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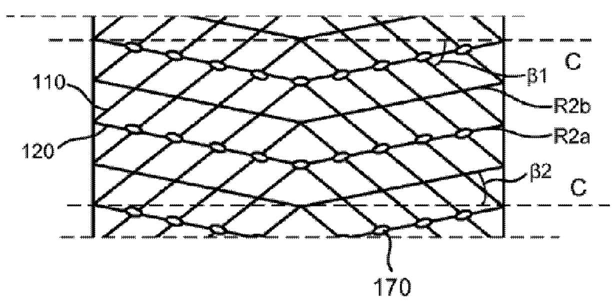
(57) Abstract:

A brazed plate heat exchanger (100) comprising a plurality of first and second heat exchanger plates (110, 120), wherein the first heat exchanger plates (110) are formed with a first pattern of ridges and grooves, and the second heat exchanger plates (120) are formed with a second pattern of ridges and grooves providing contact points between at least some crossing ridges and grooves of neighbouring plates under formation of interplate flow channels for fluids to exchange heat, said interplate flow channels being in selective fluid communication through port openings. The first pattern of ridges and grooves is different from the second pattern of ridges and grooves, so that an interplate flow channel volume on one side of the first heat exchanger plates (110) is different from an interplate flow channel volume on the opposite side of the first heat exchanger plates (110), and the first pattern of ridges and grooves exhibits a first angle (β1) and the second pattern of ridges and grooves exhibits a second angle (β2) different from the first angle (β1).



ABSTRACT

A brazed plate heat exchanger (100) comprising a plurality of first and second heat exchanger plates (110, 120), wherein the first heat exchanger plates (110) are formed with a first pattern of ridges and grooves, and the second heat exchanger plates (120) are formed with a second pattern of ridges and grooves providing contact points between at least some crossing ridges and grooves of neighbouring plates under formation of interplate flow channels for fluids to exchange heat, said interplate flow channels being in selective fluid communication through port openings. The first pattern of ridges and grooves is different from the second pattern of ridges and grooves, so that an interplate flow channel volume on one side of the first heat exchanger plates (110) is different from an interplate flow channel volume on the opposite side of the first heat exchanger plates (110), and the first pattern of ridges and grooves exhibits a first angle ($\beta 1$) and the second pattern of ridges and grooves exhibits a second angle ($\beta 2$) different from the first angle ($\beta 1$).

A BRAZED PLATE HEAT EXCHANGER AND USE THEREOF

FIELD OF THE INVENTION

The present invention relates to a brazed plate heat exchanger comprising a plurality of heat exchanger plates having a pattern of ridges and grooves providing contact points between at least some crossing ridges and grooves of neighbouring plates under formation of interplate flow channels for fluids to exchange heat. The present invention is also related to the use of such a heat exchanger.

PRIOR ART

Heat exchangers are used for exchanging heat between fluid media. They generally comprise a start plate, an end plate and a number of heat exchanger plates stacked onto one another in a manner forming flow channels between the heat exchanger plates. Usually, port openings are provided to allow selective fluid flow in and out from the flow channels in a way well known to persons skilled in the art.

A common way of manufacturing a plate heat exchanger is to braze the heat exchanger plates together to form the plate heat exchanger. Brazing a heat exchanger means that a number of heat exchanger plates are provided with a brazing material, after which the heat exchanger plates are stacked onto one another and placed in a furnace having a temperature sufficiently hot to at least partially melt the brazing material. After the temperature of the furnace has been lowered, the brazing material will solidify, whereupon the heat exchanger plates will be joined to one another to form a compact and strong heat exchanger.

It is well known by persons skilled in the art that the flow channels between the heat exchanger plates of a plate heat exchanger are created by providing the heat exchanger plates with a pressed pattern of ridges and grooves. A number of heat exchanger plates are typically stacked on one another, wherein the plates can be identical to provide a symmetric plate heat exchanger or not identical to provide an asymmetric plate heat exchanger. When stacked, the ridges of a first heat exchanger plate contact the grooves of a neighboring heat exchanger plate and the plates are thus kept at a distance from each other through contact points. Hence, flow channels are formed. In these flow channels, fluid media, such as a first and second fluid media are lead so that heat transfer is obtained between such media.

A plurality of brazed plate heat exchangers with a pressed corrugated pattern having ridges and grooves in a herringbone pattern is known in the prior art. However, there is a need to improve such prior art heat exchangers.

It is the object of the present invention to provide a plate heat exchanger with favourable flow distribution, pressure drop and heat transfer between the fluid media.

SUMMARY OF THE INVENTION

According to the invention, the above object is achieved by a brazed plate heat exchanger (BPHE) comprising a plurality of rectangular first and second heat exchanger plates, wherein the first heat exchanger plates are formed with a first pattern of ridges and grooves, and the second heat exchanger plates are formed with a second pattern of ridges and grooves providing contact points between at least some crossing ridges and grooves of neighbouring plates under formation of interplate flow channels for fluids to exchange heat, said interplate flow channels being in selective fluid communication through port openings, characterised in that the first and second patterns of ridges and grooves are corrugated patterns of obliquely extending straight lines or said first pattern is a first herringbone pattern and said second pattern is a second herringbone pattern, the first pattern of ridges and grooves is different from the second pattern of ridges and grooves, so that an interplate flow channel volume on one side of the first heat exchanger plates is different from an interplate flow channel volume on the opposite side of the first heat exchanger plates, and the first pattern of ridges and grooves exhibits a first angle between the ridge and an imaginary line across the first heat exchanger plate, perpendicular to long sides of said plate, and the second pattern of ridges and grooves exhibits a second angle between the ridge and an imaginary line across the second heat exchanger plate, perpendicular to long sides of said plate, wherein the second angle is different from the first angle, the grooves of the first heat exchanger plates are formed with identical corrugation depth, wherein first grooves of the second heat exchanger plates are formed with a first depth, and second grooves of the second heat exchanger plates are formed with a second depth different from the first depth, and brazing points between the first and second heat exchanger plates are elongated and arranged in a first angle in relation to a longitudinal direction of the plates in the interplate flow channels having bigger volume and in a second angle in relation to a longitudinal direction of the plates in the interplate flow channels having smaller volume, wherein the first angle is bigger than the second angle. The combination of different interplate flow channel volumes on opposite sides of the plates and at least two different plate patterns having different angles result in a BPHE with favourable properties for fluid distribution, wherein the fluid flow distribution and pressure drop can be balanced to achieve efficient heat exchange. This makes it possible to achieve different properties in interplate flow channels on opposite sides of the same plate, wherein the flow and pressure drop on one side can be different from the opposite side. Also, the different flow channel volumes on opposite sides of the plates can be used for different types of medias, such as a liquid in one and a gas in the other.

When a refrigerant start to evaporate it is transferred from a liquid state to a vapour state. The liquid has a density that is much higher than the vapour density. For example R410A at Tdew=5°C has 32 times higher density for the liquid than the vapour. This also mean that the vapour will move in a channel at velocities that are 32 times higher than the liquid. This will automatically lead to the dynamic pressure drop for the vapour being 32 times higher than for the liquid, i.e. vapour creates much higher pressure drop for all kind of refrigerants.

The performance (Temperature Approach, TA) of a heat exchanger is defined as the water outlet temperature (at the inlet of the heat exchanger channel) minus the evaporation temperature (Tdew) at the outlet of the heat exchanger channel. A high pressure drop along the heat exchanger surface results in different local saturation temperatures that will result in a relatively large total difference in refrigerant temperature between the inlet and outlet of the channel. The temperature will be higher at the inlet of the channel. This will have a direct, detrimental impact on the performance of the heat exchanger, since a higher inlet refrigerant temperature (due to too high channel pressure drop) makes it harder to cool the outlet water to the correct temperature. The only way for the system to compensate for the too high refrigerant inlet temperature is by lowering the evaporation temperature until correct water outlet temperature can be reached. By creating pattern for heat exchanger channels that have high heat transfer characteristics and at the same time have low pressure drop characteristics, a higher performance can be reached for the heat exchanger. A lower overall refrigerant pressure drop in the channel will not only improve the heat exchanger performance it will also have a positive impact on the total system performance and, hence, the energy consumption.

At least one of the first and second heat exchanger plates can be an asymmetric heat exchanger plate. Alternatively, the first heat exchanger plates are formed with another corrugation width than the second heat exchanger plates. The first heat exchanger plate can be a symmetric heat exchanger plate, wherein the second heat exchanger plate can be an asymmetric heat exchanger plate. Hence, first grooves of the second heat exchanger plates can be formed with a first depth, and second grooves of the second heat exchanger plates can be formed with a second depth different from the first depth. Through the combination of different angles and corrugation depth patterns, the fluid flow distribution and pressure drop can be customized for the application to achieve efficient heat exchange. The patterns of ridges and grooves can be herringbone patterns, wherein the angles of the pattern of ridges and grooves are chevron angles.

Furthermore, the depths of the first and second heat exchanger plates differ from each other in a way that the interplate flow channels have different sizes seen in cross section, wherein the interplate flow channels have different volumes on opposite sides of the plates. Hence, the interplate flow channels can have different cross section areas on opposite sides of the plates. This provides an asymmetric plate heat exchanger that combines favourable heat transfer with low pressure drop to achieve a more efficient heat exchanger for various purposes, such as for heating, refrigeration or a reversible refrigeration system.

The first and second angles, such as first and second chevron angles, can be 0-90°, 25-70° or 30-45°. Hence, the angles can be selected to achieve favourable fluid distribution. The difference between the first and second angles can be 2-35°.

Disclosed is also the use of a brazed plate heat exchanger according to the present invention for evaporation or condensation of media.

Further characteristics and advantages of the present invention will become apparent from the description of the embodiments below, the appended drawings and the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention will be described with reference to appended drawings, wherein:

Fig. 1 is a schematic and exploded perspective view of a heat exchanger according to one embodiment of the present invention,

Fig. 2 is an exploded perspective view of a part of the heat exchanger of Fig. 1, illustrating a first heat exchanger plate and a second heat exchanger plate of the heat exchanger,

Fig. 3 is a schematic section view of a part of the first heat exchanger plate according to one embodiment, illustrating identical depth of grooves of the first heat exchanger plate,

Fig. 4 is a schematic section view of a part of the second heat exchanger plate according to one embodiment, illustrating an alternating depth of grooves of the second heat exchanger plate,

Fig 5 is a schematic section view of a part of a heat exchanger comprising first and second heat exchanger plates according to one embodiment, wherein the first and second heat exchanger plates are alternatingly arranged,

Fig. 6a is a schematic front view of the first heat exchanger plate according to one embodiment, illustrating a corrugated herringbone pattern thereof having a first chevron angle,

Fig. 6b is a schematic front view of the first heat exchanger plate according to an alternative embodiment, illustrating a corrugated pattern thereof having a first angle,

Fig. 7a is a schematic front view of the second heat exchanger plate according to one embodiment, illustrating a corrugated herringbone pattern thereof having a second chevron angle,

Fig. 7b is a schematic front view of the second heat exchanger plate according to an alternative embodiment, illustrating a corrugated pattern thereof having a second angle,

Fig. 8 is a schematic view of the first heat exchanger plate arranged on the second heat exchanger plate, illustrating contact points between them according to the example of Fig. 5,

Fig. 9 is a schematic view of the second heat exchanger plate arranged on the first heat exchanger plate, illustrating contact points between them according to the example of Fig. 5,

Fig. 10 is a schematic cross section view of a part of a heat exchanger comprising first and second heat exchanger plates according to another embodiment,

Fig. 11 is a schematic cross section view of a part of a heat exchanger comprising first and second heat exchanger plates according to another embodiment,

Fig. 12 is a schematic cross section view of a part of a heat exchanger comprising first and second heat exchanger plates according to yet another embodiment, and

Fig. 13 is a schematic cross section view of a part of a stack of heat exchanger plates of first and second heat exchanger plates having different corrugation depths according to another embodiment.

DESCRIPTION OF EMBODIMENTS

With reference to Fig. 1 a brazed plate heat exchanger 100 is illustrated according to one embodiment, wherein a part thereof is illustrated more in detail in Fig. 2. The heat exchanger 100 comprises a plurality of first heat exchanger plates 110 and a plurality of second heat exchanger plates 120 stacked in a stack to form the heat exchanger 100. The first and second heat exchanger plates 110, 120 are arranged alternatingly, wherein every other plate is a first heat exchanger plate 110 and every other plate is a second heat exchanger plate 120. Alternatively, the first and second heat exchanger plates are arranged in another configuration together with additional heat exchanger plates. The heat exchanger 100 is an asymmetric plate heat exchanger.

The heat exchanger plates 110, 120 are made from sheet metal and are provided with a pressed pattern of ridges R1, R2a, R2b and grooves G1, G2a, G2b such that interplate flow channels for fluids to exchange heat are formed between the plates when the plates are stacked in a stack to form the heat exchanger 100 by providing contact points between at least some crossing ridges and grooves of neighbouring plates 110, 120 under formation of the interplate flow channels for fluids to exchange heat. The pressed pattern of Figs. 1 and 2 is a herringbone pattern. However, the pressed pattern may also be in the form of obliquely extending straight lines. In any case , the pressed pattern of ridges and grooves is a corrugated pattern. The pressed pattern is adapted to keep the plates 110, 120 on a distance from one another, except from the contact points, to form the interplate flow channels.

In the illustrated embodiment, each of the heat exchanger plates 110, 120 is surrounded by a skirt S, which extends generally perpendicular to a plane of the heat exchanger plate and is adapted to contact skirts of neighbouring plates in order to provide a seal along the circumference of the heat exchanger. Apart from the skirt S and ports O1-O4 practically the remaining part of the heat exchanger plates 110, 120 forms a heat exchanging surface 130, 140.

The heat exchanger plates 110, 120 are arranged with port openings O1-O4 for letting fluids to exchange heat into and out of the interplate flow channels. In the illustrated embodiment, the heat exchanger plates 110, 120 are arranged with a first port opening O1, a second port opening O2, a third port opening O3 and a fourth port opening O4. Areas surrounding the port openings O1 to O4 are provided at different heights such that selective communication between the port openings and the interplate flow channels is achieved. In the heat exchanger 100, the areas surrounding the port openings O1-O4 are arranged such that the first and second port openings O1 and O2 are in fluid communication with one another through some interplate flow channels, whereas the third and fourth port openings O3 and O4 are in fluid communication with one another by neighboring interplate flow channels. In the illustrated embodiment, the heat exchanger plates 110, 120 are rectangular with rounded corners, wherein the port openings O1-O4 are arranged near the corners. Alternatively, the heat exchanger plates 110, 120 are square, e.g. with rounded corners. Alternatively, the heat exchanger plates 110, 120 are circular, oval or arranged with other suitable shape, wherein the port openings O1-O4 are distributed in a suitable manner. In the illustrated embodiment, each of the heat exchanger plates 110, 120 is formed with four port openings O1-O4.

Please note that in other embodiments of the invention, the number of port openings may be larger than four, i.e. six, eight or ten. For example, the number of port openings is at least six, wherein the heat exchanger is configured for providing heat exchange between at least three fluids. Hence, according to one embodiment, the heat exchanger is a three circuit heat exchanger having at least six port openings and in addition being arranged with or without at least one integrated suction gas heat exchanger. Alternatively, the number of port openings is at least six, wherein the heat exchanger includes one or more integrated suction gas heat exchangers.

In the illustrated embodiment, the heat exchanger 100 comprises only the first and second heat exchanger plates 110, 120. Alternatively, the heat exchanger 100 comprises a third and optionally also a fourth heat exchanger plate, wherein the third and optional fourth heat exchanger plates are arranged with different pressed patterns than the first and second heat exchanger plates 110, 120, and wherein the heat exchanger plates are arranged in a suitable order.

In the illustrated embodiment, the heat exchanger 100 also comprises a start plate 150 and an end plate 160. The start plate 150 is formed with openings corresponding to the port openings O1-O4 for letting fluids into and out of the interplate flow channels formed by the first and second heat exchanger plates 110, 120. For example, the end plate 160 is a conventional end plate.

With reference to Fig. 3, a section view of the first heat exchanger plate 110 according to one embodiment is illustrated schematically. The first heat exchanger plates 110 are formed with a first pattern of ridges R1 and grooves G1. The grooves G1 of the first heat exchanger plates are formed with identical depth D1. Hence, all grooves G1 are formed with the same depth D1. For example, the depth D1 is 0.5-5 mm, such as

1-3 mm or 1.5-3 mm. For example, all ridges R1 are formed with the same height in a corresponding manner. In other words, the corrugation depth of the first heat exchanger plates 110 is symmetrical and similar throughout the plate or at least substantially throughout the plate.

With reference to Fig. 4, a section view of the second heat exchanger plate 120 is illustrated schematically according to one embodiment. For example, all second heat exchanger plates 120 are identical. The second heat exchanger plates 120 are formed with a second pattern of first and second ridges R2a, R2b and first and second grooves G2a, G2b. The first and second grooves G2a, G2b of the second heat exchanger plates 120 are formed with different depths, wherein the first grooves G2a are formed with a first depth D2a, and the second grooves G2b are formed with a second depth D2b, wherein the second depth D2b is different from the first depth D2a. For example, the first depth D2a is 0.5-5 mm, such as 0.5-3 mm, wherein the second depth D2b is 30-80% of the first depth D2a, such as 40-60% thereof. The ridges R2a, R2b have different heights in a corresponding manner. In the illustrated embodiment, the first depth D2a is larger than the second depth D2b. The first and second grooves G2a, G2b are arranged alternatingly. Alternatively, the first and second grooves G2a, G2b, and optionally further grooves having other depths, are arranged in any desired pattern. For example, the pattern of ridges and grooves of the second heat exchanger plates 120 is asymmetrical, i.e. the second heat exchanger plates 120 would form an asymmetric heat exchanger when combined with first heat exchanger plates 110 such as shown below with reference to Fig. 5. According to one embodiment, the entire heat exchanging surface of the second heat exchanger plates 120 is formed with the second pattern of ridges and grooves having at least two different corrugation depths D2a, D2b of the grooves.

With reference to Fig. 5 a plurality of the first and second heat exchanger plates 110, 120 have been stacked to schematically illustrate formation of interplate flow channels according to one embodiment. In the illustrated embodiment, every other plate is a first heat exchanger plate 110 and the remaining plates are second heat exchanger plates 120, wherein the first and second heat exchanger plates are arranged alternatingly to form an asymmetric heat exchanger 100, wherein the interplate flow channels are formed with different volumes. Alternatively, the different volumes of the interplate flow channels are formed by an extended profile on the same press depth or corrugation depth. For example, the first and second heat exchanger plates are provided with different corrugation depths. For example, the first and/or second heat exchanger plates is/are asymmetric heat exchanger plates. Alternatively, the first and/or second heat exchanger plates is/are symmetric heat exchanger plates.

With reference to Fig. 6a the first pattern of ridges R1 and grooves G1 of the first heat exchanger plate 110 is illustrated schematically. Said pattern is a pressed herringbone pattern, wherein the ridges R1 and grooves G1 are arranged with two inclined legs meeting in an apex, such as a centrally arranged apex, forming an arrow pattern. For example, the apices are distributed along an imaginary centre line, such as a longitudinal centre line of a rectangular heat exchanger plate. The pattern of the first heat exchanger plate 110, i.e. the first pattern of ridges R1 and grooves G1, exhibits a first chevron angle β1. The chevron angle is the angle between the ridge and an imaginary line across the plate, perpendicular to the long sides of a rectangular plate, which is illustrated schematically by means of the dashed line C. For example, the chevron angle is the same on both sides of the apex. For example, the entire or substantially entire first pattern of ridges and grooves is formed with the first chevron angle β1 throughout the heat exchanging surface 130 of the plate. For example, the first chevron angle β1 is between 0° and 90°, 25° and 70° or 40° and 65°.

With reference to Fig. 6b the first pattern of ridges R1 and grooves G1 of the first heat exchanger plate 110 is illustrated schematically according to an alternative embodiment, wherein the pressed pattern is in the form of obliquely extending straight lines. Hence, the pressed pattern of ridges and grooves is a corrugated pattern of obliquely extending straight lines. The obliquely extending straight lines of the first heat exchanger plates 110 are arranged in the angle β1.

With reference to Fig. 7a the second pattern of ridges R2a, R2b and grooves G2a, G2b of the second heat exchanger plate 120 is illustrated schematically. Said second pattern is a pressed herringbone pattern as described above with reference to the first heat exchanger plate 110 but with a second chevron angle β2 different from the first chevron angle β1. Hence, the second heat exchanger plate 120 is arranged with a herringbone pattern having a different angle than the first heat exchanger plate. For example, the second chevron angle β2 is between 0° and 90°, 25° and 70° or 40° and 65°. For example, the entire or substantially entire pattern of ridges and grooves of the second heat exchanger plates 120 is formed with the second chevron angle β2 throughout the heat exchanging surface 140 of the plate.

With reference to Fig. 7b the second pattern of ridges R1 and grooves G1 of the second heat exchanger plate 120 is illustrated schematically according to an alternative embodiment, wherein the pressed pattern is in the form of obliquely extending straight lines. Hence, the pressed pattern of ridges and grooves is a corrugated pattern of obliquely extending straight lines. The obliquely extending straight lines of the second heat exchanger plates 120 are arranged in the angle β2.

Hence, the first and second heat exchanger plates 110, 120 are formed with different chevron angles β1, β2 and different pressed patterns resulting in different interplate volumes. For example, the first and second heat exchanger plates 110, 120 are provided with different corrugation depths. Alternatively or in addition, the first and second heat exchanger plates 110, 120 are provided with different corrugation frequencies. For example, the first and second heat exchanger plates 110, 120 are provided with the same corrugation depth but different corrugation frequencies. Hence, the first and second heat exchanger plates 110, 120 are provided with different corrugation depths and/or different corrugation frequencies. For example, one of the first and second heat exchanger plates 110, 120 is a symmetric heat exchanger plate, wherein the other is asymmetric. Alternatively, both the first and second heat exchanger plates 110, 120 are asymmetric. Alternatively, both the first and second heat exchanger plates 110, 120 are symmetric.

In Figs. 8 and 9 contact points between the first and second plates 110, 120 are illustrated schematically using the example of Fig. 5. In and/or around the contact points 170 between crossing ridges and grooves brazing joints 170 are formed. In the embodiment of Figs. 8 and 9 brazing joints 170 are formed in all contact points.

Alternatively, brazing joints 170 are formed in only some of the contact points. In Fig. 8 the first heat exchanger plate 110 is arranged on the second heat exchanger plate 120, wherein contact points are formed in a first pattern. In Fig. 8 all crossings between the ridges R1 of the first heat exchanger plate 110 and ridges or grooves of the second heat exchanger plate 120 result in a contact point.

Fig. 9 is a schematic view of the second heat exchanger plate 120 arranged on the first heat exchanger plate 110, wherein contact points are formed in a second pattern. In Fig. 9 only crossings between the first ridges R2a of the second heat exchanger plate 120 result in a contact point, which may form a brazing joint 170, wherein the second ridges R2b are arranged with a gap to the crossing ridges or grooves of the first heat exchanger plate 110. Hence, and no contact points are formed, and no brazing joint is formed, between the second ridges R2b of the second heat exchanger plate 120 and the first heat exchanger plate 110. In Fig. 9 all contact points are showed with a brazing joint 170.

According to the invention, the brazing joints 170 between the first and second heat exchanger plates 110, 120 are elongated, such as oval, wherein the brazing joints 170 are arranged in a first orientation in the interplate flow channels having bigger volume and in a second orientation in the interplate flow channels having smaller volume to provide a favourable pressure drop in the desired interplate flow channels. The brazing joints 170 are arranged in a first angle in relation to a longitudinal direction of the plates 110, 120 in the interplate flow channels having bigger volume and in a second angle in the remaining interplate flow channels. According to the invention, the first angle is bigger than the second angle.

With reference to Fig. 10 a cross section of a part of a heat exchanger comprising first and second heat exchanger plates 110, 120 according to another embodiment is illustrated schematically. In the embodiment of Fig. 10 the first heat exchanger plate 110 is a symmetric heat exchanger plate, wherein the second heat exchanger plate 120 is an asymmetric heat exchanger plate as described above. Hence, the corrugation depth of the first heat exchanger plate 110 is constant, wherein the corrugation depth of the second heat exchanger plate 120 is varying. The second heat exchanger plate 120 is formed with at least two different corrugation depths. Also, the first and second heat exchanger plates 110, 120 are formed with corrugated patterns different angles, such as chevron angles, as described above. In the embodiment of Fig. 10 the chevron angle of the first heat exchanger plate 110 is 54 degrees, wherein the chevron angle of the second heat exchanger plate 120 is 61 degrees. For example, neighbouring interplate volumes are different, so that the interplate volume on one side of the first heat exchanger plates 110 is different from the interplate volume on the opposite side of the first heat exchanger plates 110. Of course, this also apply for the second heat exchanger plates 120. Hence, the interplate volume between the first and second heat exchanger plates is different from the interplate volume between the second and first heat exchanger plates. Similarly, a cross section area on one side of the first heat exchanger plates 110 is different from the cross section area on the opposite side of the first heat exchanger plates 110.

With reference to Fig. 11 a cross section of a part of a heat exchanger comprising first and second heat exchanger plates 110, 120 according to yet another embodiment is illustrated schematically. In the embodiment of Fig. 11 the first heat exchanger plate 110 is a symmetric heat exchanger plate, wherein the second heat exchanger plate 120 is an asymmetric heat exchanger plate as described above. In the embodiment of Fig. 11 the chevron angle of the first heat exchanger plate 110 is 45 degrees, wherein the chevron angle of the second heat exchanger plate 120 is 61 degrees.

With reference to Fig. 12 a cross section of a part of a heat exchanger comprising first and second heat exchanger plates 110, 120 according to yet another embodiment is illustrated schematically. In the embodiment of Fig. 12 the first heat exchanger plate 110 is an asymmetric heat exchanger plate, wherein the second heat exchanger plate 120 is also an asymmetric heat exchanger plate. In the embodiment of Fig. 12 the chevron angle of the first heat exchanger plate 110 is different from the chevron angle of the second heat exchanger plate 120 as described above. Also, the interplate flow channels have different volumes as described above. For example, the brazing joints are elongated, such as oval, and arranged in a first orientation in the interplate flow channels having bigger volume and in a different, second orientation in the interplate flow channels having smaller volume.

With reference to Fig. 13 a cross section of a part of a stack of first and second heat exchanger plates 110, 120 according to yet another embodiment is illustrated schematically. In the embodiment of Fig. 13 the first and second heat exchanger plates 110, 120 are provided with different corrugation depths. The first heat exchanger plate

110 is a symmetric heat exchanger plate, wherein the second heat exchanger plate 120 is an asymmetric heat exchanger plate. Alternatively, both the first and second heat exchanger plates 110, 120 are symmetric or asymmetric. The chevron angle of the first heat exchanger plate 110 is different from the chevron angle of the second heat exchanger plate 120 and the interplate flow channel volumes formed by the first and second heat exchanger plates 110, 120 when brazed together in brazing joints are different.

The heat exchanger according to the present invention is, e.g. used for condensation or evaporation, wherein at least one media at some point is in gaseous phase. For example, the heat exchanger is used for heat exchange, wherein condensation or evaporation takes place in the interplate flow channels of bigger volume. For example, a liquid media, such as water or brine, is conducted through the interplate flow channels having smaller volume.

CLAIMS

1. A brazed plate heat exchanger (100) comprising a plurality of rectangular first and second heat exchanger plates (110, 120), wherein the first heat exchanger plates (110) are formed with a first pattern of ridges and grooves, and the second heat exchanger plates (120) are formed with a second pattern of ridges and grooves providing contact points between at least some crossing ridges and grooves of neighbouring plates under formation of interplate flow channels for fluids to exchange heat, said interplate flow channels being in selective fluid communication through port openings, **characterised** in that

the first and second patterns of ridges and grooves are corrugated patterns of obliquely extending straight lines or said first pattern is a first herringbone pattern and said second pattern is a second herringbone pattern,

the first pattern of ridges and grooves is different from the second pattern of ridges and grooves, so that an interplate flow channel volume on one side of the first heat exchanger plates (110) is different from the interplate flow channel volume on the opposite side of the first heat exchanger plates (110),

the first pattern of ridges and grooves exhibits a first angle ($\beta 1$) between the ridge and an imaginary line across the first heat exchanger plate, perpendicular to long sides of said plate, and the second pattern of ridges and grooves exhibits a second angle ($\beta 2$) between the ridge and an imaginary line across the second heat exchanger plate, perpendicular to long sides of said plate, wherein the second angle ($\beta 2$) is different from the first angle ($\beta 1$),

the grooves (G1) of the first heat exchanger plates (110) are formed with identical corrugation depth (D1), wherein first grooves (G2a) of the second heat exchanger plates (120) are formed with a first depth (D2a), and second grooves (G2b) of the second heat exchanger plates (120) are formed with a second depth (D2b) different from the first depth (D2a), and

brazing points (170) between the first and second heat exchanger plates (110, 120) are elongated and arranged in a first angle in relation to a longitudinal direction of the plates in the interplate flow channels having bigger volume and in a second angle in relation to a longitudinal direction of the plates in the interplate flow channels having smaller volume, wherein the first angle is bigger than the second angle.

2. The brazed plate heat exchanger of claim 1, wherein a depth (D1) of the grooves (G1) of the first heat exchanger plate (110) is in the range of 0.5-5 mm, preferably in the range of 0.6-2 mm.

3. The brazed plate heat exchanger of any of claims 1 or 2, wherein a first depth (D2a) of the second heat exchanger plate (120) is in the range of 0.5-5 mm, preferably in the range of 0.6-3 mm, and a second depth (D2b) of the second heat exchanger plate (120) is in the range of 30-80% of the first depth (D2a).

4. The brazed plate heat exchanger of any of the preceding claims, wherein the first angle (β1) of the first pattern of ridges and grooves is in the range of 25-70°.

5. The brazed plate heat exchanger of any of the preceding claims, wherein the second angle (β2) of the second pattern of ridges and grooves is in the range of 25-70°.

6. The brazed plate heat exchanger of any of the preceding claims, wherein a difference between the first angle (β1) of the first pattern of ridges and grooves and the second angle (β2) of the second pattern of ridges and grooves is in the range of 2-35°.

7. The brazed plate heat exchanger of any of the preceding claims, wherein the heat exchanger plates (110, 120) are provided with different corrugation widths.

8. Use of a brazed plate heat exchanger according to any of claims 1-7 for evaporation or condensation of media.

9. Use of a brazed heat exchanger according to claim 8, wherein media is evaporated or condensed in the interplate flow channels of smaller volume, wherein liquid media is conducted to the interplate flow channels of bigger volume.

I följande bilaga finns en översättning av patentkraven till svenska. Observera att det är patentkravens lydelse på engelska som gäller.

A Swedish translation of the patent claims is enclosed. Please note that only the English claims have legal effect.

PATENTKRAV

1. Lödd plattvärmeväxlare (100) innefattande ett flertal rektangulära första och andra värmeväxlarplattor (110, 120), varvid de första värmeväxlarplattorna (110) är utformade med ett första mönster av åsar och spår, och de andra värmeväxlarplattorna (120) är utformade med ett andra mönster av åsar och spår som tillhandahåller kontaktpunkter mellan åtminstone några korsande åsar och spår hos intilliggande plattor under bildande av flödeskanaler mellan plattorna för fluider att utbyta värme, varvid nämnda flödeskanaler är i selektiv fluidförbindelse med portöppningar, **kännetecknad** av att

det första och andra mönstret av åsar och spår är korrugerade mönster av snedställda raka linjer eller det första mönstret är ett första fiskbensmönster och det andra mönstret är ett andra fiskbensmönster,

det första mönstret av åsar och spår skiljer sig från det andra mönstret av åsar och spår, så att en flödeskanalvolym mellan plattorna på ena sidan av de första värmeväxlarplattorna (110) skiljer sig från flödeskanalvolymen mellan plattorna på motsatt sida av de första värmeväxlarplattorna (110),

det första mönstret av åsar och spår uppvisar en första vinkel (β1) mellan åsen och en tänkt linje tvärs den första värmeväxlarplattan, vinkelrätt mot långsidor hos nämnda platta, och det andra mönstret uppvisar en andra vinkel (β2) mellan åsen och en tänkt linje tvärs den andra värmeväxlarplattan, vinkelrätt mot långsidor hos nämnda platta, varvid den andra vinkeln (β2) skiljer sig från den första vinkeln (β1),

spåren (G1) hos de första värmeväxlarplattorna (110) är utformade med identiskt korrugeringsdjup (D1), varvid första spår (G2a) hos de andra värmeväxlarplattorna (120) är utformade med ett första djup (D2a), och andra spår (G2b) hos de andra värmeväxlarplattorna (120) är utformade med ett andra djup (D2b) som skiljer sig från det första djupet (D2a), och

lödfogar (170) mellan de första och andra värmeväxlarplattorna (110, 120) är långsträckta och anordnade i en första vinkel relativt en längdriktning hos plattorna i flödeskanalerna med större volym och i en andra vinkel relativt en längdriktning hos plattorna i flödeskanalerna med mindre volym, varvid den första vinkeln är större än den andra vinkeln.

2. Lödd plattvärmeväxlare enligt krav 1, varvid ett djup (D1) hos den första värmeväxlarplattans (110) spår (G1) är i intervallet 0,5-5 mm, företrädesvis i intervallet 0,6-2 mm.

3. Lödd plattvärmeväxlare enligt något av krav 1 och 2, varvid ett första djup (D2a) hos den andra värmeväxlarplattan (120) är i intervallet 0,5-5 mm, företrädesvis i intervallet 0,6-3 mm, och ett andra djup (D2b) hos den andra värmeväxlarplattan (120) är i intervallet 30-80 % av det första djupet (D2a).

4. Lödd plattvärmeväxlare enligt något av föregående krav, varvid den första vinkeln (β1) hos det första mönstret av åsar och spår är i intervallet 25-70°.

5. Lödd plattvärmeväxlare enligt något av föregående krav, varvid den andra vinkeln (β2) hos det andra mönstret av åsar och spår är i intervallet 25-70°.

6. Lödd plattvärmeväxlare enligt något av föregående krav, varvid en skillnad mellan den första vinkeln (β1) hos det första mönstret av åsar och spår och den andra vinkeln (β2) hos det andra mönstret av åsar och spår är i intervallet 2-35°.

7. Lödd plattvärmeväxlare enligt något av föregående krav, varvid värmeväxlarplattorna (110, 120) är försedda med olika korrugeringsbredder.

8. Användning av en lödd plattvärmeväxlare enligt något av kraven 1-7 för förångning eller kondensering av media.

9. Användning av en lödd värmeväxlare enligt krav 8, varvid media förångas eller kondenseras i flödeskanalerna med mindre volym, varvid media i vätskeform leds till flödeskanalerna med större volym.

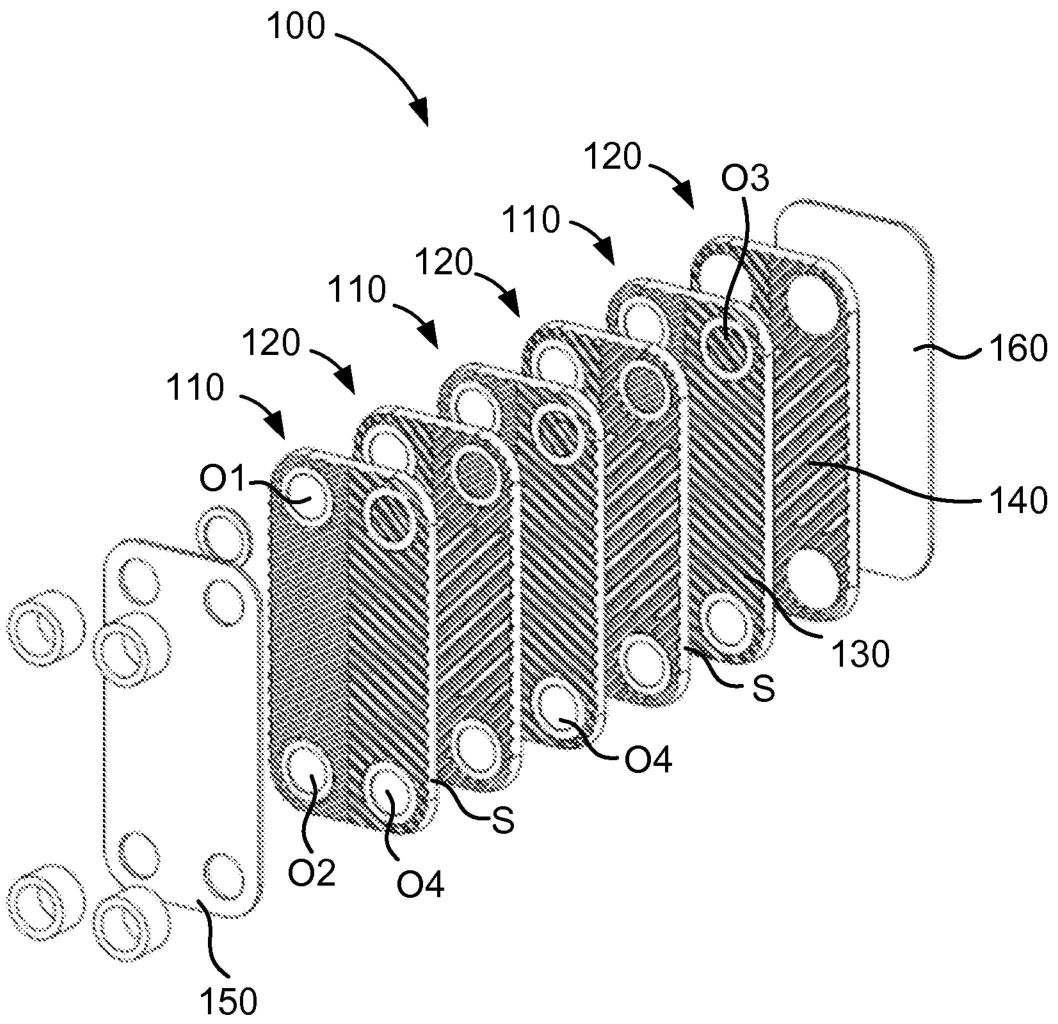


Fig. 1

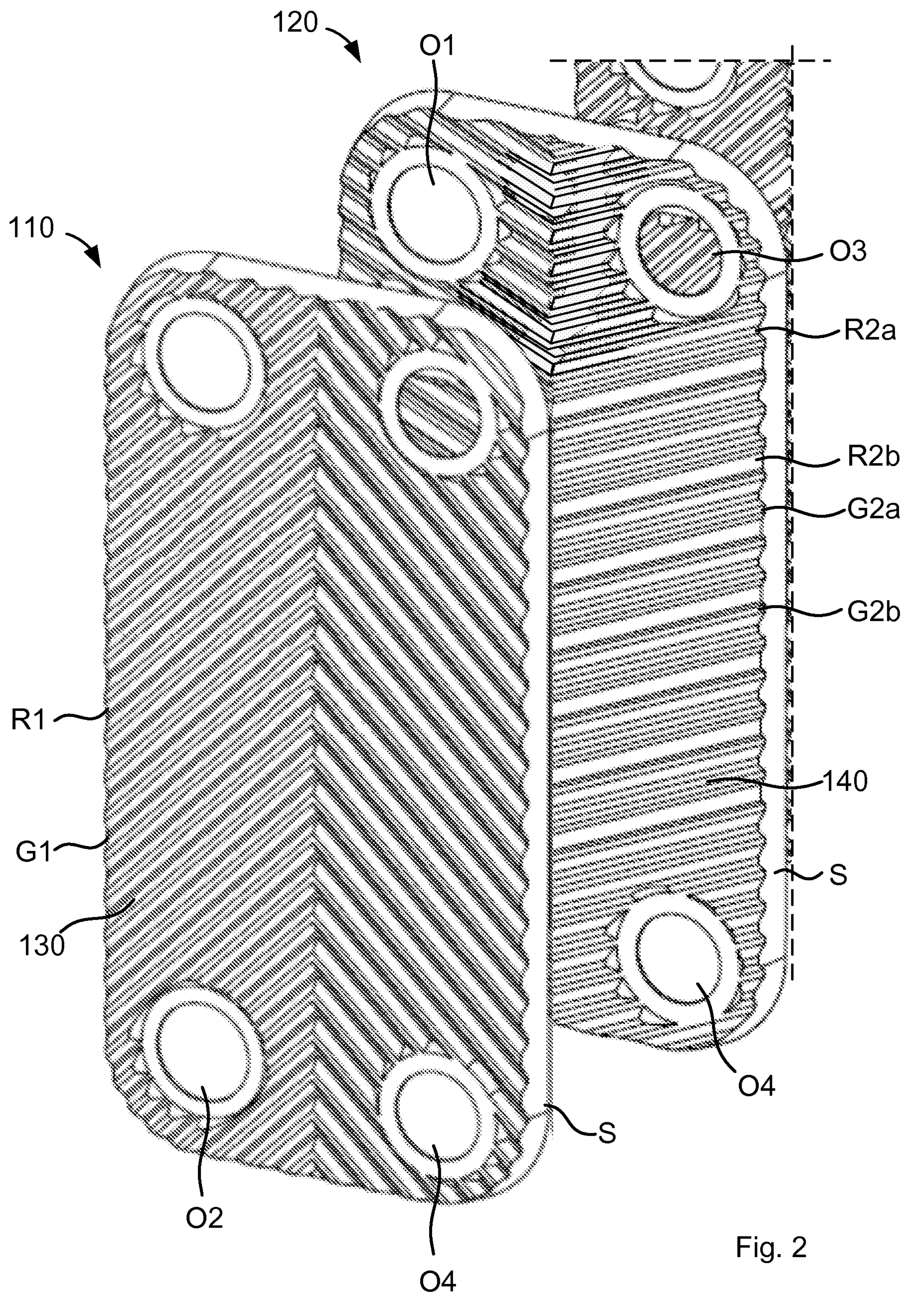


Fig. 2

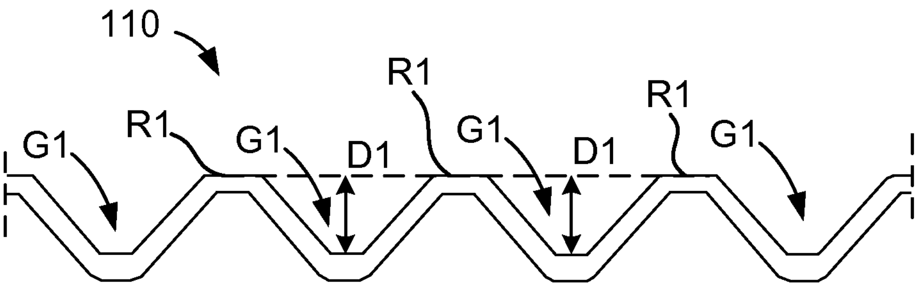


Fig. 3

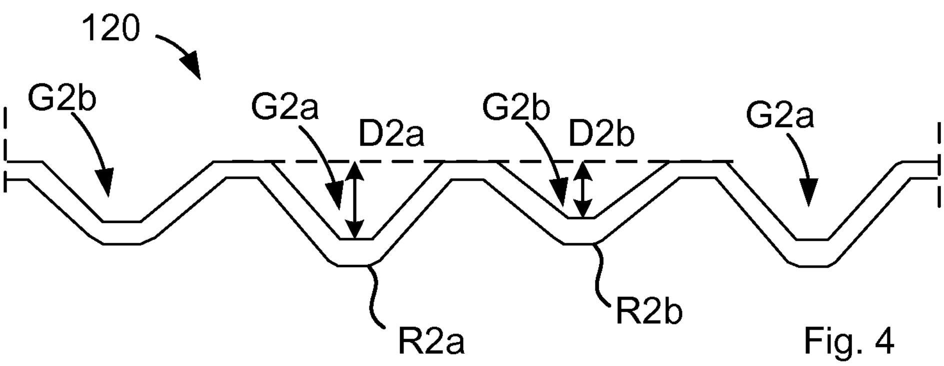


Fig. 4

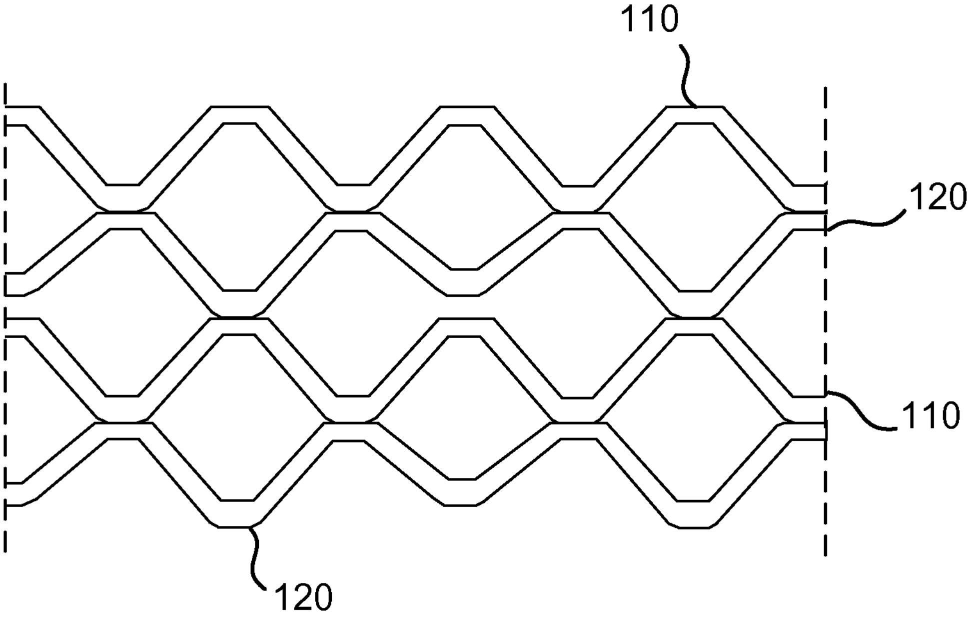


Fig. 5

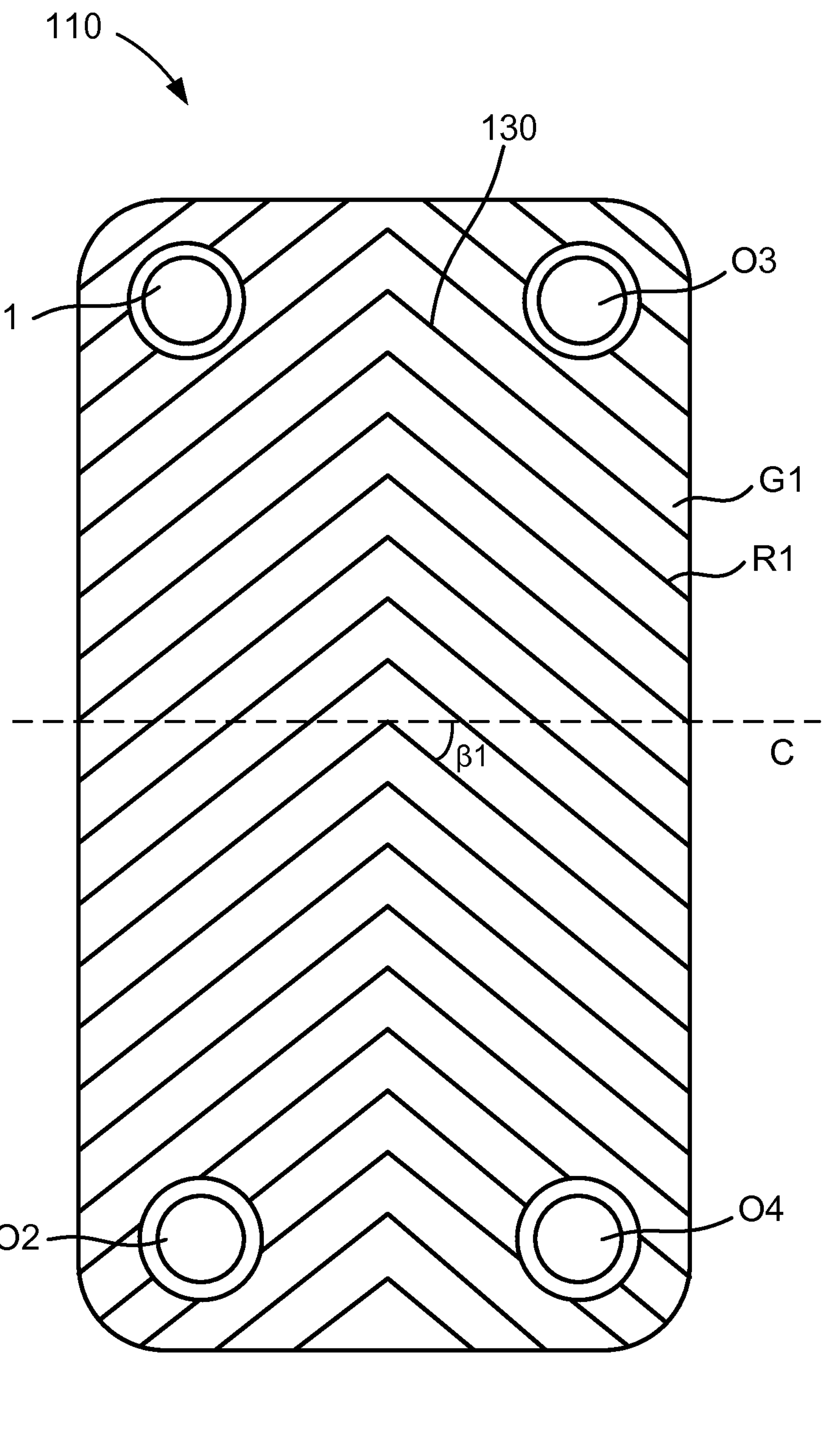


Fig. 6a

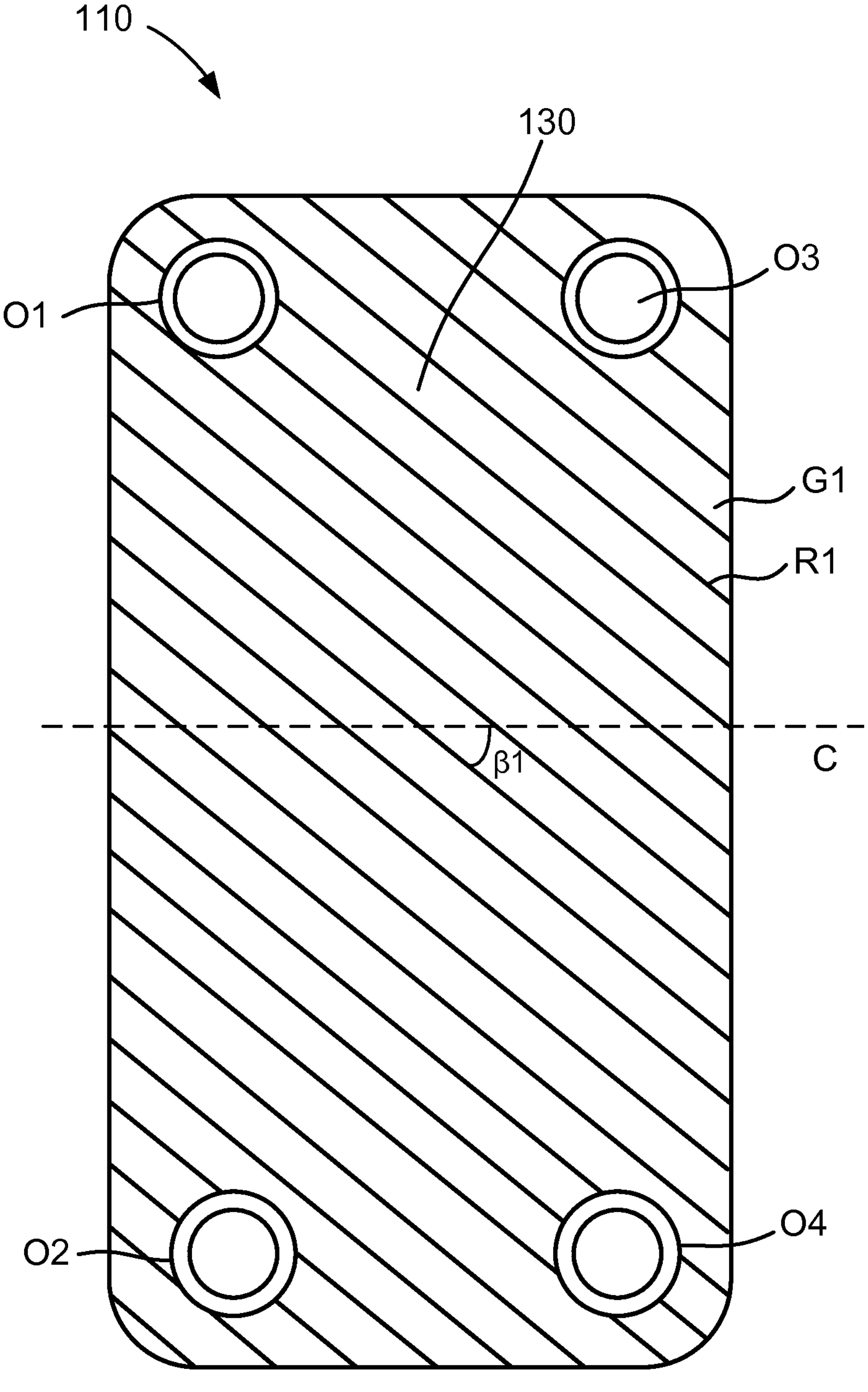


Fig. 6b

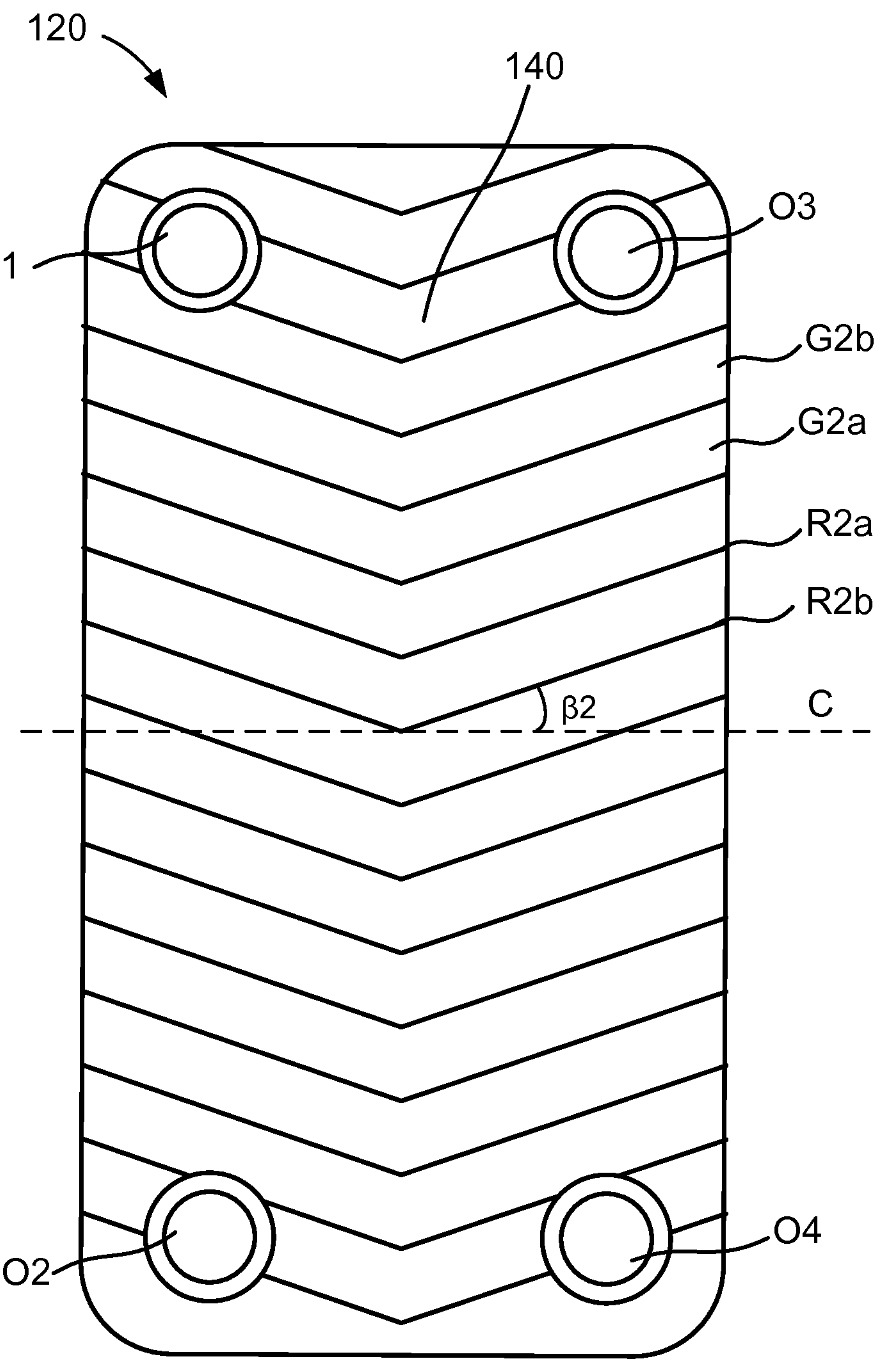


Fig. 7a

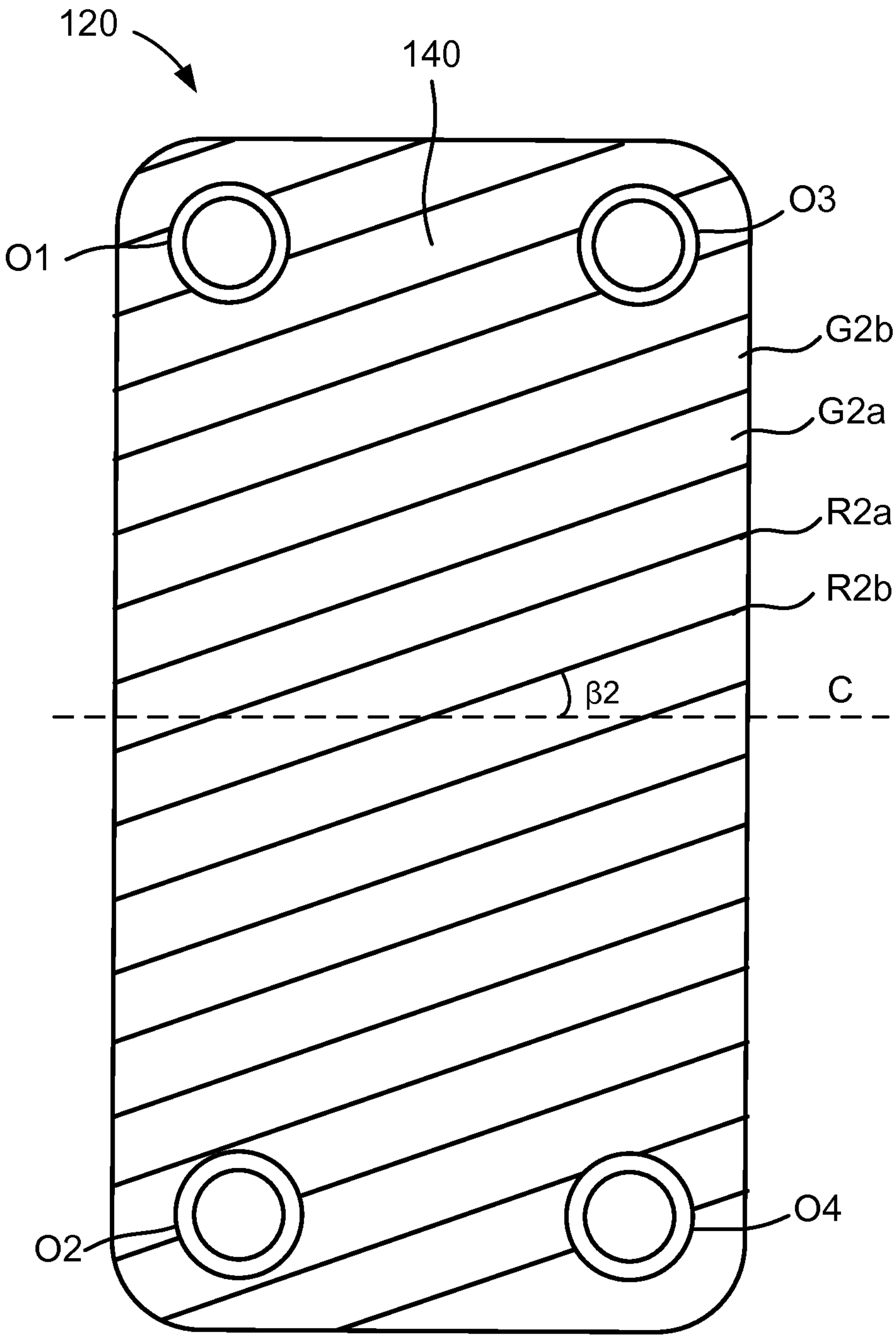


Fig. 7b

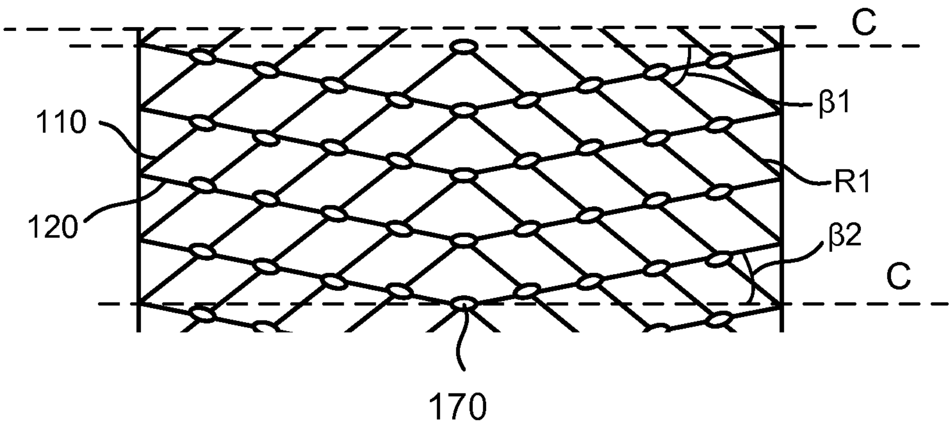


Fig. 8

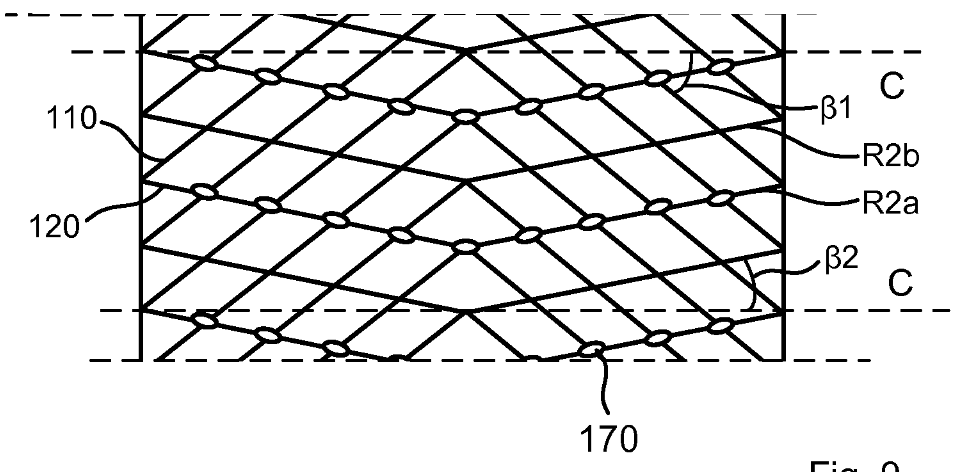


Fig. 9

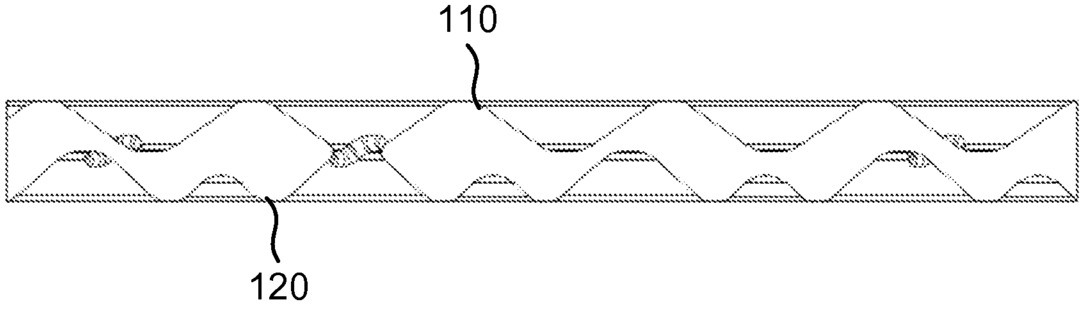


Fig. 10

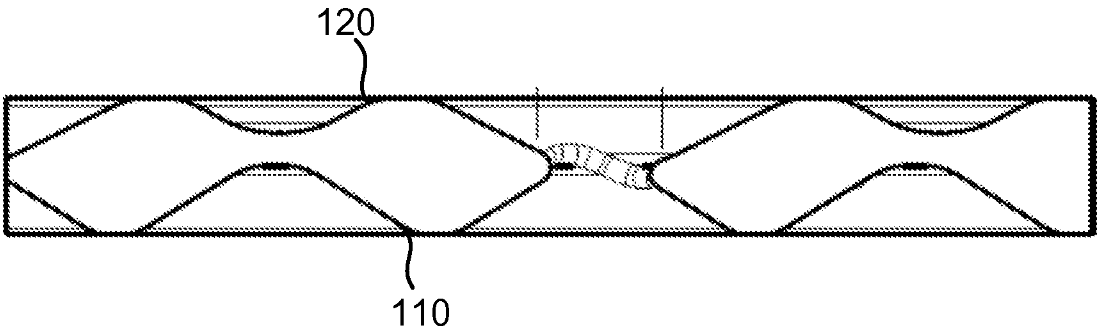


Fig. 11

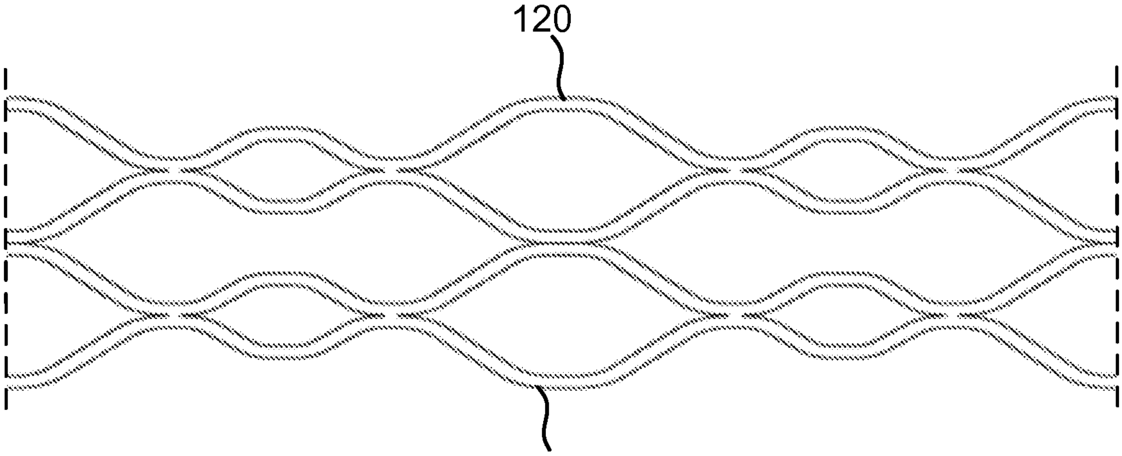


Fig. 12

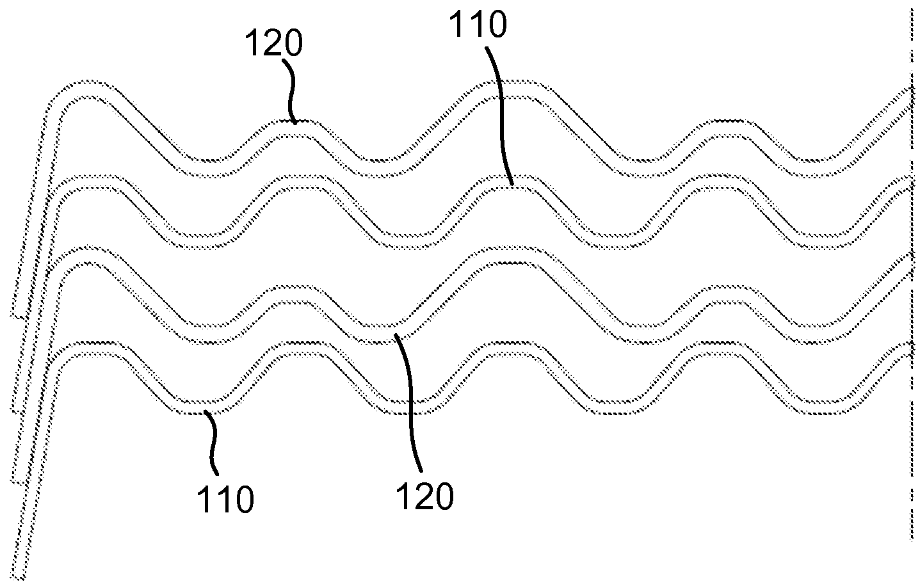


Fig. 13