volume of fluid. It is well known that refrigerant such as difluoromethane (also called difluromethylene, or R-32) and coolant such as water-glycol mixture may have different thermophysical properties. As explained above, the refrigerant channel and the coolant channel is having uniform volume of fluid flowing therein. Hence, there is a possibility that the heat exchange between the refrigerant and the coolant is sub-optimum, as phase change temperature of both the refrigerant and the coolant are different. As a result, thermal performance of the heat exchanger is reduced. Some of the conventional heat exchangers may have corrugation to increase pressure drop of the refrigerant and coolant in their respective channel to achieve optimum heat exchange. However, such designs may not be optimal.

[0004] As the radius/depth of each corrugation in the plates is similar, cross-section of the channels is same throughout the heat exchanger. As the thermal properties of the coolant and refrigerant are different, heat exchange between the coolant and refrigerant can be sub-optimal, thereby affecting performance of the heat exchanger.

[0005] Accordingly, there remains a need for a heat exchanger providing optimum thermal performance. Further, there remains another need for a simple design of refrigerant and coolant channels of a heat exchanger that increases flow of coolant or reduces flow of refrigerant into the heat exchanger to achieve effective heat exchange between the refrigerant and the coolant. Yet, there remains another need for dissimilar cross-section between refrigerant and coolant channels in a heat exchanger to optimize thermal performance of the heat exchanger.

[0006] In the present description, some elements or parameters may be indexed, such as a first element and a second element. In this case, unless stated otherwise, this indexation is only meant to differentiate and name elements, which are similar but not identical. No idea of priority should be inferred from such indexation, as these terms may be switched without betraying the invention. Additionally, this indexation does not imply any order in mounting or use of the elements of the invention.

[0007] In view of the foregoing, an embodiment provides a heat exchanger for heat exchange between a first fluid and a second fluid. The heat exchanger includes a stack of corrugated plates forming at least one first channel for the first fluid and at least one second channel for the second fluid. In that, the cross-section of the first channel is different from the cross-section of the second channel. Further, the corrugated plates further comprising corrugations having crest ridges and trough ridges formed along the extension of the plates and the undulating profile of crest ridges is different from the undulating profile of trough ridges.

[0008] Further, the corrugated plates includes a first set of plates having first corrugations and a second set of plates having second corrugations. The first set of plates and the second set of plates are alternately stacked together for defining the cross section of first channel and the second channel.

[0009] In one embodiment, the profile of the crest ridges is smaller than of the trough ridges in the first set of plates and the profile of the crest ridges is bigger than of the trough ridges in the second set of plates.

[0010] Further, the ratio between the radius "R2" of the crest ridges and the radius "R1" the trough ridges in the first set of plates is 1:1.45, and the ratio between the radius "R’2" of the crest ridges and the radius "R’1" of the trough ridges in the second set of plates is 1.45:1.

[0011] In another embodiment, the profile of the crest ridges is bigger than of the trough ridges in the first set of plates and the profile of the crest ridges is smaller than of the trough ridges in the second set of plates.

[0012] Further, the ratio between radius of the crest ridges and the trough ridges in the first set of plates is 1.45:1, and the ratio between the radius of the crest ridges and the trough ridges in the second set of plates is 1:1.45.

[0013] Generally, the trough ridges of the first set of plates is substantially in proximity to the crest ridges of the second set of plates.

[0014] Further, the trough ridges (of the first set of plates is brazed to the crest ridges of the second set of plates.

[0015] In one example, the first channel is delimited by a first side of a first plate amongst the first set of plates and a second side of adjacent second plate amongst the second set of plates.

[0016] In another example, the second channel is delimited by a first side of a second plate amongst the second set of plates and a second side of adjacent first plate amongst the first set of plates.

[0017] Generally, the volume of the first channel is lesser than the second channel.

[0018] Here, the corrugated plates further includes first openings forming first conduits for enabling the first fluid flow in the first channel and second openings forming second conduits for enabling the second fluid flow in the second channel.

[0019] Further, the first openings are defined on one side of the corrugated plates and the second openings are defined on opposite of the corrugated plates.

[0020] In case, the heat exchanger is configured for an operation as a condenser, the first fluid being a refrigerant and the second fluid being a liquid coolant.

[0021] Further, the pitch of the first corrugations formed on the first set of plates is equal to the pitch of the second corrugations formed on the second set of plates.

[0022] Other characteristics, details and advantages of the invention can be inferred from the description of the invention hereunder. A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying figures, wherein:

Fig. 1 illustrates a schematic view a schematic view of the heat exchanger;

Figs. 2 and 3 show different cross-sectional views of the heat exchanger of Fig. 1 showing first channels and the second channels respectively;

Figs. 4A and 4B illustrate top views of the two plates of the heat exchanger of Fig. 1, depicting a first opening and a second opening to enable fluid flow into the first and second channels respectively;

Fig. 5A shows a top view of the plates depicting cutting plane A-A' and B-B';

Fig. 5B illustrates a cross-sectional view of the plates of Fig. 5A cut at the cutting plate A-A';

Fig. 5C illustrates a cross-sectional view of the plates of Fig. 5A cut at the cutting plate B-B';

Fig. 6A illustrates a sectional view of the plates of the Figs. 5A-B depicting the crest and trough ridges of the first and second sets of plates;

Fig. 6B shows a section of view of the first plate of the first set of plates of Fig. 5B depicting the radius of the crest ridges and the trough ridges; and

Fig. 6C shows a section of view of the second plate of the second set of plates of Fig. 5B depicting the radius of the crest ridges and the trough ridges.

[0023] It must be noted that the figures disclose the invention in a detailed enough way to be implemented, the figures helping to better define the invention. The invention should however not be limited to the embodiments disclosed in the description.

[0024] The present invention relates to a plate heat exchanger having dis-similar cross-section of channels between a refrigerant channel and a coolant channel to enhance heat exchange between the refrigerant and the coolant. Generally, conventional plate heat exchanger has a stack of plates forming the refrigerant and coolant channels. The channels may have uniform cross-section across the heat exchanger. In other words, the cross-section of the refrigerant channel is same as the cross-section of the coolant channel across the heat exchanger. In addition, flow rate of the refrigerant and the coolant into their respective channels is same. As thermophysical properties of the refrigerant and the coolant are different, heat exchange between the refrigerant and the coolant is inefficient or sub-optimal. For instance, phase temperature of the coolant and the refrigerant is different; it is possible that the heat exchange between the refrigerant and the coolant cannot be optimum in the heat exchanger in case the coolant and refrigerant is flowing at same flow rate and volume into their respective channels. In order to increase heat exchange between the refrigerant and the coolant, pressure drop of the refrigerant is increased, however, such technique still inefficient to achieve optimum heat exchange between both the refrigerant and coolant. Such technique has some energy loss and requires more energy to create the pressure drop of the refrigerant. To avoid above-mentioned problems, a design of channels of the heat exchanger is changed. Particularly, the channels are designed in such a way that the flow-rate or volume of refrigerant flowing into the refrigerant channels is lesser than the flow-rate or volume of coolant flowing into the coolant channels. Further, geometry and design of the channels are further explained with respect to the forthcoming figures.

[0025] Figs. 1 to 3 illustrate different views a plate heat exchanger 100, in accordance with an embodiment of the present invention. Particularly, Fig. 1 shows a schematic view of the heat exchanger 100 and Figs. 2 and 3 show different cross-sectional views of the heat exchanger 100 of Fig. 1. The heat exchanger 100 may be configured for heat exchange between a first fluid and a second fluid, for example, a refrigerant and a liquid coolant. The liquid coolant can be water or water-glycol mixture. In this example, the heat exchanger 100 is configured for an operation as a condenser, here the first fluid being a refrigerant and the second fluid being a liquid coolant. The heat exchanger 100 includes a plurality of plates 102 stacked together to form at least two fluid channels, namely, first channels 102A being refrigerant channels and second channels 102B being liquid coolant channels. In one embodiment, the plates 102 are corrugated plates. In another embodiment, the plates 102 may have corrugations on its surface. Generally, the corrugations on the plates 102 are to increase pressure drop of the first fluid and the second fluid.

[0026] As shown in detailed view of Fig. 2, the first channels 102A and the second channels 102B are alternately formed with each other by the plates 102. In other words, the plates 102 are stacked together so as to delimit one first channel 102A by a bottom surface of a first plate and a top surface of a second plate and to delimit one second channel 102B by a bottom surface of the second plate and a top surface of a third plate. In one embodiment, the stack of plates 102 are brazed together without disturbing the fluid channels formed therein. In one example, at least a portion of the top surface of one plate is brazed to at least a portion of the bottom surface of the adjacent plate without disturbing the fluid flow path defined therein. As shown in the detailed view of Fig. 2, the cross-section of the first channels 102A is different from the cross-section of the second channels 102B. For instance, the flow-rate of the first fluid flowing into the first channels 102A is different from the flow-rate of the second fluid flowing into the second channels 102B, due to dissimilar cross-section between the first channels 102A and the second channels 102B. It is evident from detailed view of the Fig. 2 that the cross-section of the first channels 102A is smaller than of the cross-section of the second channels 102B.

[0027] In this present example, the plates 102 may be corrugated plates having crest ridges and trough ridges formed along the extension of plates 102. Here, one crest ridge and one trough ridge defining a pitch of the corrugate plates 102. In this embodiment, the undulating profile of the crest ridges is different from the profiled of the trough ridges of the plates 102. Further, the plates 102 further comprising a first set of plates 206 having first corrugations 206A and a second set of plates 208 having second corrugations 208A. As shown in Fig. 2, the first set of plates 206 and the second set of plates are alternately stacked together for defining the cross-section of the first channel 102A and the second channel 102B.

[0028] Further, the plates 102 may comprise openings 202, 204 forming conduits 202A-B, 204A-B to enable fluid flow in the first channels 102A and the second channels 102B. Particularly, the openings 202, 204 may be classified into two sets of openings, a first set of openings 202 enabling the first fluid circulation in the first channels 102A and a second set of openings 204 enabling the second fluid circulation in the second channels 102B. As shown in Fig. 2, the first set of openings 202 forming the first conduits 202A, 202B is to introduce and receive the first fluid to/ from the first channels 102A respectively. Here, the first fluid, i.e., the refrigerant, flowing into the heat exchanger 100 is represented as "REF_IN" and the first fluid flowing out from the heat exchanger 100 is represented as "REF_OUT". As shown in Fig. 3, the second set of openings 204 forming the second conduits 204A, 204B is to introduce and receive the second fluid to/from the second channels 102B respectively. Here, the second fluid, i.e., the coolant flowing into the heat exchanger 100 is represented as "COOL_IN" and the first fluid flowing out from the heat exchanger 100 is represented as "COOL_OUT" in the Figs. 2 and 3. Further, the first set of openings 202 and the second set of openings 204 formed on the plates 102 are clearly shown in Figs. 4A and 4B. The openings 202, 204 may further comprise collars 302 configured to promote laminar fluid flow between the conduits 202A-B, 204A-B and the respective fluid channels 102A-B.

[0029] Figs. 4A and 4B illustrate top views of the two plates 102 of the heat exchanger 100 of Fig. 1, depicting the first opening 202 and the second opening 204. In the plate 102 as shown in Fig. 4A, the first set of openings 202 is formed on opposite ends of the plates 102. In other words, the first set of openings 202 providing the first fluid to the first channel 102A is formed on a first end 108A of the plates 102, whereas the first set of openings 202 receiving the first fluid from the first channels 102A is formed on a second end 108B of the plates 102. Similarly, the second set of openings 202 is formed on opposite ends of the plates 102. In other words, the second set of openings 204 providing the second fluid to the second channel 102B is formed on the first end 108A of the plates 102, whereas the second set of openings 204 receiving the second fluid from the second channels 102B is formed on the second end 108B of the plates 102.

[0030] In another embodiment, the first set of openings 202 providing the first fluid to the first channel 102A and the first set of openings 202 receiving the first fluid from the first channel 102A are formed on same end of the plates 102, i.e., either on the first end 108A or the second end 108B of the plates 102. Similarly, the second set of openings 204 enabling the second fluid circulation in the second channel 102B are formed on same end of the plates 102. In such embodiment, each of the first channel 102A and the second channel 102B may require a partition plate to enable two-pass flow in the heat exchanger 100. The above-mentioned embodiment is not shown in any of the figures.

[0031] Figs. 5A-C illustrate different view of the plates 102 of Fig. 2. Here, Fig. 5A shows a top view of the plates 102 depicting cutting plane A-A' and B-B', Fig. 5B is a cross-sectional view of the plates 102 of Fig. 5A cut at the cutting plate A-A' and Fig. 5C is a cross-sectional view of the plates 102 of Fig. 5A cut at the cutting plate B-B'. As explained above and shown in Figs. 5B-C, the first set of plates 206 and the second set of plates 208 are alternately arranged and brazed together. Here, the first set of plates 206 and the second set of plates 208 are brazed together at few portions as shown in Fig. 5B, without disturbing fluid flow path there-between. Particularly, the bottom side of the one plate is brazed to the top side of the adjacent plate at few portions and it can be seen in Fig. 5B. It is evident from the Figs. 5B-C that the plates 102 are brazed at few portions without disturbing fluid flow in the first channels 102A and the second channels 102B.

[0032] In this example as shown in Fig. 5B, a stack of four plates 102 is depicted to show the first channels 102A and the second channels 102B. Here, the first plate 302 and the third plate 306 are part of the first set of plates 206 and the second and fourth plates 304, 308 are part of the second set of plates 208. Further, the cross-section of the first channel 102A and the second channel 102B is defined by volume or surface area delimited by two surfaces/sides of the adjacent plates 102. For instance, as shown in Fig. 5B, the cross-section of the first channel 102A is defined by a bottom surface of the first plate 302 and a top surface of the second plate 304. Similarly, the cross-section of the second channel 102B is defined by a bottom surface of the second plate 304 and a top surface of the third plate 306.

[0033] As explained above, the plates 102 include the crest ridges 502 and the trough ridges 504 formed along the extension of plates 102. It is evident from the Fig. 5B, the undulating profile of the crest ridges 502 is different from the trough ridges 504 of the plates 102, thereby forming non-uniform cross-section between the first channel 102A and the second channel 102B. In the present example, design of the crest and trough ridges of the first set of plates 206 is different from the design of the crest and trough ridges of the second set of plates 208. Geometry and profile of the crest and trough ridges of the first set of plates 206 and the second set of plates 208 are explained with respect forthcoming figures. Although the profiles of the crest and trough ridges of the first set of plates 206 and the second set of plates 208 are different, the pitch of the first corrugations 206A on the first set of plates 206 is equal to the pitch of the second corrugations 208B on the second set of plates 208.

[0034] As the first set of plates 206 and the second set of plates 208 are alternately stacked together, the trough ridges of the first plate 302 are in proximity to the crest ridges of the second plate 304, thereby forming the cross-section of the first channel 102A. Similarly, the trough ridges of the second plates 304 are in proximity to the crest ridges of the third plate 306, thereby forming the cross-section of the second channel 102B. In some instance, the surface of area or volume of the first channel 102A and the second channel 102B can be altered without changing cross-section of the channels. As profile of the crest and trough ridges of the first set of plates 206 is different from the profile of crest and trough ridges of the second set of plates 208, the cross-section of the first channels 102A is different from the cross-section of the second channels 102B. As a result, flow rate or volume of the first fluid flowing into the first channels 102A is smaller than the flow rate or volume of the second fluid flowing into the second channel 102B, thereby enhancing/increasing heat exchange between the refrigerant and the coolant.

[0035] Fig. 6A illustrates a sectional view of the plates 102 of the Figs. 5A-B depicting the crest and trough ridges 502A, 504A of the first plate 302 of the first set of plates 206 and the crest and trough ridges 502B, 504B of the second plate 304 of the second set of plates 208. As shown in Fig. 6A, the crest ridges 502A and trough ridges 504A of the first corrugation 206A are defined by corrugation angle and corrugation radius. In the present example, the profile of the crest ridges 502A and trough ridges 504A of the first set of plates 206 are measured by angle of corrugation and radius of the first corrugation 206A. Similarly, the profile of the crest ridges 502B and trough ridges 504B of the second set of plates 208 are measured by angle of corrugation and radius of the second corrugation 208A.

[0036] According to one embodiment, the profile of the crest ridges 504A is smaller than the profile of the trough ridges 504A in the first set of plates 206 as shown in Fig. 6B. Further, the profile of the crest ridges 502B is bigger than of the trough ridges 504B in the second set of plates 208 as shown in Fig. 6C.

[0037] Fig. 6B shows a section of view of the first plate 302 of the first set of plates 206 of Fig. 5B depicting the radius of the crest ridges 502A and the trough ridges 504A. Fig. 6C shows a section of view of the second plate 304 of the second set of plates 208 of Fig. 5B depicting the radius of the crest ridges 502B and the trough ridges 504B. Here, angle of the first corrugations of the first plate 302 is represented as "α and β", the radius of the trough ridges 504A is represented as "R1" and the radius of the crest ridges 502A is represented as "R2" in Fig. 6B. It is evident from Fig. 6B, the radius R2 of the crest ridges 502A is smaller than of the radius R1 of the trough ridges 504A in the first plate 302 of the first set of plates 206. Further, the angle "β" of the crest ridges 502A is smaller than the angle "α" of the trough ridges 504A in the first set of plates 206. In one example, a ratio between the radius R2 of the crest ridges 502A and the radius R1 of the trough ridges 504A in the first plate 302 is 1:1.45

[0038] Similarly, angle of the second corrugations of the second plate 302 amongst the second set of plates 208 is represented as "α' and β'", the radius of the trough ridges 504B is represented as "R'1" and the radius of the crest ridges 502B is represented as "R'2" in Fig. 6C. Further, the profile of the crest ridges 502B is bigger than the profile of the trough ridges 504B in the second plate 304. In other words, the radius R 2 of the crest ridges 502B is bigger than of the radius R'1 of the trough ridges 504B in the second plate 304. Further, the angle "β'" of the crest ridges 502B is bigger than the angle "α'" of the trough ridges 504B in the second plate 304 amongst the second set of plates 208. In one example, the ratio between the radius R'2 of the crest ridges 502B and the radius R'1 the trough ridges 504B in the second plate 304 amongst the second set of plates 208 is 1.45:1.

[0039] As the first plate 302 and the second plate 304 are alternately stacked together to form the first channels 102A and the second channels 102B, surface volume/area of the first channels 102A is different from the surface volume/area of the second channels 102B. Particularly, surface volume of the first channels 102A is smaller than of the second channels 102B due to different in dimensions between the first set of plates 206 and the second set of plates 208. In one example, a ratio between the surface volume of the first channel 102A and the second channel 102B is 1:1.45. As a result, the volume of the first fluid flowing into the first channels 102A is lesser than the volume of the second fluid flowing into the second channels 102B. As explained above, thermos-physical properties of the refrigerant and the coolant are different; hence, the heat exchange between the first channels 102A and the second channels 102B is optimum. As a result, thermal performance of the heat exchanger 100 is increased.

[0040] In another embodiment, the profile of the crest ridges 502A is bigger than the profiled of the trough ridges 504A in the first set of plates 102A. In such case, the ratio between the radius of the crest ridges 502A in the first set of plates 206 and the radius of the trough ridges 504A in the first set of plates 206 is 1.45:1. Further, the profile of the crest ridges 502B in the second set of plates is bigger than the profile of the trough ridges 504B in the second set of plates 208. So, the ratio between the radius of the crest ridges 502B and the trough ridges 504B in the second set of plates 208 is 1.45:1. However, it is not shown in the figures.

[0041] In another aspect of the invention, it is possible to change surface volume or flow rate of fluid flowing into the channels without altering cross-section of the channels. In such case, the profile of the crest and trough ridges 502, 504 of the plates 102 is substantially same. However, differential flow rate of fluid into the first channel 102A and the second channel 102B can be achieved by strategically arranging the one plate with respect to another plate.

[0042] In any case, the invention cannot and should not be limited to the embodiments specifically described in this document, as other embodiments might exist. The invention shall spread to any equivalent means and any technically operating combination of means.

Claims

1. A heat exchanger (100) for heat exchange between a first fluid and a second fluid, comprising:
   a stack of corrugated plates (102) forming at least one first channel (102A) for the first fluid and at least one second channel (102B) for the second fluid, **characterized in that** the cross-section of the first channel (102A) is different from the cross-section of the second channel (102B), the corrugated plates (102) further comprising corrugations having crest ridges (502) and trough ridges (504) formed along the extension of the plates (102), wherein the undulating profile of crest ridges (502) is different from the undulating profile of trough ridges (504).

2. The heat exchanger (100) according to claim 1, wherein the corrugated plates (102) comprise a first set of plates (206) having first corrugations (206A), and a second set of plates (208) having second corrugations (208A), wherein the first set of plates (206) and the second set of plates (208) are alternately stacked together for defining the cross section of first channel (102A) and the second channel (102B).

3. The heat exchanger (100) according to the preceding claim, wherein the profile of the crest ridges (502A) is smaller than of the trough ridges (504A) in the first set of plates (206) and the profile of the crest ridges (502B) is bigger than of the trough ridges (504B) in the second set of plates (208).

4. The heat exchanger (100) according to the claim 3, wherein the ratio between the radius "R2" of the crest ridges (502A) and the radius "R1" the trough ridges (504B) in the first set of plates (206) is 1:1.45, and the ratio between the radius "R'2" of the crest ridges (502B) and the radius "R'1" of the trough ridges (504B) in the second set of plates (208) is 1.45:1.

5. The heat exchanger (100) according to claim 2, wherein the profile of the crest ridges (502A) is bigger than of the trough ridges (504B) in the first set of plates (206) and the profile of the crest ridges (502B) is smaller than of the trough ridges (504B) in the second set of plates (208).

6. The heat exchanger (100) according to the claim 5, wherein the ratio between radius of the crest ridges (502A) and the trough ridges (504A) in the first set of plates (206) is 1.45:1, and the ratio between the radius of the crest ridges (502B) and the trough ridges (504B) in the second set of plates (208) is 1:1.45.

7. The heat exchanger (100) according to any of the claims 2 to 6, wherein the trough ridges (504A) of the first set of plates (206) is substantially in proximity to the crest ridges (502B) of the second set of plates (208).

8. The heat exchanger (100) according to any of the claims 2 to 6, wherein the trough ridges (504A) of the first set of plates (206) is brazed to the crest ridges (504B) of the second set of plates (208).

9. The heat exchanger (100) according to any of the claims 2 to 8, wherein the first channel (102A) is delimited by a first side of a first plate (302) amongst the first set of plates (206) and a second side of adjacent second plate (304) amongst the second set of plates (208).

10. The heat exchanger (100) according to any of the claims 2 to 8, wherein the second channel (102B) is delimited by a first side of a second plate (304) amongst the second set of plates (208) and a second side of adjacent first plate (306) amongst the first set

of plates (206).

11. The heat exchanger (100) according to any of the preceding claims, wherein the volume of the first channel (102A) is lesser than the second channel (102B).

12. The heat exchanger (100) according to any of the preceding claims, wherein the corrugated plates (102) further comprise first openings (202) forming first conduits (202A-B) for enabling the first fluid flow in the first channel (102A) and second openings (204) forming second conduits (204A-B) for enabling the second fluid flow in the second channel (102B).

13. The heat exchanger (100) according to the preceding claim, wherein the first openings (202) are defined on one side of the corrugated plates (102) and the second openings (204) are defined on opposite of the corrugated plates (102).

14. The heat exchanger (100) according to any of the preceding claims, wherein the heat exchanger (100) is configured for an operation as a condenser, the first fluid being a refrigerant and the second fluid being a liquid coolant.

15. The heat exchanger (100) according to any of the preceding claims 2 to 14, wherein the pitch of the first corrugations (206A) formed on the first set of plates (206) is equal to the pitch of the second corrugations (208A) formed on the second set of plates (208).

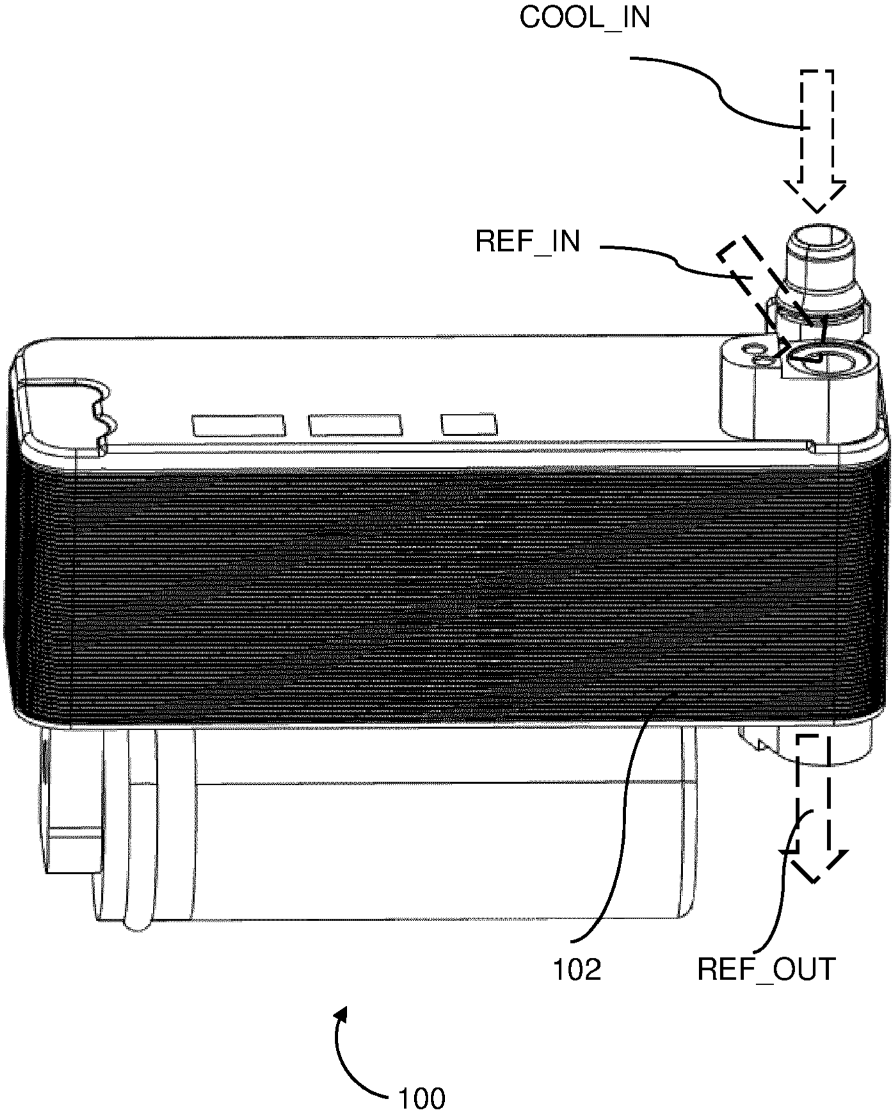


FIG. 1

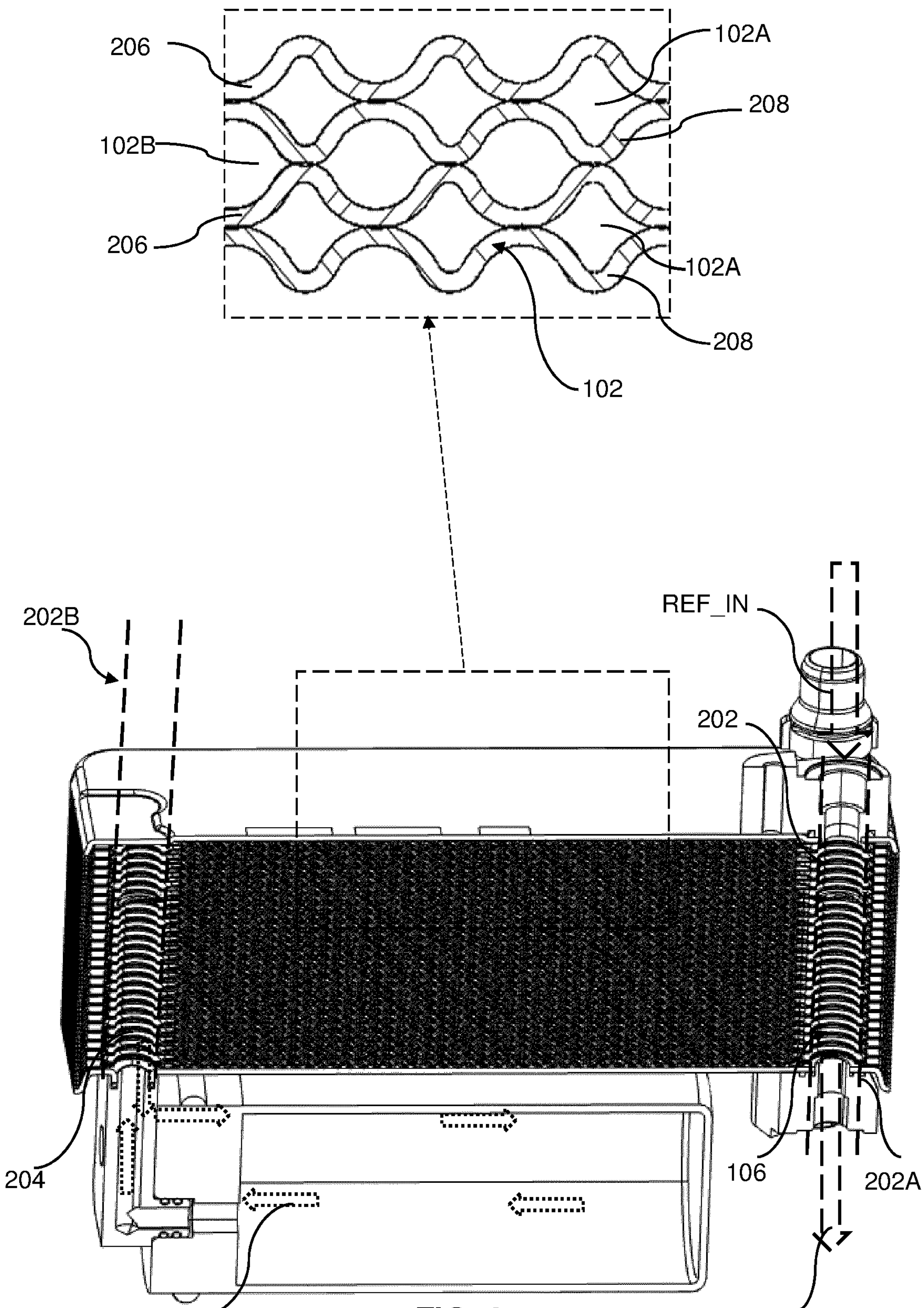

206
102A
208
102B
206
102A
208
102
202B
REF_IN
202
204
106
202A
REF
REF_OUT

FIG. 2

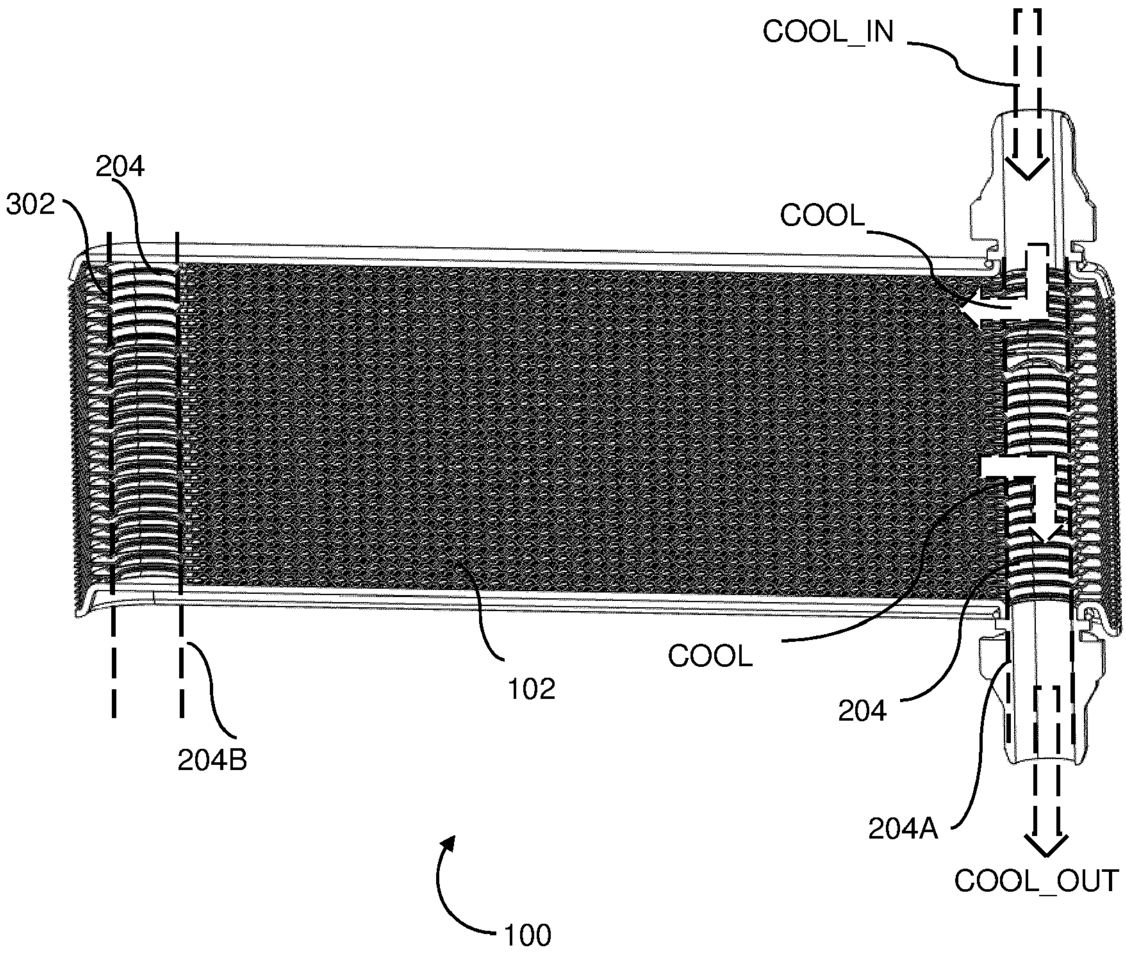


FIG. 3

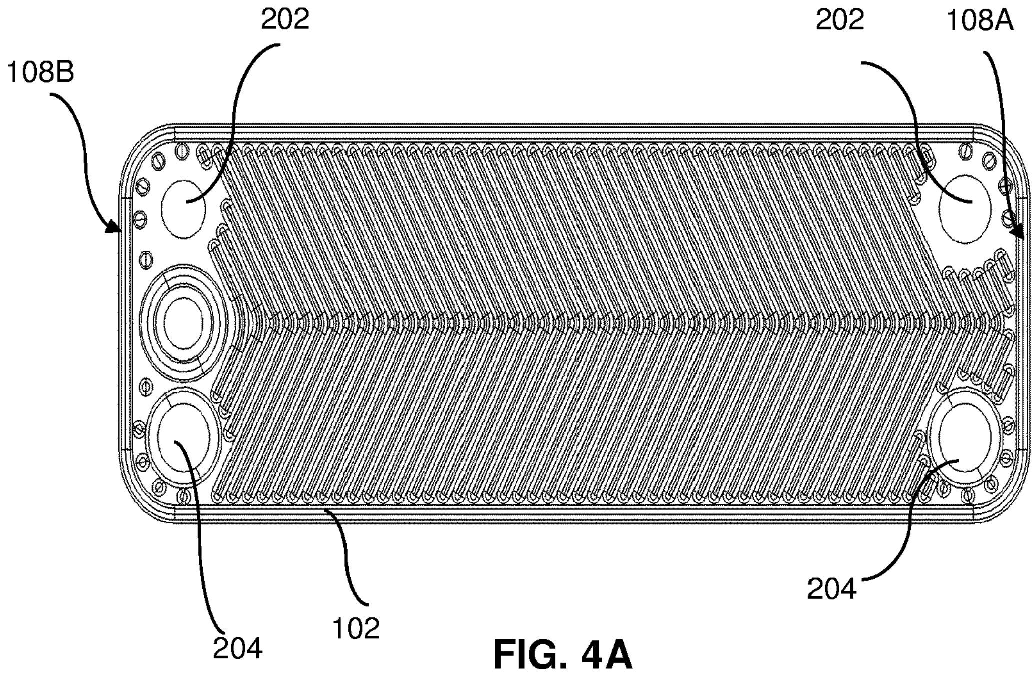


FIG. 4A

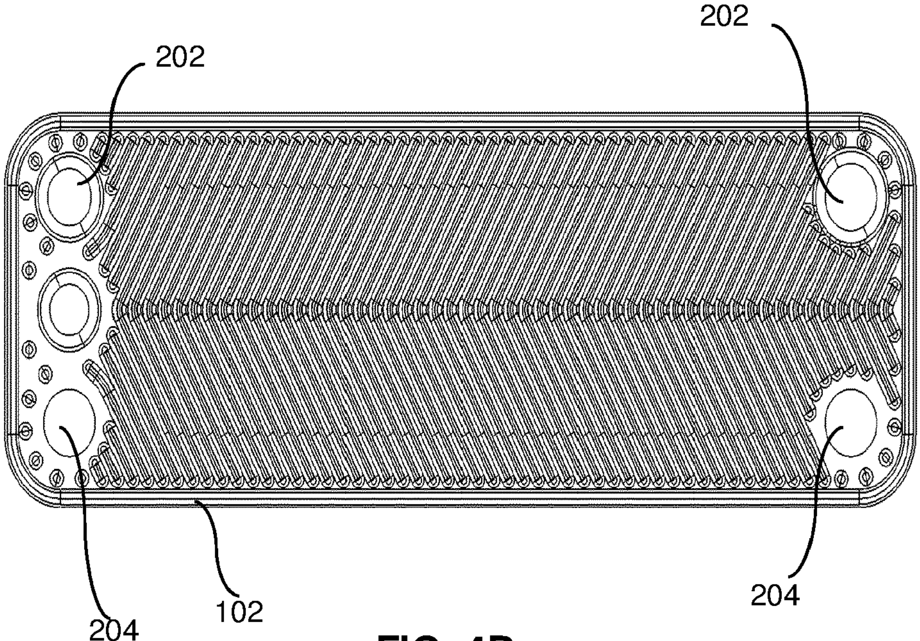


FIG. 4B

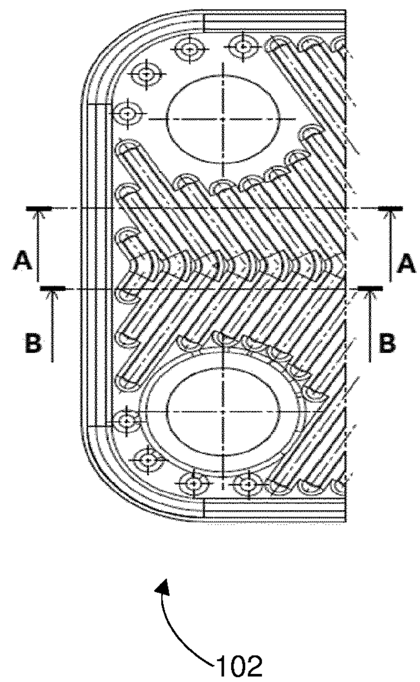
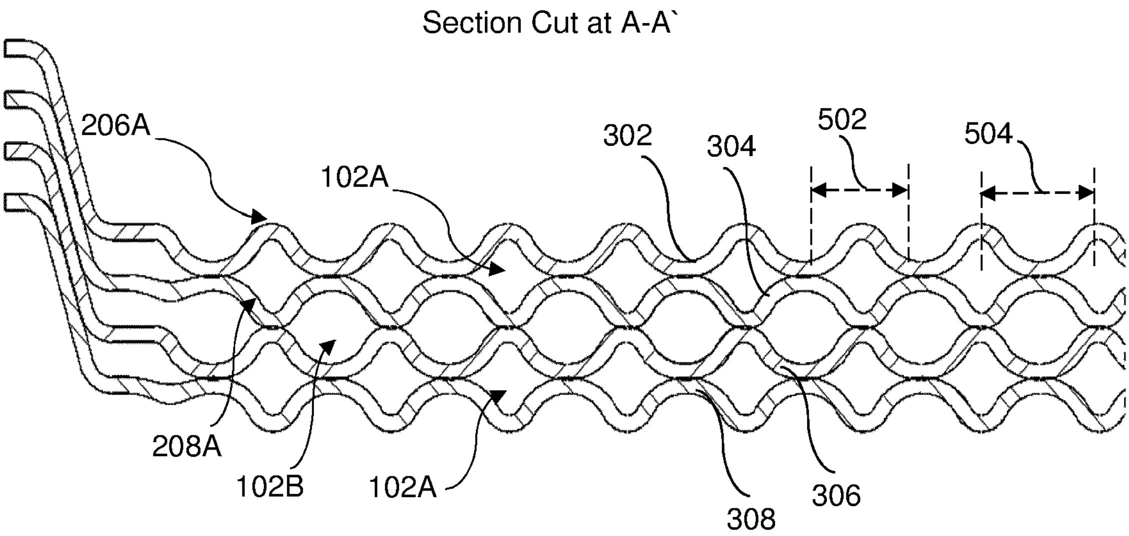


FIG. 5A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206A
102A
302
304
502
504
208A
102B
102A
308
306

FIG. 5B

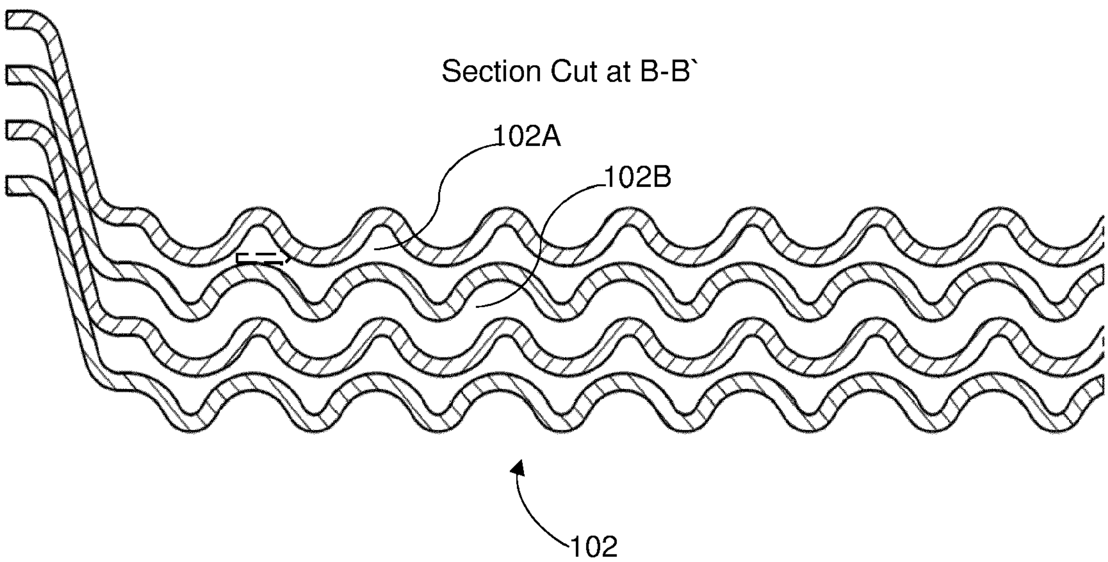
Section Cut at B-B`
102A
102B
102

FIG. 5C

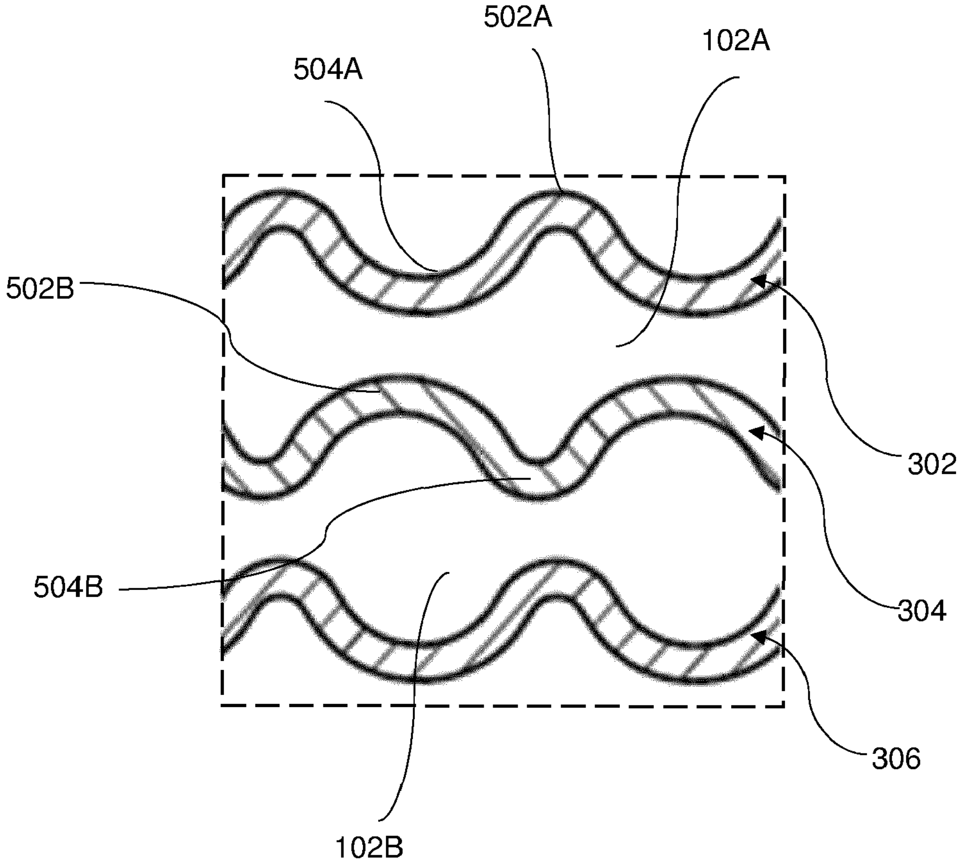

FIG. 6A

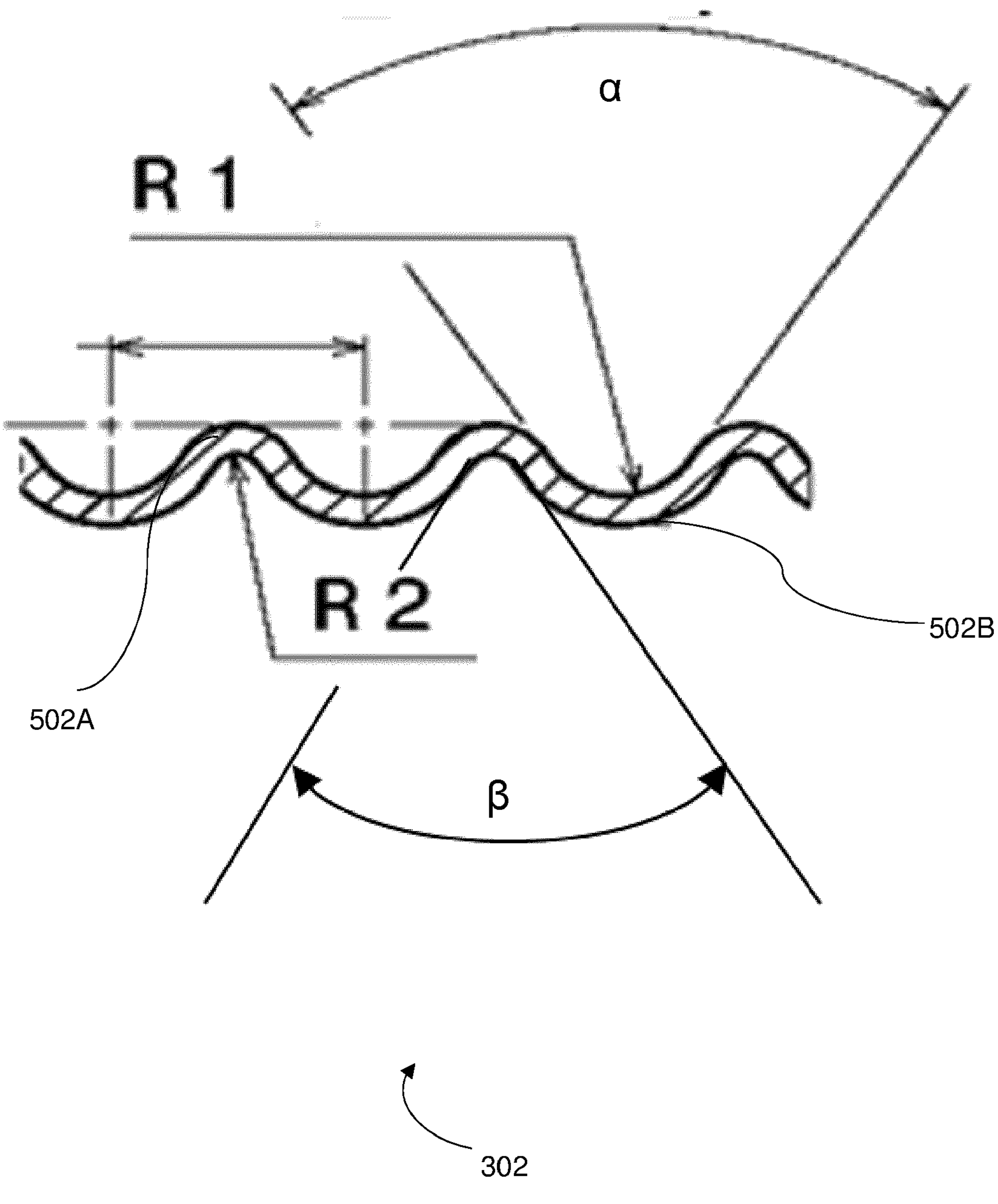

FIG. 6B

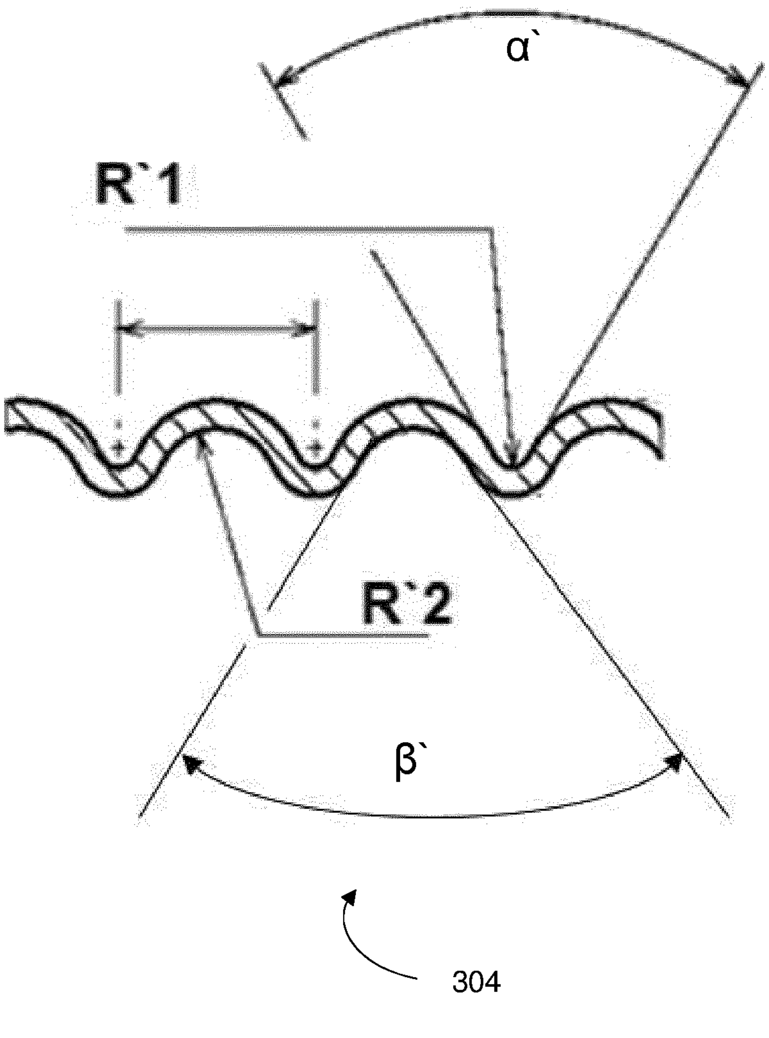

FIG. 6C

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EUROPEAN SEARCH REPORT

Application Number
EP 21 19 5560

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2021/063091 A1 (LEE SUKYOUNG [KR] ET AL) 4 March 2021 (2021-03-04) * figures 3,4 *	1-15	INV. F28D9/00 F28F3/04
X	JP 2001 280887 A (HISAKA WORKS LTD) 10 October 2001 (2001-10-10) * figures 1-4 *	1-15	
X	CN 1 598 468 A (PENG SUOHUA [CN]) 23 March 2005 (2005-03-23) * figure 7 *	1	
X	CN 2 674 384 Y (PENG SUOHUA [CN]) 26 January 2005 (2005-01-26) * figures 5,7 *	1	

TECHNICAL FIELDS SEARCHED (IPC)
F28D
F28F

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	1 February 2022	Martínez Rico, Celia

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01-02-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2021063091 A1	04-03-2021	KR 20210026216 A	10-03-2021
		US 2021063091 A1	04-03-2021
		WO 2021040228 A1	04-03-2021
JP 2001280887 A	10-10-2001	NONE	
CN 1598468 A	23-03-2005	NONE	
CN 2674384 Y	26-01-2005	NONE	

EPO FORM P0459

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