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(54) HEAT SHRINK ASSEMBLY HEAT EXCHANGERS

(57) A heat exchanger assembly includes a first member (102) defining fluid passages therein for a first heat exchanger fluid. A second member (106) defines fluid passages therein for a second heat exchanger fluid. The second member (106) is engaged to the second member (106) with an interference fit. A method of assembling a heat exchanger includes thermally resizing

at least one of a first heat exchanger member and a second heat exchanger member and assembling the second heat exchanger member to the first heat exchanger member. The method includes thermally equalizing the first and second heat exchanger members to engage the second heat exchanger member to the first heat exchanger member with an interference fit.

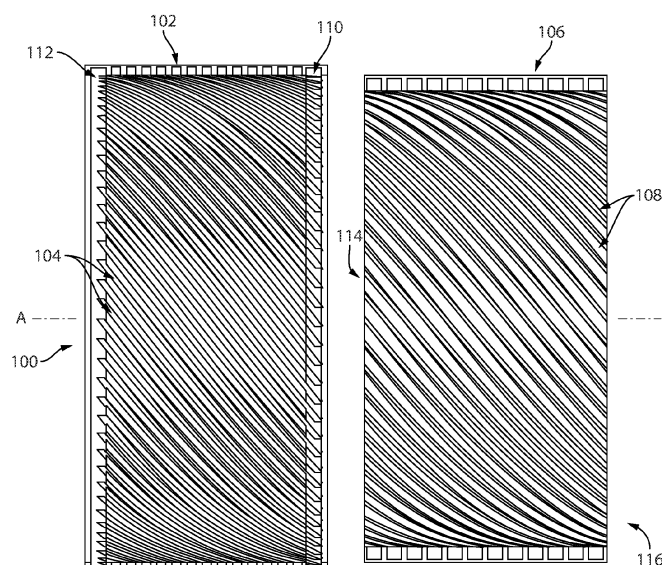


Fig. 1

Description

BACKGROUND

1. Field

[0001] The present disclosure relates to heat exchangers, and more particularly to heat exchangers for aerospace applications and the like.

2. Description of Related Art

[0002] Heat exchangers are costly to assembly because the fluids cannot cross-leak. Any manufacturing defect can present problems with cross-leaking, so assemblies must be carefully checked over before use. The conventional techniques have been considered satisfactory for their intended purpose. However, there is an ever present need for improved systems and methods for assembling heat exchangers. This disclosure provides a solution for this need.

SUMMARY

[0003] A heat exchanger assembly includes a first member defining fluid passages therein for a first heat exchanger fluid. A second member defines fluid passages therein for a second heat exchanger fluid. The second member is engaged to the first member with an interference fit.

[0004] The fluid passages of first member can be sealed against the second member by the interference fit. The fluid passages of the second member can be sealed against the first member by the interference fit.

[0005] The first and second members can be cylindrical, wherein the second member is engaged inside the first member. The fluid passages of the first and second members can be helical. The first member can define a first circumferential groove in an inner surface thereof at a first axial end thereof. The first member can define a second circumferential groove in an inner surface thereof at a second axial end thereof opposite the first axial end. The first circumferential groove can be in fluid communication with the second circumferential groove through the fluid passages of the first member.

[0006] An inlet header and an outlet header can be included, wherein the inlet header is in fluid communication with the first circumferential groove to supply fluid to the fluid passages of the first member, and wherein the outlet header is in fluid communication with the second circumferential groove to provide an outlet for fluid from the fluid passages of the first member. Each fluid passage of the second member can include a respective inlet at a first axial end of the second member, and a respective outlet at a second axial end of the second member opposite the first axial end of the second member.

[0007] The first and second members can be a first heat exchanger pair. Additional heat exchanger pairs can

be nested within the first heat exchanger pair. An outer cylindrical shell can be engaged to the first member with an interference fit. An inner cylindrical shell can be engaged inside an innermost member of the additional heat exchanger pairs with an interference fit. The additional heat exchanger pairs can be nested within the first heat exchanger pair form a circular duct housed within an outer shell.

[0008] At an end of the first and second members, the first and second members can be sealed by a weld joint, a braze joint, and/or an O-ring. The fluid passages of at least one of the first and second members can be sealed by the interference fit, and at least partially by a braze joint.

[0009] A method of assembling a heat exchanger includes thermally resizing at least one of a first heat exchanger member and a second heat exchanger member and assembling the second heat exchanger member to the first heat exchanger member. The method includes thermally equalizing the first and second heat exchanger members to engage the second heat exchanger member to the first heat exchanger member with an interference fit.

[0010] Thermally resizing can include heating the first heat exchanger member. Thermally resizing can include cooling the second heat exchanger member. The first heat exchanger member can be cylindrical, the second heat exchanger member can be cylindrical, and assembling the second heat exchanger member to the first heat exchanger member can include placing the second heat exchanger member within the first heat exchanger member.

[0011] These and other features of the systems and methods of the subject disclosure will become more readily apparent to those skilled in the art from the following detailed description of the preferred embodiments taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] So that those skilled in the art to which the subject disclosure appertains will readily understand how to make and use the devices and methods of the subject disclosure without undue experimentation, preferred embodiments thereof will be described in detail herein below with reference to certain figures, wherein:

Fig. 1 is an exploded cross-sectional side elevation view of an embodiment of a heat exchanger assembly constructed in accordance with the present disclosure, showing the first and second members prior to assembly;

Fig. 2 is a series of cross-sectional side elevation views, showing the same members as Fig. 1 at left, in the middle showing the second member being inserted into the first member, and at right showing the second member engaged with an interference fit to the first member;

Fig. 3 is a cross-sectional perspective view of the assembly of Fig. 1, showing the first and second members with additional pairs of members nested within them;

Fig. 4 is a cross-sectional side elevation view of another configuration of the nested pairs of heat exchanger members of Fig. 3, showing the fluid passages on the radially outboard surfaces of the first and second members; and

Fig. 5 is a cross-sectional perspective view of another configuration of the assembly of Fig. 3, showing nested heat exchanger pairs without an inner shell.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] Reference will now be made to the drawings wherein like reference numerals identify similar structural features or aspects of the subject disclosure. For purposes of explanation and illustration, and not limitation, a partial view of an embodiment of a heat exchanger assembly in accordance with the disclosure is shown in Fig. 1 and is designated generally by reference character 100. Other embodiments of systems in accordance with the disclosure, or aspects thereof, are provided in Figs. 2-5, as will be described. The systems and methods described herein can be used to facilitate assembly and quality control of heat exchanger assemblies using thermal resizing and interference fits.

[0014] The heat exchanger assembly 100 includes a first member 102 defining fluid passages 104 therein for a first heat exchanger fluid, e.g. a colder fluid in heat exchange. A second member 106 defines fluid passages 108 therein for a second heat exchanger fluid, e.g. a hotter fluid in heat exchange. The first and second members 102, 106 are cylindrical, and as will be discussed further below, the second member 106 engages inside the first member 102. The fluid passages 104, 108 are helical, and are defined on radially inward facing surfaces of the members 102, 106.

[0015] The first member 102 defines a first circumferential groove 110 in an inner surface thereof at a first axial end thereof relative to axis A. The first member 102 also defines a second circumferential groove 112 in the inner surface thereof at a second axial end thereof opposite the first axial end. The first circumferential groove 110 is in fluid communication with the second circumferential groove 112 through the fluid passages 104 of the first member 102. Each fluid passage of the second member 106 includes a respective inlet 114 at a first axial end of the second member 106, and a respective outlet 116 at a second axial end of the second member 106 opposite the first axial end of the second member, relative to axis A.

[0016] With reference now to Fig. 2, a method of assembling a heat exchanger includes thermally resizing at least one of the first heat exchanger member 102 and the second heat exchanger member 106 at stage 1 of Fig. 2. Thermally resizing includes heating the first heat

exchanger member 102 to thermally expand it, and/or cooling the second heat exchanger member 106 to thermally contract it, e.g. using a cryogenic liquid bath or the like. With the members 102, 106 thermally resized, they can be assembled together as indicated by stage 2 in Fig. 2, until the second member 106 is fully in place as shown by stage 3 in Fig. 2. At this point, the members 102, 106 can be thermally equalized to engage the second heat exchanger member 106 to the first heat exchanger member 102 with an interference fit.

[0017] Although shapes other than cylindrical are contemplated, in the case of cylinders, the outer diameter of the second member 106 at a given temperature should be slightly larger than the inner diameter of the first member 102 at the given temperature to ensure the interference fit results after thermal equalization, with the second member 106 within the first member 102. The result is an interference fit that seals the fluid passages 104 (labeled in Fig. 1) of first member 102 against the inner surface of the second member 106. If relatively cooler fluid in the first member 102 is exchanging heat with relatively warmer fluid in the second member 106, the interference fit will be enhanced by operating the heat exchanger assembly 100, as the thermal contraction/expansion caused by the fluids will tend to contract the first member 102 and expand the second member 106.

[0018] With reference now to Fig. 3, the first and second members 102, 106 are a first heat exchanger pair 118. Additional heat exchanger pairs 120 can be nested within the first heat exchanger pair 118. The additional heat exchanger pairs 120 can be constructed and assembled in the same manner as the first heat exchanger pair 118. Each additional pair can be assembled into the assembly using thermal resizing, e.g. wherein each member is assembled individually, or as pairs, or as sub-assemblies of pairs. An outer cylindrical shell 122 can be engaged to the first member 102 with an interference fit using thermal resizing. An inner cylindrical shell 124 can similarly be engaged inside an innermost member 102, 106 of the additional heat exchanger pairs 120 with an interference fit also using thermal resizing.

[0019] The additional heat exchanger pairs 120 can be nested within the first heat exchanger pair 118 form an annular heat exchanger duct housed between the inner and outer shells 124, 122. The second heat exchange fluid can flow through the duct as indicated by the large arrows in Fig. 3, passing through the inlets 114, passages 108, and outlets 116 of the respective first members 106, each of which are labeled in Fig. 1. The first heat exchange fluid can flow from the channels 110, through the passages 104, into the channels 112 of each of the respective first members 102, each of which is labeled in Fig. 1. Fluid can be supplied to the channels 112 by an inlet header 126, which connects into each of the inlet channels 110 labeled in Fig. 1. Fluid can egress from the outlet channels 112 labeled in Fig. 1 through an outlet header 128. While schematically shown external to the assembled members 102, 106, the headers 126, 128

could also be made internal, e.g. with bores and/or piping to connect the channels respective 110, 112.

[0020] With reference now to Fig. 4, it is contemplated that instead of having the passages 104, 108 defined in inner surfaces of their respective members 102, 106 as shown in Fig. 1, the fluid passages 104, 108 can be formed on the radially outward surfaces. In this case, the fluid passages of the second member 106 sealed against the first member by the interference fit.

[0021] With reference to Fig. 5, instead of having an inner shell 124 with an annular duct as shown in Fig. 3, the additional heat exchanger pairs 120 can be nested within the first heat exchanger pair 118 form a full circular duct housed within an outer shell 122. Those skilled in the art will readily appreciate that the scope of this disclosure provides for any suitable shape of heat exchanger assembly wherein the interference fit can be maintained in the assembly.

[0022] With reference again to Fig. 4, the ends of the members 102, 106 can be welded, brazed e.g., having a braze ring in place first, and/or an O-ring can be put in a groove so that the first fluid doesn't leak out the ends into the second fluid. One such O-ring groove 103 is shown and labeled in Fig. 4, with an O-ring 105, understanding that a braze ring would also look similar before braze operation where it then fills the joints between member 102, 106. Any or all of the interfaces between the two members 102, 106 can be sealed in a similar manner, and it is also contemplated that the ends of members 102, 106 can be welded together outside faces, e.g. at any or all weld joint positions 107 labeled in Fig. 4, to seal that end leak path. The interference fit is intended to form a tight seal between adjacent passages (for example 104). It is also contemplated if needed in a given application, a thin layer of braze (e.g., paste or plating) can be applied between the two members 102, 106. Then the whole assembly 100 can undergo a braze cycle. Examples of braze joint locations 109 where braze can be applied between layers of members 102, 106 are labeled in Fig. 4.

[0023] Systems and methods as disclosed herein provide potential benefits including providing lower cost heat exchangers than using traditional techniques. Systems and methods as disclosed herein provide the potential for reduction/elimination of chance of cross-leaks in heat exchangers. Additionally, sub-component testing can be used to reduce risk cross-leaks in final assemblies.

[0024] The methods and systems of the present disclosure, as described above and shown in the drawings, provide for facilitation of assembly and quality control in heat exchanger assemblies using thermal resizing and interference fits. While the apparatus and methods of the subject disclosure have been shown and described with reference to preferred embodiments, those skilled in the art will readily appreciate that changes and/or modifications may be made thereto without departing from the scope of the subject disclosure.

Claims

1. A heat exchanger assembly comprising:

5 a first member (102) defining fluid passages therein for a first heat exchanger fluid; and
a second member (106) defining fluid passages therein for a second heat exchanger fluid, wherein the second member (106) is engaged to the first member (102) with an interference fit.

2. The assembly as recited in claim 1, wherein the fluid passages of first member (102) are sealed against the second member (106) by the interference fit.

3. The assembly as recited in claim 1, wherein the first and second members (102, 160) are cylindrical, wherein the second member (106) is engaged inside the first member (102).

4. The assembly as recited in claim 3, wherein the first member (102) defines a first circumferential groove in an inner surface thereof at a first axial end thereof, wherein the first member (102) defines a second circumferential groove in an inner surface thereof at a second axial end thereof opposite the first axial end, and wherein the first circumferential groove is in fluid communication with the second circumferential groove through the fluid passages of the first member (102), and optionally further comprising an inlet header and an outlet header, wherein the inlet header is in fluid communication with the first circumferential groove to supply fluid to the fluid passages of the first member (102), and wherein the outlet header is in fluid communication with the second circumferential groove to provide an outlet for fluid from the fluid passages of the first member (102).

5. The assembly as recited in claim 3, wherein each fluid passage of the second member (106) includes a respective inlet at a first axial end of the second member (106), and a respective outlet at a second axial end of the second member (106) opposite the first axial end of the second member (106).

6. The assembly as recited in claim 3, wherein the fluid passages of the first and second members are helical.

7. The assembly as recited in claim 3, wherein the first and second members are a first heat exchanger pair, and further comprising additional heat exchanger pairs that are nested within the first heat exchanger pair.

8. The assembly as recited in claim 7, further comprising:

an outer cylindrical shell engaged to the first member (102) with an interference fit; and
 an inner cylindrical shell engaged inside an innermost member of the additional heat exchanger pairs with an interference fit.

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9. The assembly as recited in claim 7, wherein the additional heat exchanger pairs nested within the first heat exchanger pair form a circular duct housed within an outer shell. 10
10. The assembly as recited in any preceding claim, wherein the fluid passages of the second member (106) are sealed against the first member (102) by the interference fit. 15
11. The assembly as recited in any preceding claim, wherein at an end of the first and second members, the first and second members are sealed by a weld joint, a braze joint, and/or an O-ring, and/or wherein the fluid passages of at least one of the first and second members are sealed by the interference fit, and at least partially by a braze joint. 20
12. A method of assembling a heat exchanger comprising: 25
 thermally resizing at least one of a first heat exchanger member and a second heat exchanger member; 30
 assembling the second heat exchanger member to the first heat exchanger member; and
 thermally equalizing the first and second heat exchanger members to engage the second heat exchanger member to the first heat exchanger member with an interference fit. 35
13. The method as recited in claim 12, wherein thermally resizing includes heating the first heat exchanger member. 40
14. The method as recited in claim 12, wherein thermally resizing includes cooling the second heat exchanger member. 45
15. The method as recited in any of claims 12 to 14, wherein the first heat exchanger member is cylindrical, wherein the second heat exchanger member is cylindrical, and wherein assembling the second heat exchanger member to the first heat exchanger member includes placing the second heat exchanger member within the first heat exchanger member. 50

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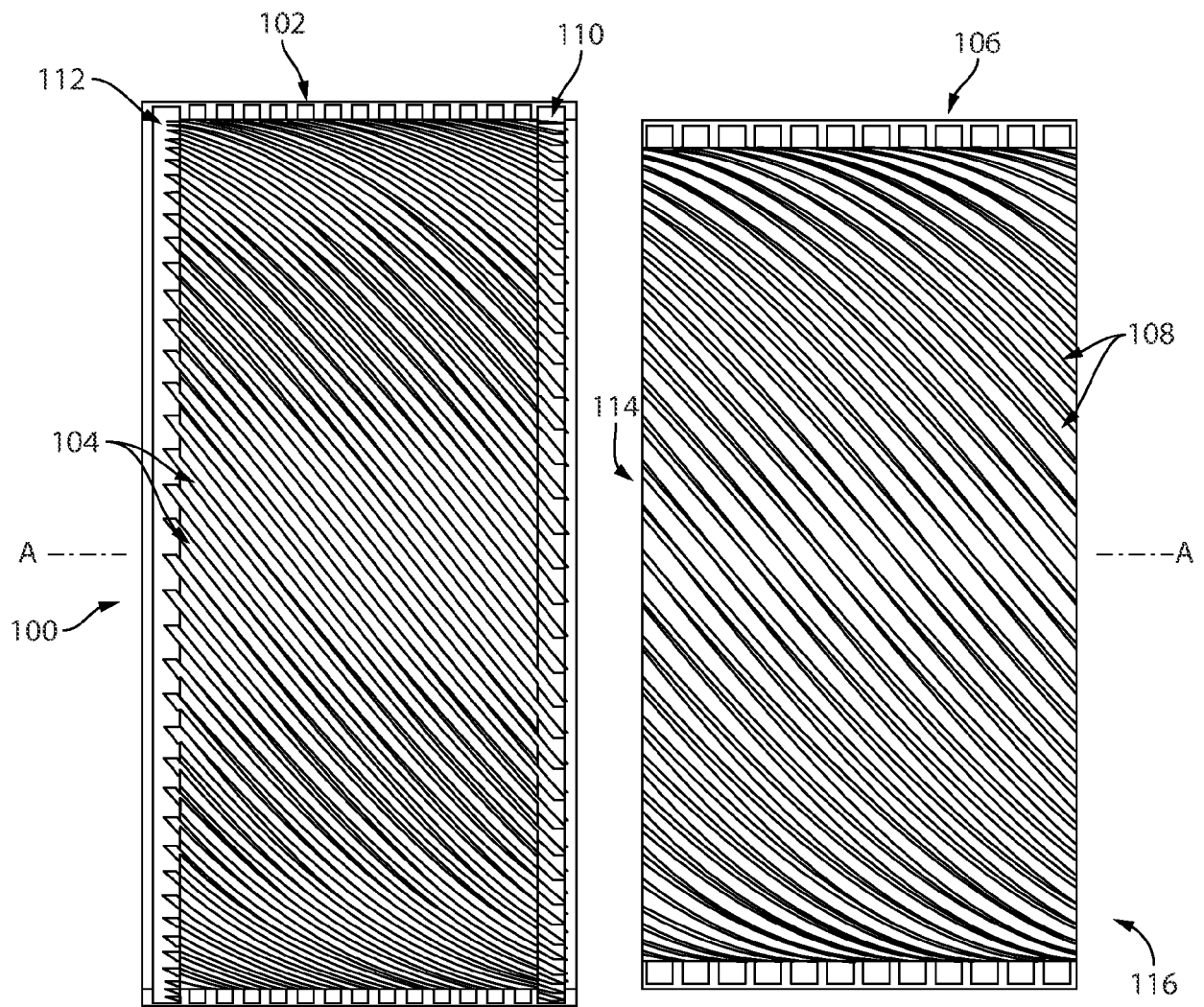


Fig. 1

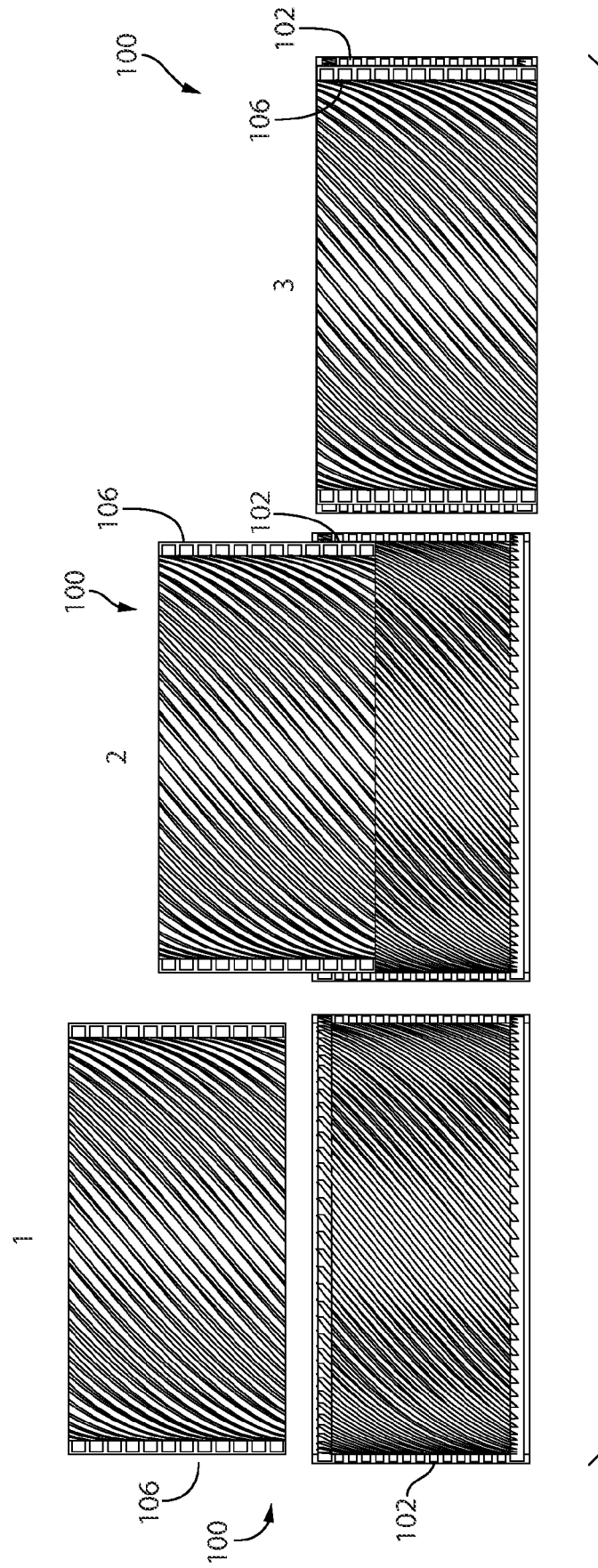


Fig. 2

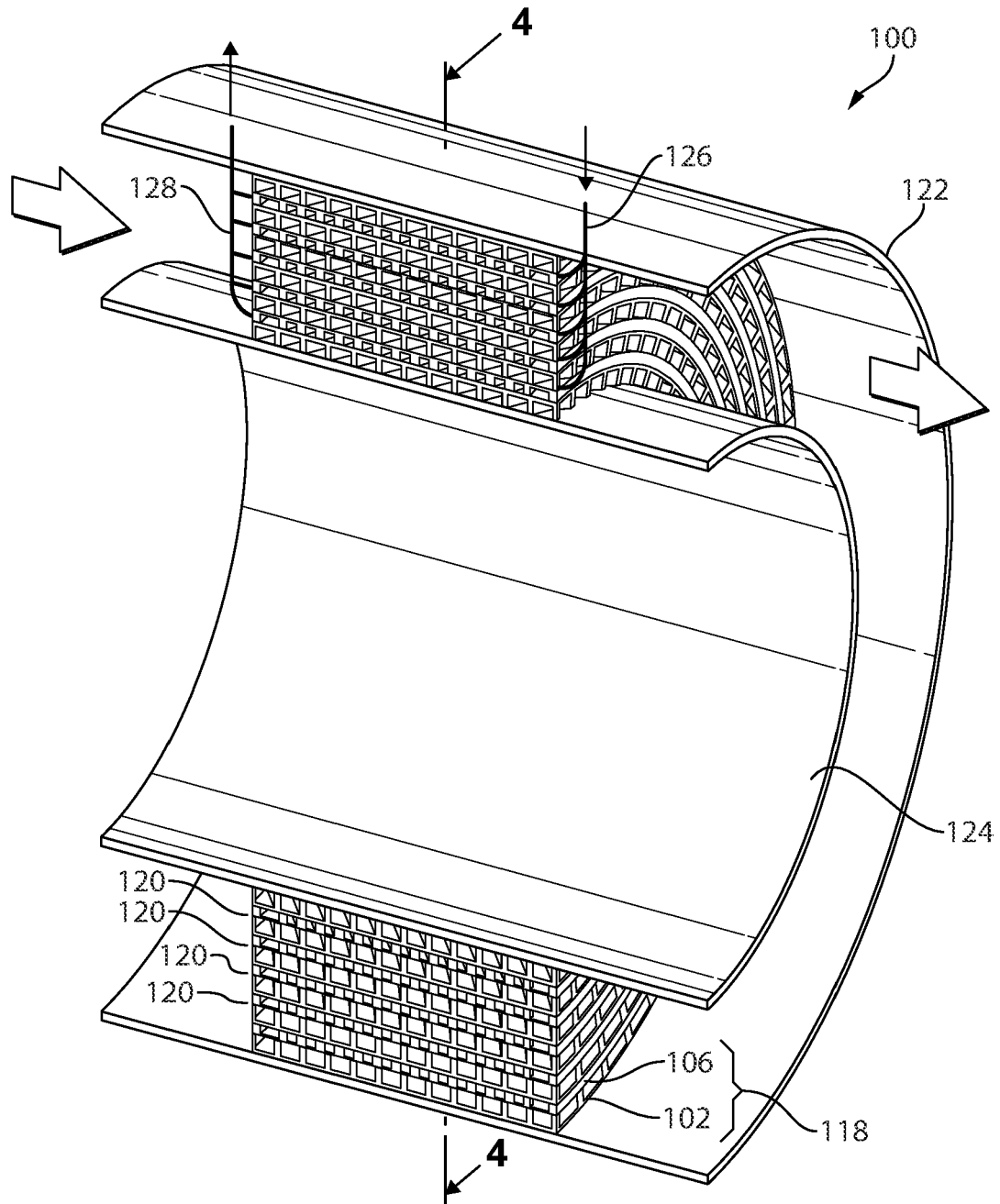


Fig. 3

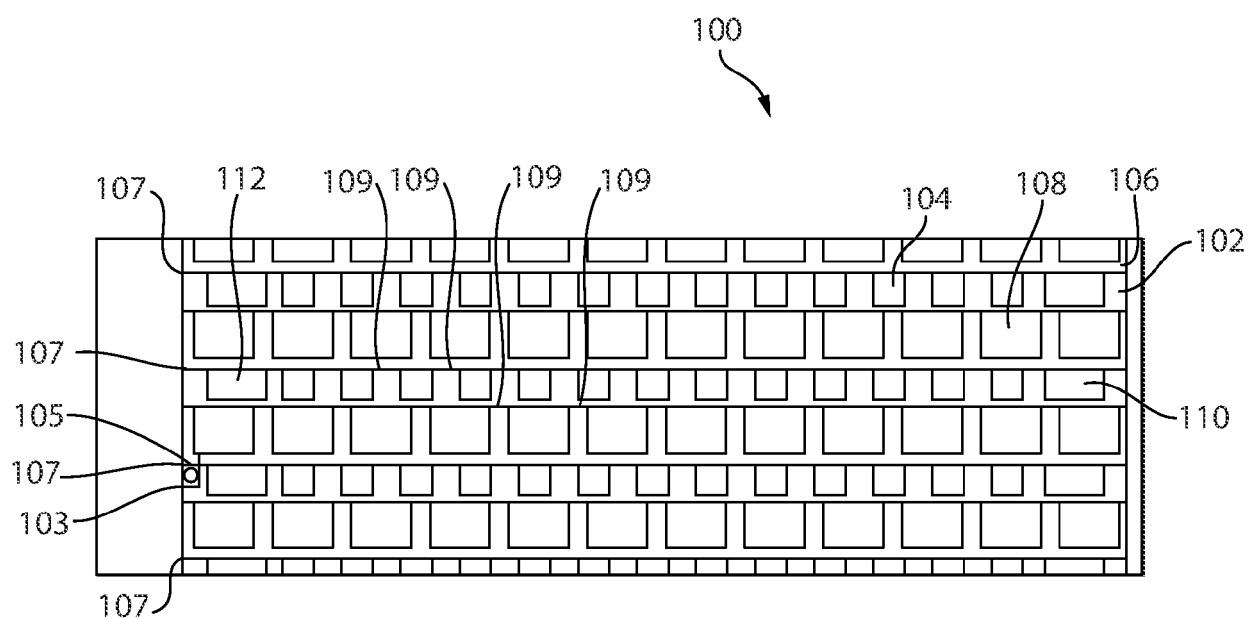


Fig. 4

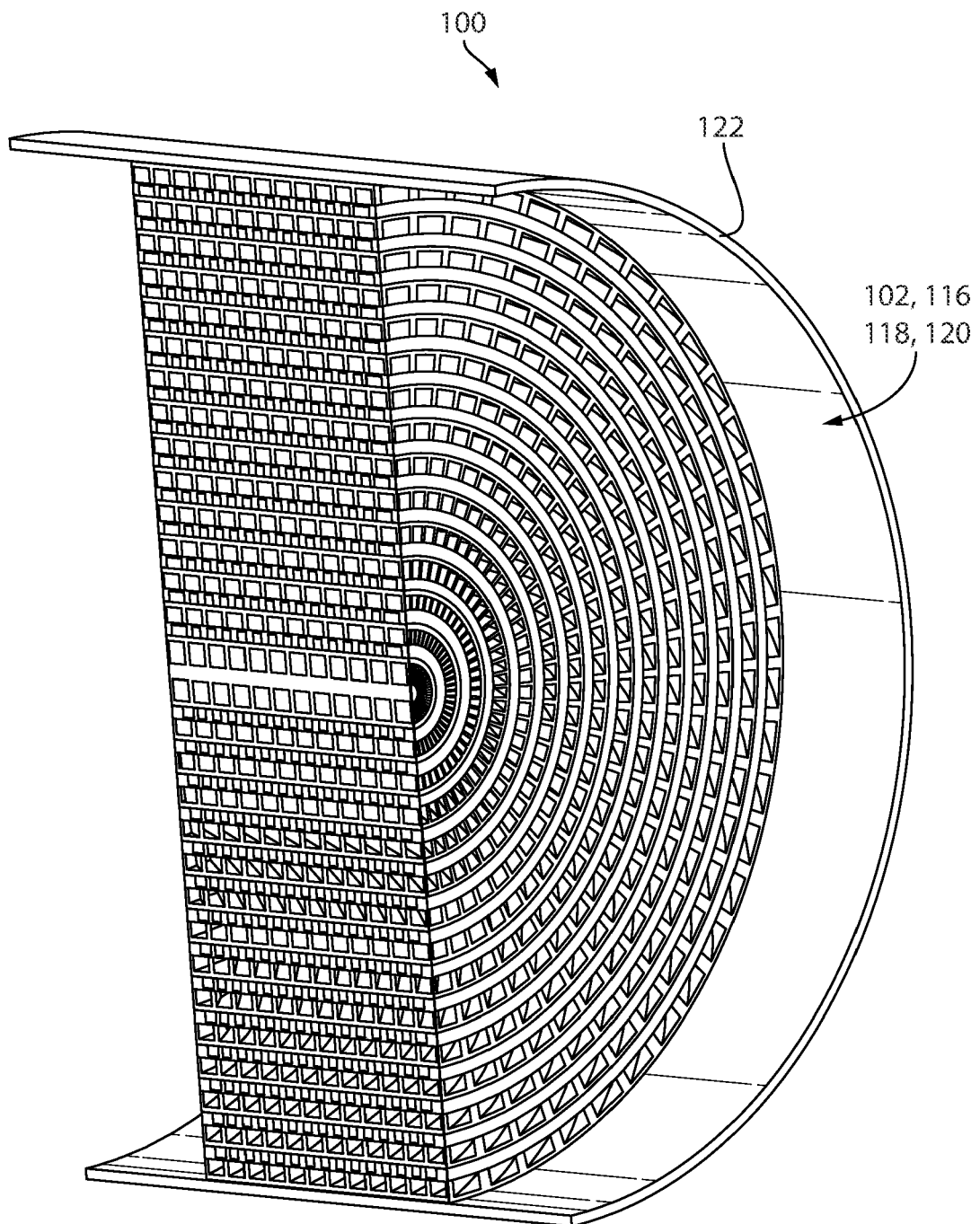


Fig. 5



EUROPEAN SEARCH REPORT

Application Number

EP 22 20 9062

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 20 March 2023	Examiner Bain, David
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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