US 20100300651A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2010/0300651 A1

(43) Pub. Date: Dec. 2, 2010

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(54) DOUBLE-WALLED PLATE HEAT EXCHANGER

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(21) Appl. No.: **12/473,945**

(22) Filed: **May 28, 2009**

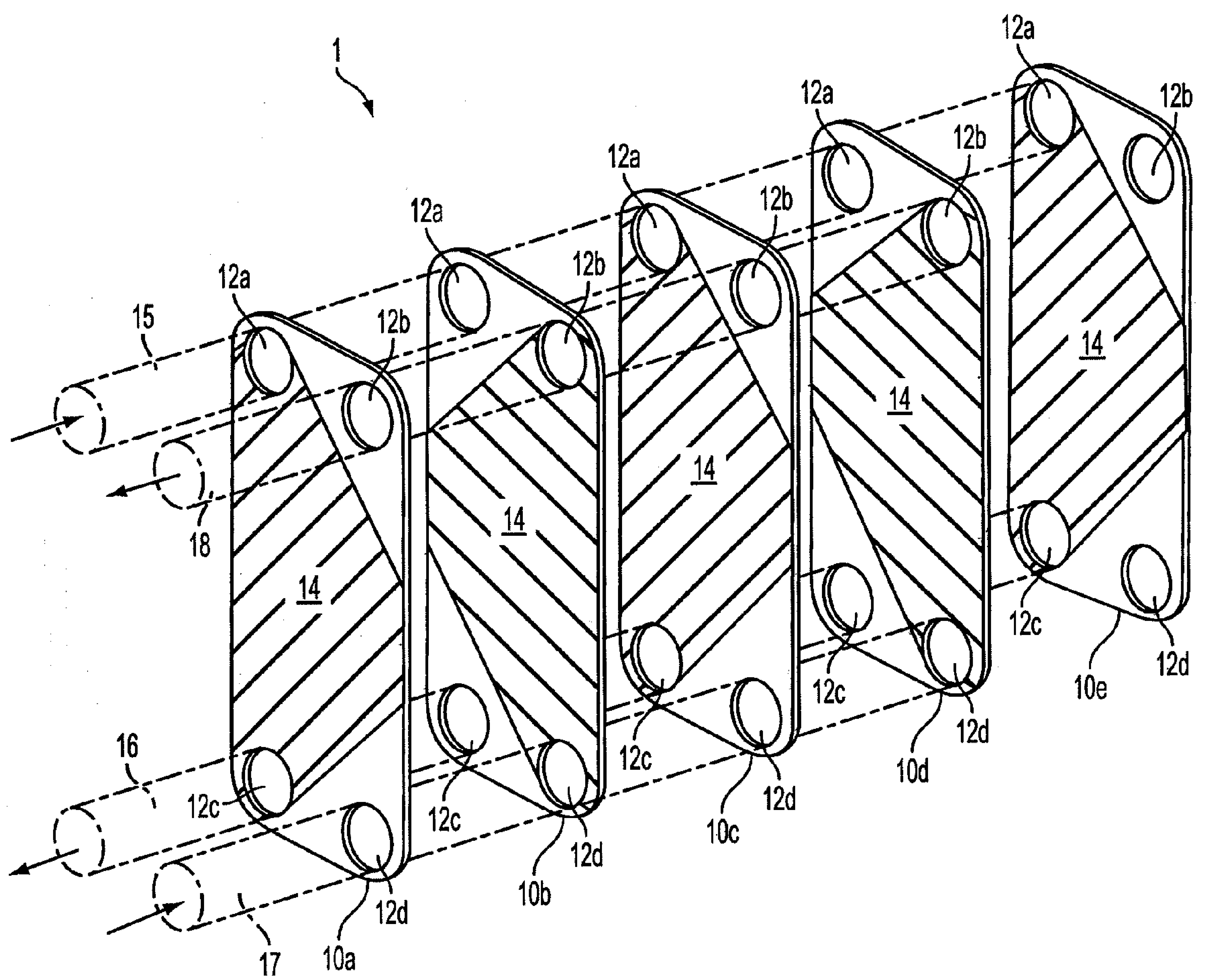
Publication Classification

(51) **Int. Cl.**
F28F 7/00 (2006.01)
F28F 3/08 (2006.01)
F28F 3/14 (2006.01)

(52) **U.S. Cl.** **165/76**; 165/166; 165/170

(57) **ABSTRACT**

A double-walled plate heat exchanger and method of managing the same includes a first plate including a first skin, a second skin, at least two port holes, and a leakage escape path between the first and second skins for allowing leaked fluid to exit the double-walled plate heat exchanger, the leakage escape path being in contact with a leakage orifice in one of the skins, and an outer edge of the double-walled plate heat exchanger, the first plate further including a second plate in contact with the second skin.



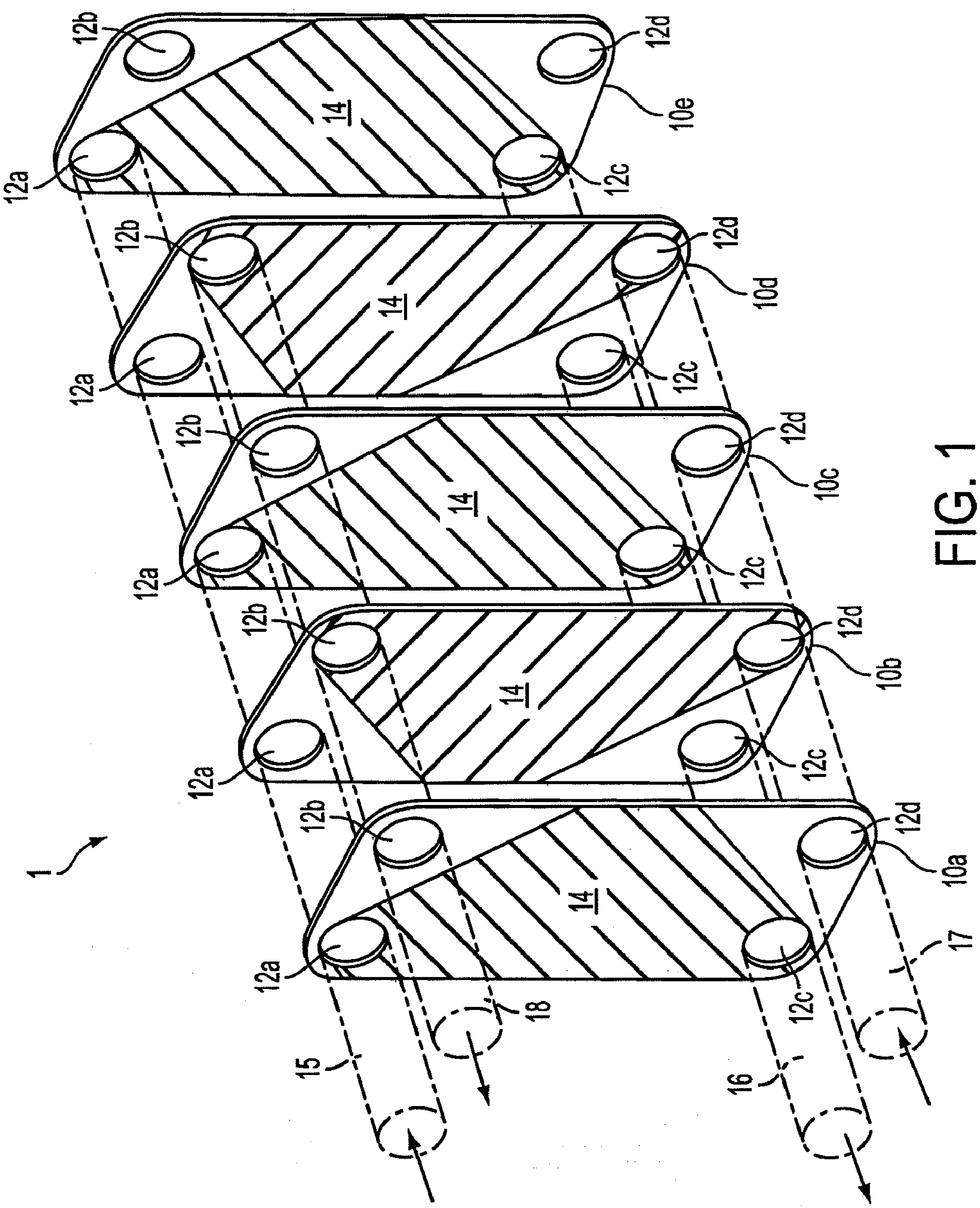


FIG. 1

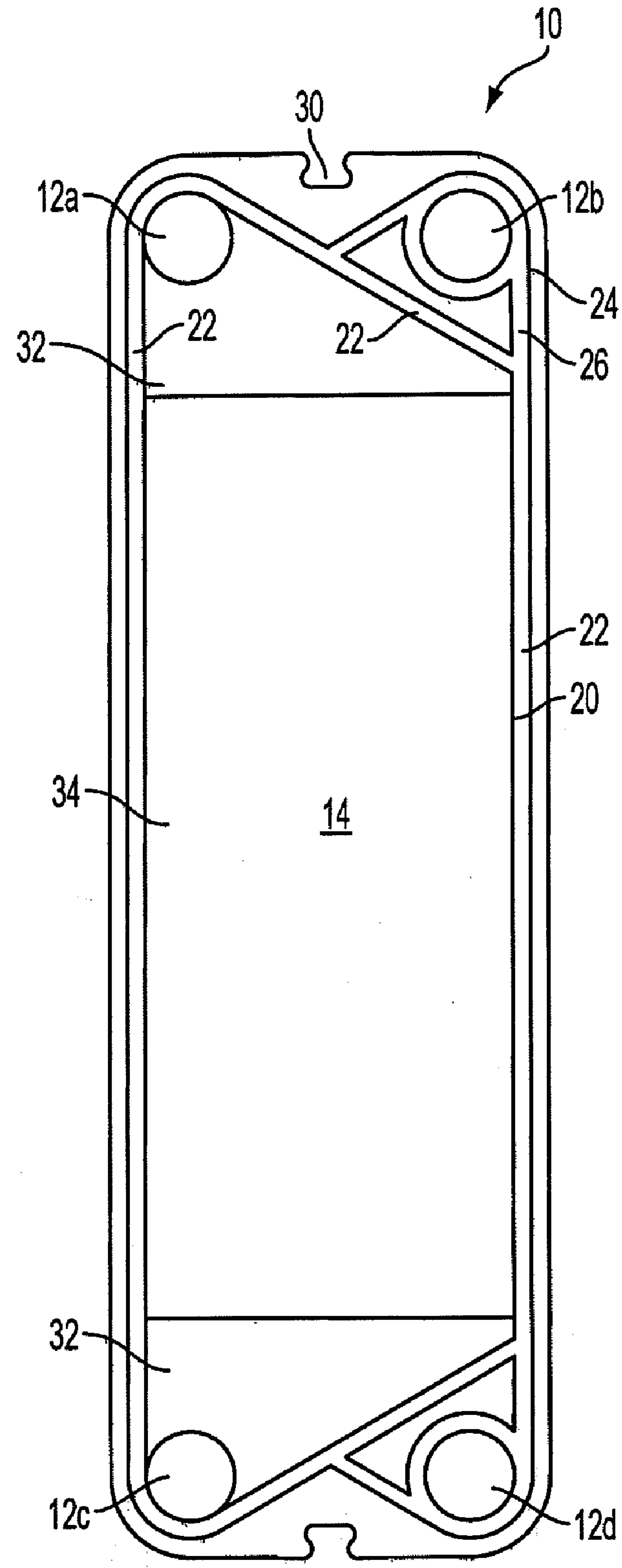


FIG. 2

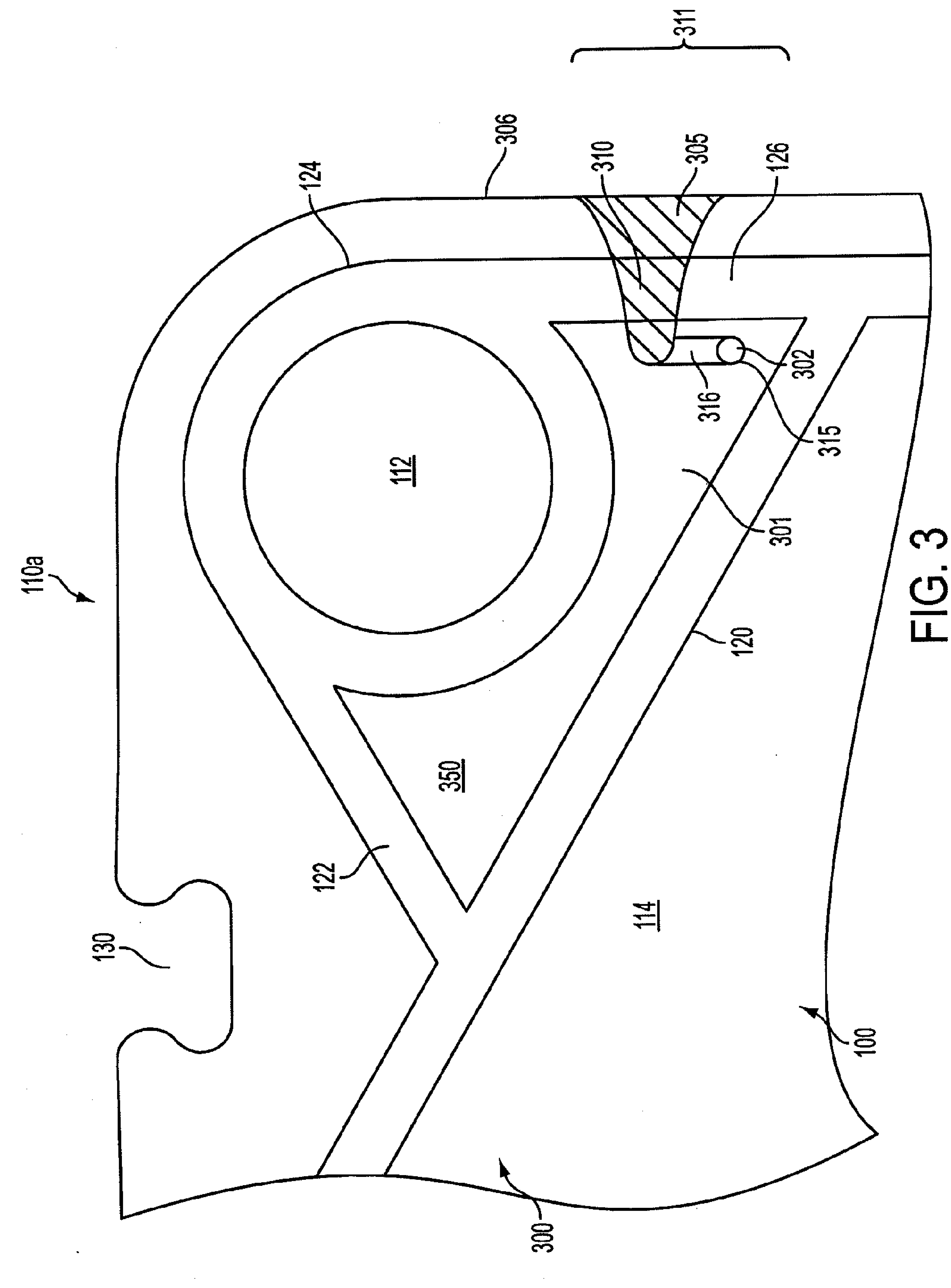

311
306
124
310
305
126
112
302
316
315
301
110a
120
350
122
114
130
100
300

FIG. 3

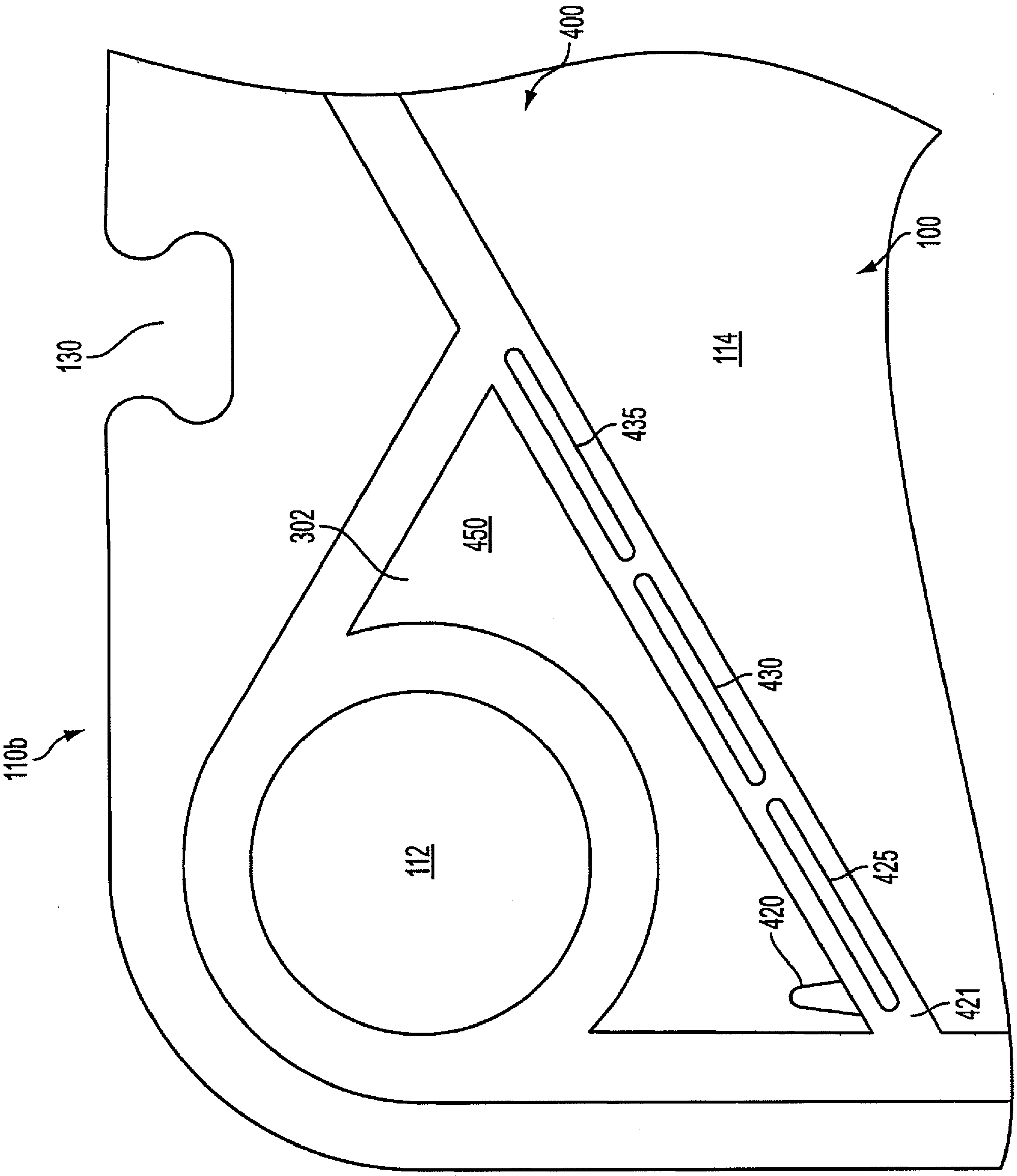


FIG. 4

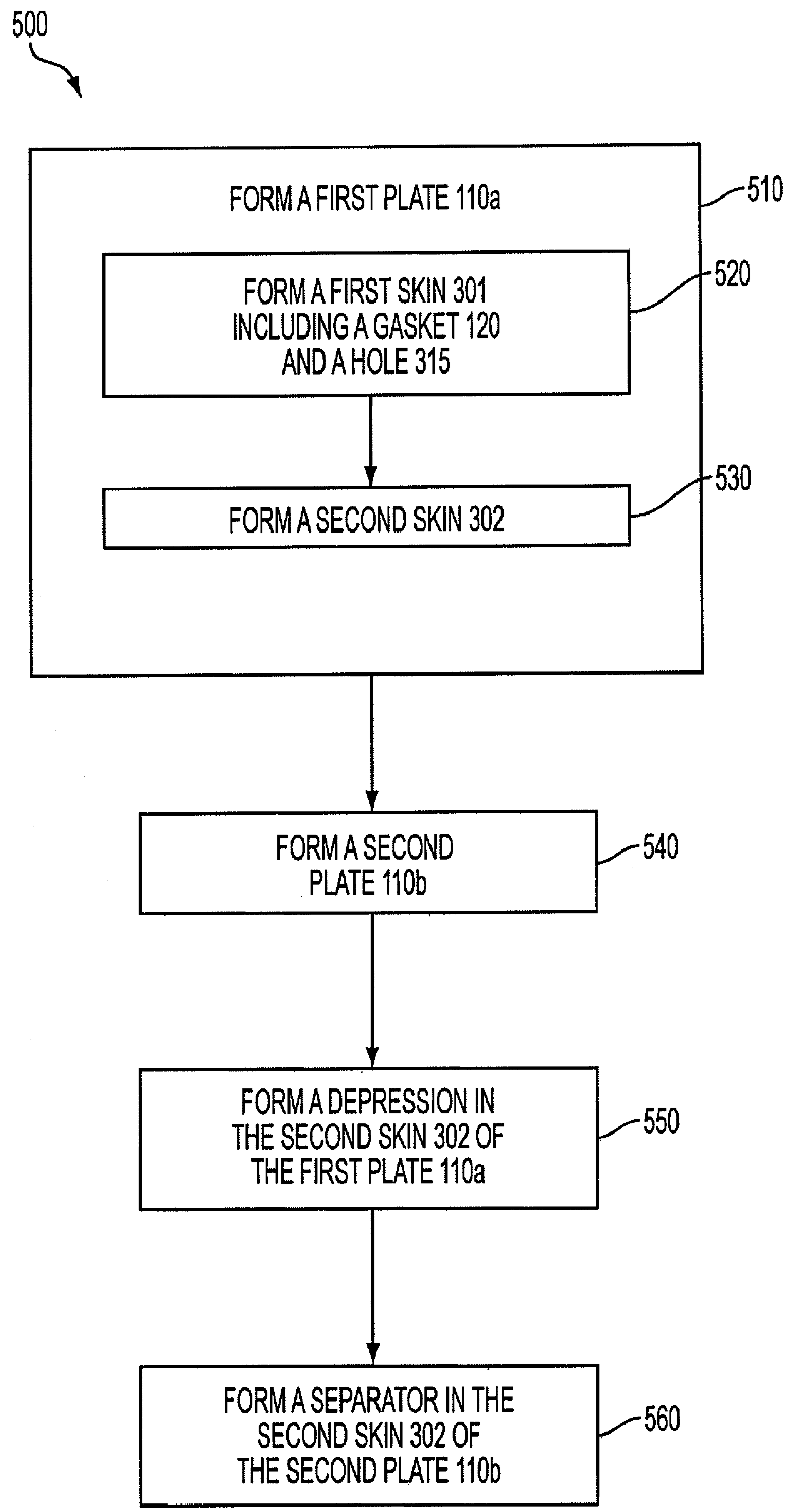

500
FORM A FIRST PLATE 110a
510
FORM A FIRST SKIN 301 INCLUDING A GASKET 120 AND A HOLE 315
520
FORM A SECOND SKIN 302
530
FORM A SECOND PLATE 110b
540
FORM A DEPRESSION IN THE SECOND SKIN 302 OF THE FIRST PLATE 110a
550
FORM A SEPARATOR IN THE SECOND SKIN 302 OF THE SECOND PLATE 110b
560

FIG. 5

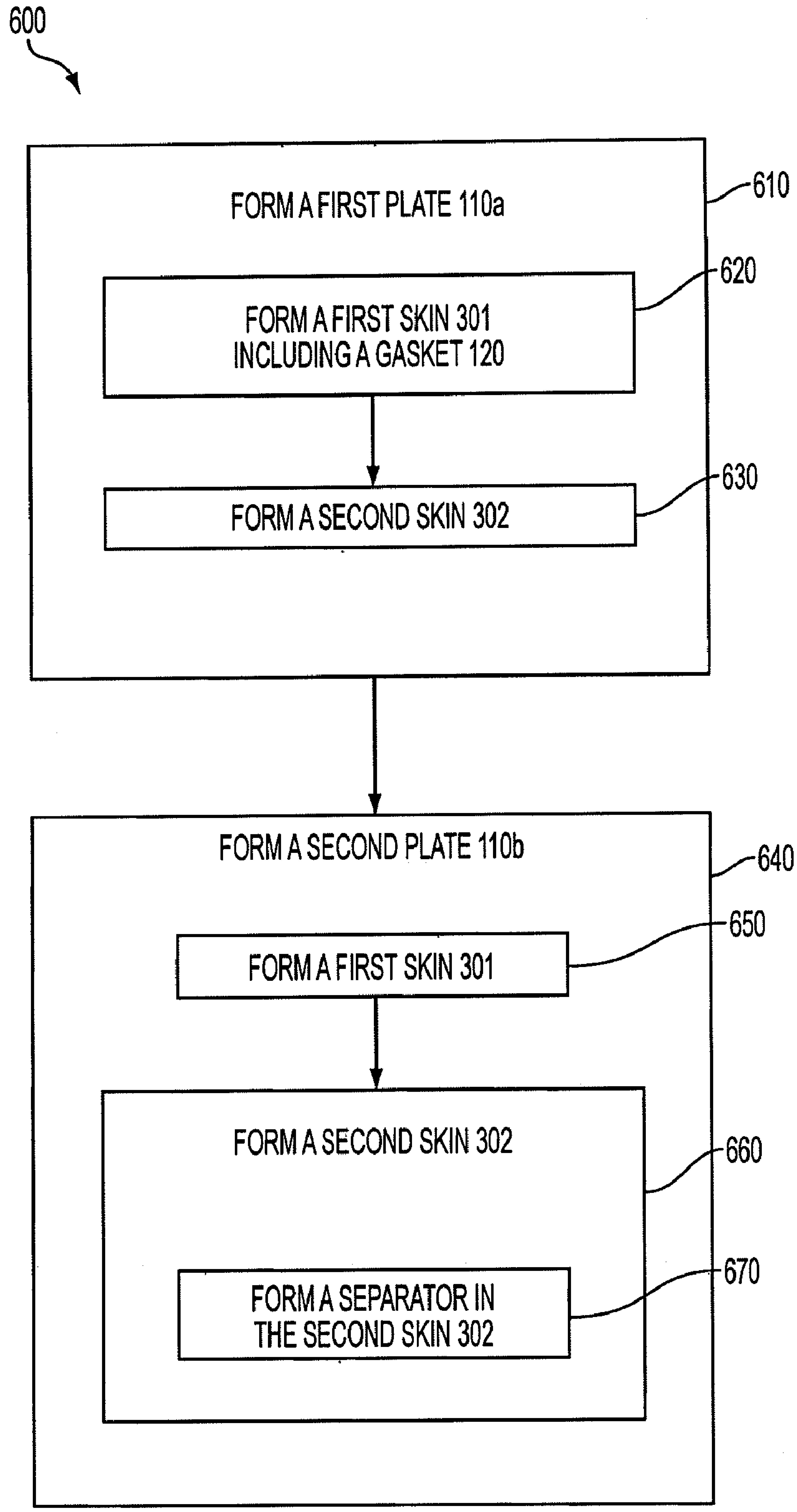

600
FORM A FIRST PLATE 110a
610
FORM A FIRST SKIN 301 INCLUDING A GASKET 120
620
FORM A SECOND SKIN 302
630
FORM A SECOND PLATE 110b
640
FORM A FIRST SKIN 301
650
FORM A SECOND SKIN 302
660
FORM A SEPARATOR IN THE SECOND SKIN 302
670

FIG. 6

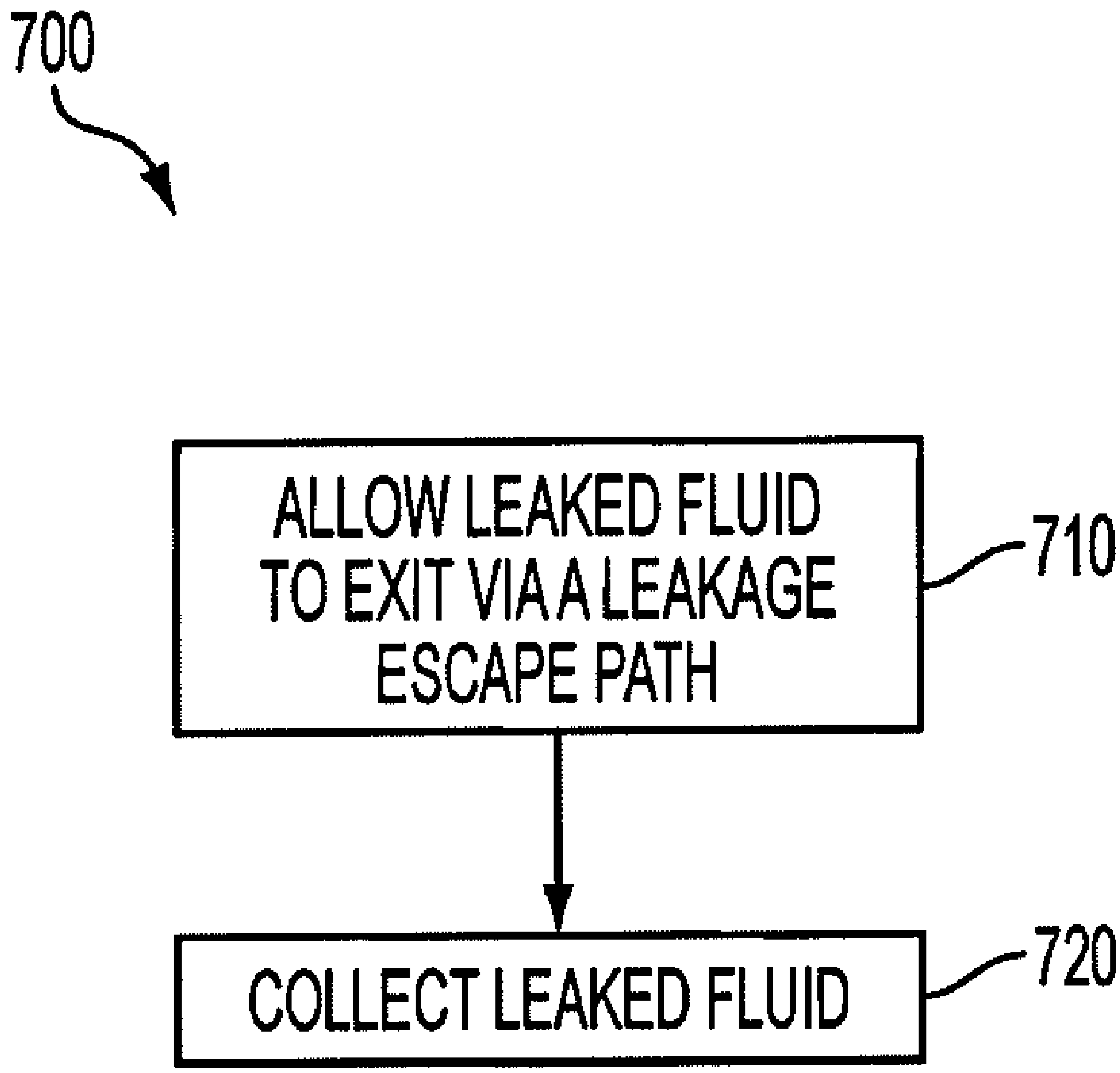

700
ALLOW LEAKED FLUID TO EXIT VIA A LEAKAGE ESCAPE PATH
710
COLLECT LEAKED FLUID
720

FIG. 7

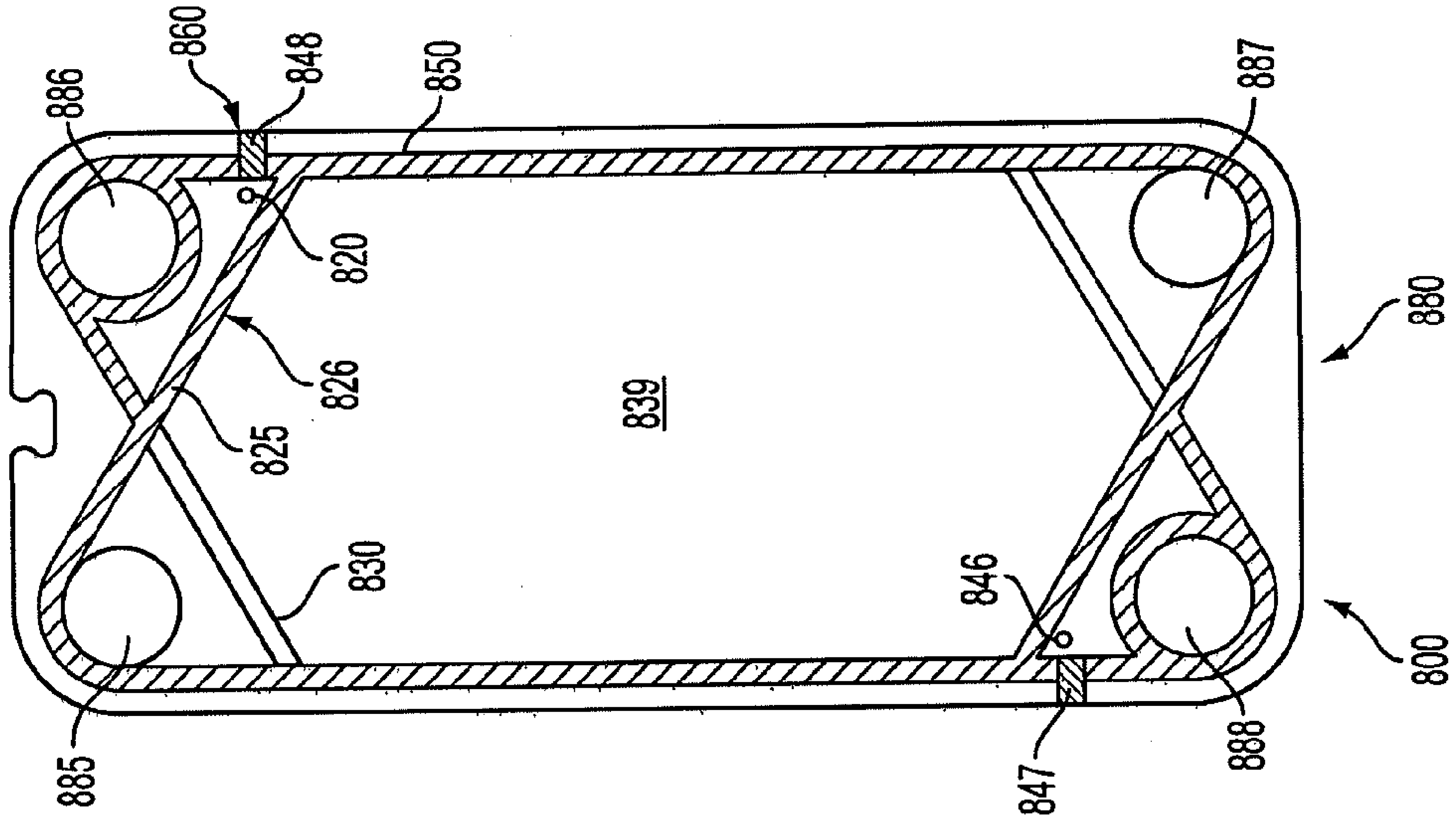


FIG. 8C

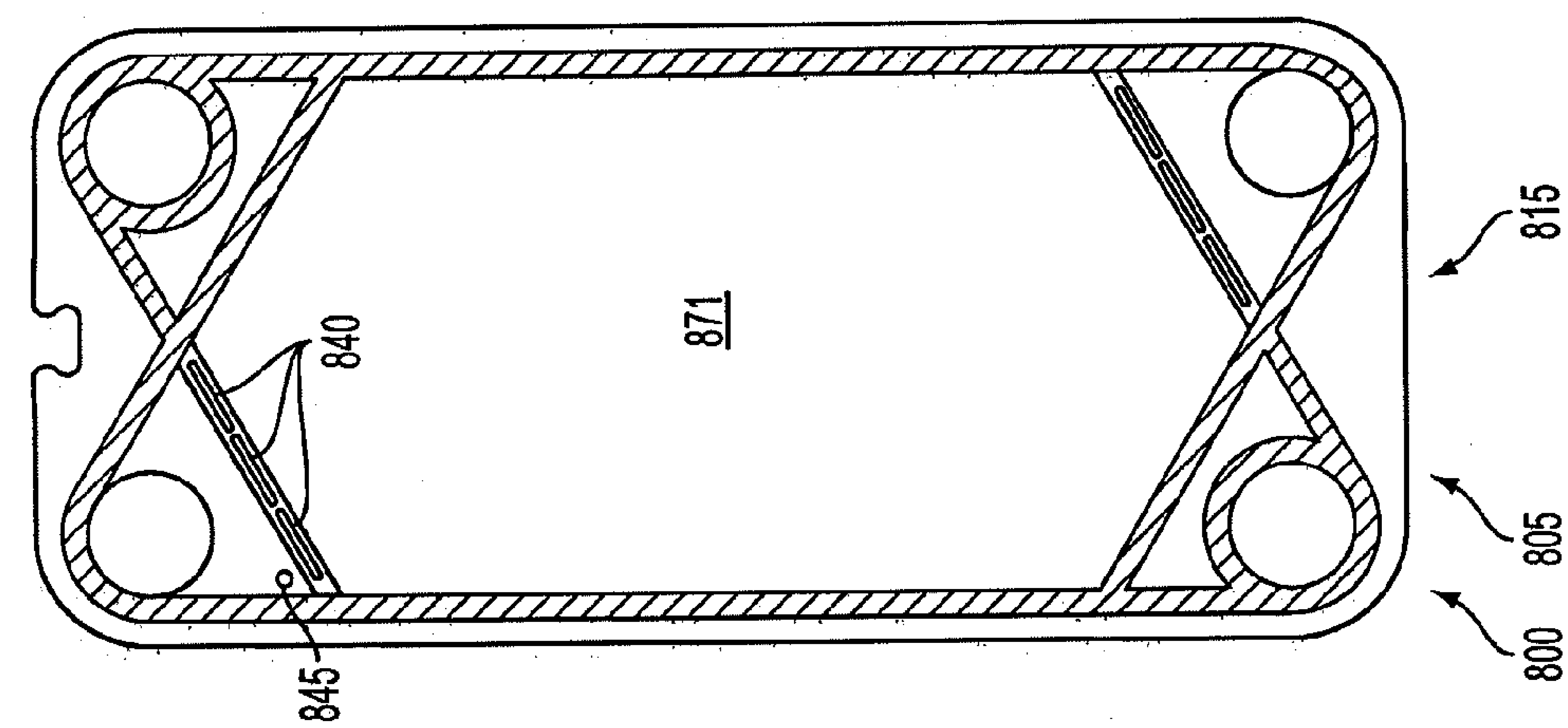


FIG. 8B

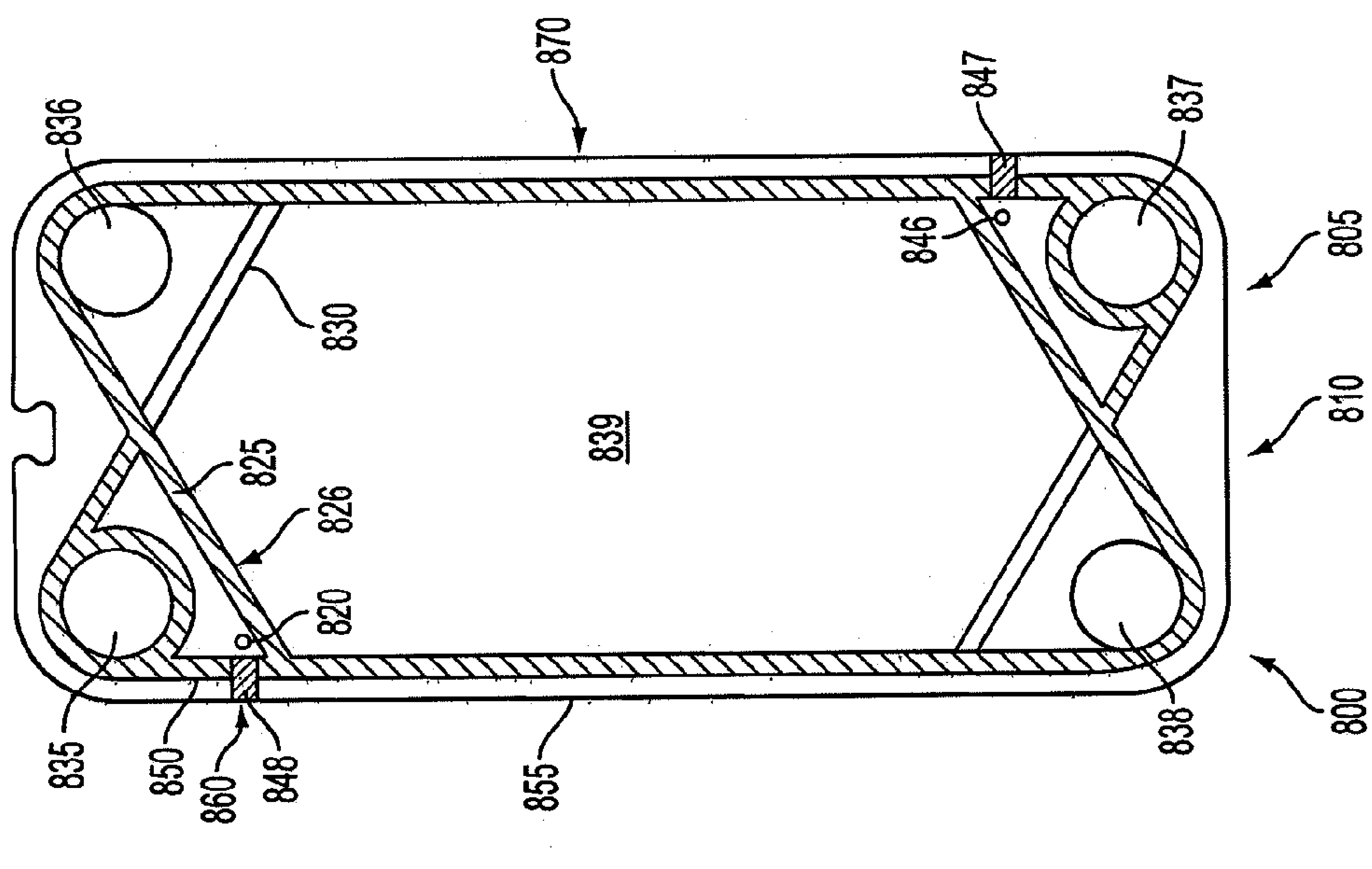


FIG. 8A

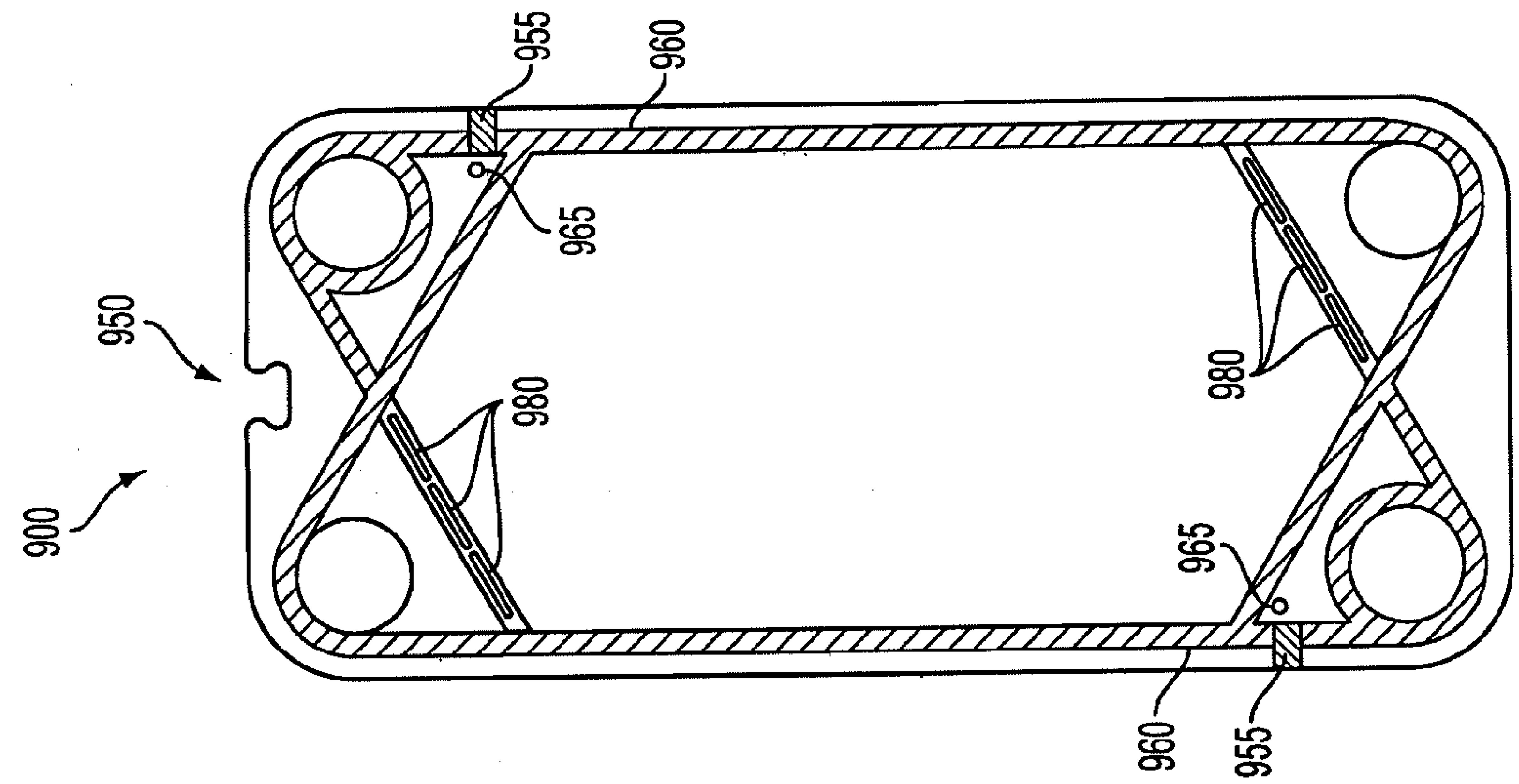


FIG. 9C

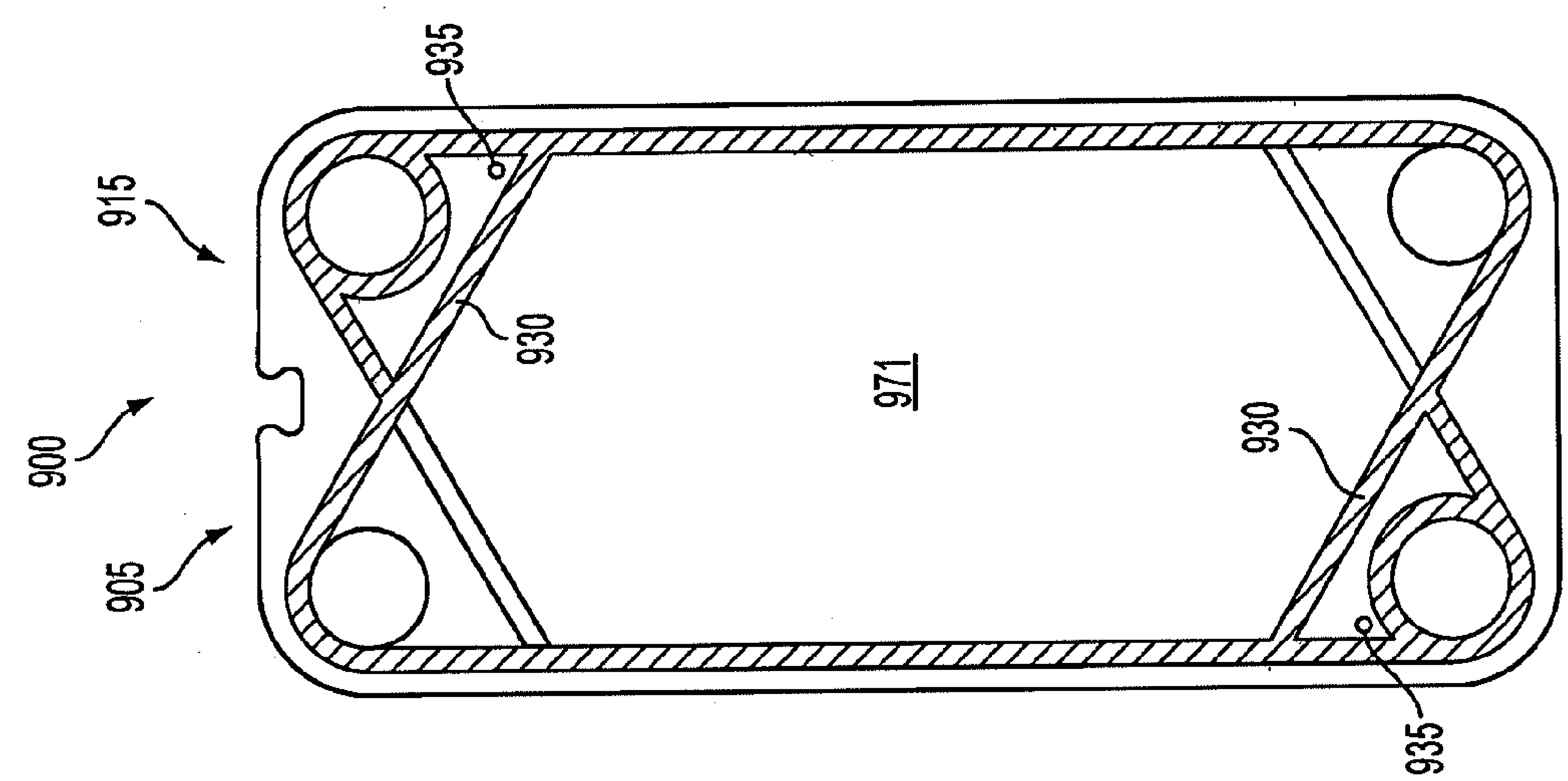


FIG. 9B

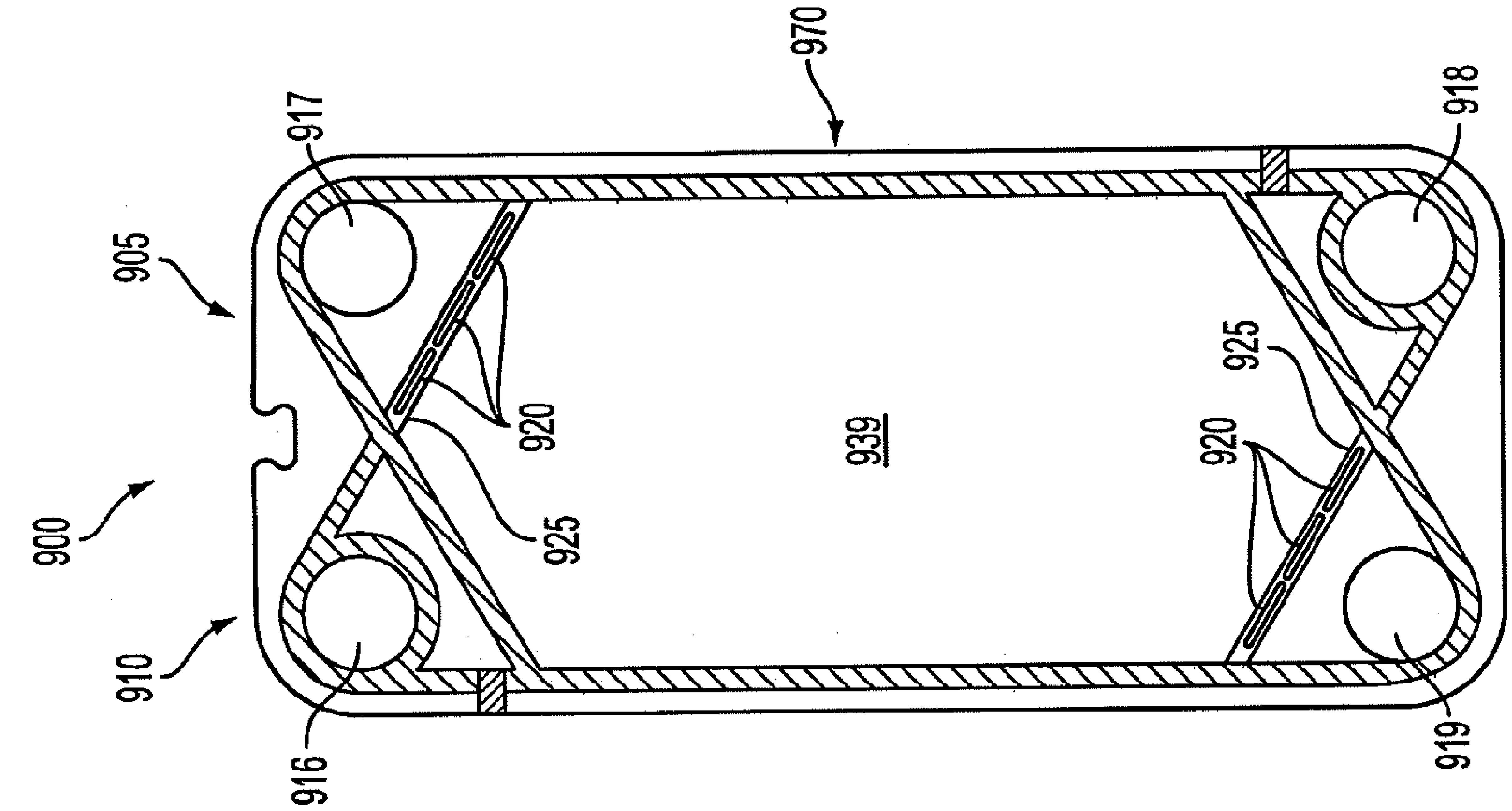


FIG. 9A

DOUBLE-WALLED PLATE HEAT EXCHANGER

FIELD OF THE INVENTION

[0001] The present invention relates to double-walled plate heat exchangers.

BACKGROUND OF THE INVENTION

[0002] Plate heat exchangers are used in many process fields where a fluid in a liquid or gas form is heated or cooled to a suitable temperature during continuous flow through the plate heat exchanger. When a fluid is to be heated, it is caused to flow through a small passage in the plate heat exchanger, the passage having a large thermal contact face exposed to a heat-emitting fluid which preferably passes through the plate heat exchanger in counterflow to the fluid for heating. When a fluid is to be cooled, the other fluid in the heat exchanger is heat-absorbing.

[0003] FIG. **1** is a schematic of a conventional single-walled plate heat exchanger **1**. FIG. **1** shows five rectangular plates **10***a*-**10***e*, generally referred to as plate **10**, which is typically just a small part of the total number of plates of the plate heat exchanger **1**. Each of the plates **10** has four port holes **12***a*-**12***d*, collectively referred to as port hole **12**, as well as a heat transfer area **14**. A first fluid flows between two adjacent plates **10** from a first distribution channel **15** at a fluid inlet, e.g., port hole **12***a*, to a second distribution channel **16** at a fluid outlet, e.g., port hole **12***c*.

[0004] When the plates are pressed together, a series of flow cavities are formed in between each pair of plates, e.g., plates **10***a*, **10***b*. Thus, the first fluid will usually flow through alternating cavities formed between the plates **10**, while a second fluid will flow through the other cavities. The other fluid is added through a third distribution channel **17** and leaves the plate heat exchanger **1** through a fourth distribution channel **18** after flowing through the cavities formed between the plates **10**. The two fluids can flow through the cavities in a counterflow manner, thereby encouraging heat transfer. There will thus be a thermal exchange between the two liquids via the plates **10**, without physical contact between the two fluids. This thermal exchange may take place such that one of the fluids may be cooled or heated by releasing energy to or receiving energy from the other fluid.

[0005] FIG. **2** is a schematic of a plate **10** in a conventional plate heat exchanger **1**. The plate **10**, e.g., any one of plates **10***a*-**10***e*, is provided with a gasket **20** which is secured to the plate **10**. The gasket **20** has a gasket part **22** which substantially follows the periphery of the individual plate **10** and thus seals the cavity formed between two plates **10** upon assembly of the plate heat exchanger **1**. The gasket part **22** permits fluid flow over the plate **10** from an inlet, e.g., port holes **12***a*, **12***c*, of a distribution channel **15-18** to its outlet, e.g., **12***b*, **12***d*, respectively.

[0006] The gasket part **22** also prevents fluid passage from the other port holes **12** to the cavity between the two plates. For example, the first fluid passing through port holes **12***a* and **12***c* has no contact with the second fluid passing through port holes **12***b* and **12***d*. As shown, the gasket **20** additionally has two ring-shaped gasket parts **24** surrounding and sealing off the other port holes **12***b*, **12***d* which do not communicate with the cavity between the plates. The ring-shaped gasket parts **24**, as depicted, are an integral part of the gasket **20**, since they are connected to the gasket part **22** through connectors **26**.

[0007] It will be seen from FIG. **2** that the plate **10** has a notch **30** which can accommodate a guide rail (not shown) upon assembly of the plate heat exchanger **1**, thereby ensuring correct assembly. The heat transfer area **14** of the plate **10** across which the fluid flows is divided into a central area **34** molded in a pattern, e.g. washboard-shaped, while end areas **32** around the port holes **12***a*-**12***d* are provided with diagonal channels. The molding of the plates **10** serves several functions, including reduction of the flow rate of the fluid to ensure good heat transfer between the fluids, while distributing the pressure from the compression of the plate heat exchanger **1** to the entire cross-section of the plate.

[0008] One problem that may arise with respect to one of the above-described designs, is one of these inner plates, **10***b*-**10***d* can develop an unintended perforation, e.g., a hole or a crack, in the zone transferring heat from the hot medium to the cold medium. The aforementioned perforation may allow the higher-pressure medium to pass through the perforation into the lower-pressure medium, which is not desirable. For example, the higher pressure medium may be glycol and the lower pressure medium may be potable water, resulting in the contamination of the potable water with the toxic glycol.

[0009] A proposed solution to the above-described drawback uses double-walled plates replacing single-walled plates as described above. It is known to replace each of the inner plates **10***b-d* with double-walled elements. Such elements are made from two metal skins which have undergone stretch forming together. The two metal skins are typically tightly and permanently joined in the corner port holes **12**.

[0010] If there is an unintended perforation in the heat transfer area, the medium in that area penetrates the perforation and enters the space between the two skins and leaks out to the atmosphere. A process operator is thus alerted to a problem which he must attend to.

[0011] The drawback with the above is that the two skins have been joined permanently, so that the space between the skins cannot be inspected. This drawback is significant for most applications and rather serious for fluid foods.

[0012] A proposed solution to this drawback uses port holes **12** that are not permanently joined, but by making different-sized holes in the two skins, and providing a suitable sealing member, such as peripheral sealing gasket-carrying grooves, at these port holes **12**, the permanent joining is avoided altogether. Thus, the space between the plates **10** is able to be inspected.

[0013] However, because the two skins are in close contact, any leakage into the space between the skins does not easily reach the external edge of the plate heat exchanger **1** for easy observation by the process operator, which means the process operator may not be properly alerted to a problem.

[0014] Essentially, where peripheral sealing gasket-carrying grooves exist, the gasket compression through the plate stack hinders leakage to the external edge. One known solution to this is placing metal tapes between the skins in line with the gasket sealing members or by creating a small channel. In either case, the net result is one or more leak paths in the space between the plates **10** in line with the gasket sealing members on each side. Typically, the sealing portion extends around the heat exchange portion as well as the flow openings, (e.g., port holes **12**).

[0015] This has significant drawbacks, as one sealing potion envelopes the other. In such a scenario, a gasket leak across the port hole gasket **24** can cause cross contamination. Secondly, because of the compressive loads exercised by port hole gaskets **24**, the location of the peripheral sealing gasket-carrying grooves is inappropriate, as it is not possible to properly inspect the plate heat exchanger **1** for leaks, or to know which plate **10** has a leak.

[0016] For external leakage, virtually all conventional plate heat exchangers **1** have a leakage groove in a so-called vent space. This vent space is in free communication with the atmosphere around the plate heat exchanger **1**. This communication is achieved by locally removing the sealing portion of the surrounding gasket **20**. Often, the plate **10** is weakened at the same time to ensure that there is no impediment to leakage. The purpose of this design is to make sure that, in a conventional plate heat exchanger **1**, there is a double-gasket barrier between hot and cold media, the space between the barriers being open to atmosphere. The problem is that this space is not in between the two skins of the double-walled plate **10** but on the front face of a front plate, e.g., plate **10***a*-**10***d*, where the gasket **20** is on only one side of the plate **10***a*-**10***d*.

[0017] Accordingly, there is a need and desire to provide a plate heat exchanger with multi-layered plates which provides drainage of fluid that accumulates between plates, prevents cross-contamination of fluids, and allows inspection of the heat exchanger for leaks.

SUMMARY OF THE INVENTION

[0018] Embodiments of the present invention advantageously provide a plate heat exchanger with multi-layered plates which provides drainage of fluid that accumulates between plates, prevents cross-contamination of fluids, and allows inspection of the heat exchanger for leaks.

[0019] An embodiment of the invention includes a double-walled plate heat exchanger and method of managing the same includes a first plate including a first skin, a second skin, at least two port holes, and a leakage escape path between the first and second skins for allowing leaked fluid to exit the double-walled plate heat exchanger, the leakage escape path being in contact with a leakage orifice in one of the skins, and an outer edge of the double-walled plate heat exchanger, the first plate further including a second plate in contact with the second skin.

[0020] Another embodiment of the invention includes a method of managing a leak in a double-walled plate heat exchanger, the method including allowing fluid leaked between first and second skins of a first plate in a double-walled plate heat exchanger to exit the double-walled plate heat exchanger via a leakage escape path, the leakage escape path including a leakage orifice, the first plate further including first and second port holes.

[0021] Another embodiment of the invention includes a double-walled plate heat exchanger includes leakage escape means for allowing fluid leaked between first and second skins of a first plate in a double-walled plate heat exchanger to exit the double-walled plate heat exchanger, the leakage escape means including at least one leakage orifice means for allowing the leaked fluid to exit via first skin.

[0022] Another embodiment of the invention includes a double-walled plate heat exchanger which includes leakage escape means for allowing fluid leaked between first and second skins of a first plate in a double-walled plate heat exchanger to exit the double-walled plate heat exchanger, the leakage escape means including leakage orifice means for allowing the leaked fluid to exit from between the first and second skins, the first plate having at least two port holes.

[0023] There have thus been outlined, rather broadly, certain embodiments of the invention in order that the detailed description thereof herein may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional embodiments of the invention that will be described below and which will form the subject matter of the claims appended hereto.

[0024] In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of embodiments in addition to those described and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein, as well as the abstract, are for the purpose of description and should not be regarded as limiting.

[0025] As such, those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. **1** is a schematic view of a conventional single-walled plate heat exchanger.

[0027] FIG. **2** is a schematic view of a plate in a conventional plate heat exchanger.

[0028] FIG. **3** is a schematic view of a portion of a plate in a double-walled plate heat exchanger in accordance with an embodiment of the present invention.

[0029] FIG. **4** is a schematic view of another portion of the plate in a double-walled plate heat exchanger shown in FIG. **3**.

[0030] FIG. **5** is a flow chart of a method of forming a plate heat exchanger in accordance with an embodiment of the present invention.

[0031] FIG. **6** is a flow chart of another method of forming a plate heat exchanger in accordance with an embodiment of the present invention.

[0032] FIG. **7** is a flow chart of a method of managing a leak in a double-walled plate heat exchanger.

[0033] FIG. **8** is a schematic view of a portion of a double-walled plate heat exchanger in accordance with an embodiment of the present invention.

[0034] FIG. **9** is a schematic view of a portion of a double-walled plate heat exchanger in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0035] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof and show by way of illustration specific embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice them, and it is to be understood that other embodiments may be utilized, and that structural, logical, processing, and electrical changes may be made. The progression of processing steps described is an example; however, the sequence of steps is not limited to that set forth herein and may be changed as is known in the art, with the exception of steps necessarily occurring in a certain order.

[0036] The invention will now be described with reference to the drawing figures, in which like reference numerals refer to like parts throughout.

[0037] Turning now to the figures, FIG. **3** is a schematic view of a portion of a plate utilized in a double-walled plate heat exchanger in accordance with an embodiment of the present invention. Similar to the plate **10** illustrated in FIG. **2**, a double-walled plate heat exchanger **100** includes a plate **110** which is provided with a gasket **120** that is secured to a front side **300** of the plate **110**. As shown here, a first plate is referenced as **110***a*. Each plate made in accordance with the invention may be the same as plate **110***a*, although a second plate described below will be referenced as **110***b* for ease of description.

[0038] As illustrated, plate **110**, e.g., first plate **110***a*, comprises two skins **301**, **302**. The gasket **120** has a gasket part **122** which substantially follows the periphery of the individual plate **110** and thus seals the heat transfer area **114** formed between two plates **110** upon assembly of the plate heat exchanger **100**. The gasket part **122** permits fluid flow over the plate **110** from an inlet, e.g., port hole **112** as depicted in FIG. **3**. The gasket part **122** also prevents fluid passage from the other port holes to the heat transfer area **114** between the two plates **110***a*, **110***b*.

[0039] As shown, the gasket **120** has a ring-shaped gasket part **124** surrounding and sealing off the port holes **112** which does not communicate with the heat transfer area **114** between the plates. The ring-shaped gasket part **124** is an integral part of the gasket **120**, since it is connected to the gasket part **122** through connector **126**. It will be seen from FIG. **3** how the plate **110** has a notch **130** which can accommodate a guide rail (not shown) upon assembly of the plate heat exchanger **100**, thereby ensuring correct assembly. The plate **110** also has additional port holes **112**, each of which may be formed and surrounded by a ring-shaped gasket part **124** as depicted for the port hole **112** shown in FIG. **3**. It should be appreciated that, in a preferred embodiment, four port holes **112** would be utilized, such that fluid flow for non-leaked fluid will be similar to that shown in the FIG. **1** distribution channels **15-18**.

[0040] In order to allow escape of fluid trapped between skins of the double-walled plate heat exchanger **100**, a leakage escape path **311** is provided between the first and second skins **301**, **302** for allowing leaked fluid to exit the double-walled plate heat exchanger **100**, the leakage escape path **311** is in contact with at least one leakage orifice **315** and an outer edge **306** of the double-walled plate heat exchanger **100**. The leakage orifice **315** is provided in a vent area **350** of the front plate **300**. The first skin **301** is provided with the gasket **120**. The second skin **302** may be viewed through the leakage orifice **315**. A leakage groove **305** is provided across the gasket connector **126**, so fluid may escape to the atmosphere at the outer edge **306** of the double-walled plate heat exchanger **100**. In gasket area **310**, the gasket may be recessed, or even completely removed or eliminated, to allow passage of fluid across the leakage groove **305**. Depending on the positioning of the leakage orifice **315** with respect to the leakage groove **305**, an optional groove extension **316** may be provided to further guide fluid from the leakage orifice **315** to the leakage groove **305**.

[0041] FIG. **4** is a schematic view of another portion of the plate in a double-walled plate heat exchanger shown in FIG. **3**. The feature illustrated in FIG. **4** is the second skin **302** of the double-walled plate heat exchanger **100**. The second skin **302** includes a vent area **450** which includes an indentation **420** that connects a leak guide **421**. The leak guide **421** may include ribs **425**, **430**, **435** that aid in keeping the skins **301**, **302** apart when pressed together, so that leaked fluid may pass along the leak guide **421**.

[0042] It should be appreciated that, in the absence of leaking of the fluids, the two fluids are kept completely separate by the gasket **120**. Accordingly, if a leak occurs between the skins of the plate **110**, for example, via a defect in, crack in, or corrosion of one of the skins **301**, **302**, internal pressure will tend to push the fluid toward the leak guide **421** or directly to the indentation **420**, and leakage orifice **315**, depending on the location of the defect causing the leak. The fluid will them flow through the leakage orifice **315** to the leakage groove **305**, and out to the atmosphere where it will either dissipate or be collected for analysis and/or disposal. The location of the expected leak will thus be known in advance, so an operator will know where to look, in general, for leaks.

[0043] Another embodiment of the present invention involves providing one or more leakage orifices **315** in the front plate **300** in the vent area **350**, **450**, such that the space between the double-walled plates **110***a* and **110***b* is in communication with this vent area **350**, **450**. The vent area **350**, **450** is open to the atmosphere via the break in the sealing at the periphery, e.g., gasket area **310**. In this way, any fluid which has reached the space between the skins **301**, **302** of the plate **110**, e.g., via a perforation, is able to leak out into the vent space **350**, **450** and then out of the vent space **350**, **450** to the edge **306** of the double-walled plate heat exchanger **100**.

[0044] It should be noted that the leakage orifice **315** is positioned on a surface which is in a relatively close contact with the second skin **302**. To further ensure that this close contact does not become a resistance to leakage flow, the second skin **302** is modified by a depression or depressions, i.e., indentation **420**, which align with the leakage orifice **315** in the front skin **301** to reduce flow resistance.

[0045] The leak guide **421** may be provided at an edge of the heat exchange portion of the second skin **302** which is not in contact with a sealing member. This positioning is preferred to reduce the hydraulic resistance to the leakage path out of the heat exchange zone. Substantial design changes can be made in this area since these surfaces do not have to seal against a gasket **120**. Various shapes and inclinations, longitudinal or transverse or intermediate, or attachments of various thicknesses and numbers can be made to allow leakage to reach the leakage orifices and depressions (e.g., leakage orifice **315**, indentation **420**) made in the first and second skins **301**, **302** in the vent space **350**, **450** as described above.

[0046] Located within the heat transfer area **114**, proximate to the leak guide **421**, distribution areas are positioned. These distribution areas may have large flat portions. When the skins **301**, **302** touch flat-on-flat, oftentimes it is more difficult for leakage to overcome the flow resistance. Accordingly, a rib or ribs, e.g., ribs **425**, **430**, **435**, may be formed in one or both skins which create a local separation to carry leakage from the heat transfer area **114** to the vent space **350**, **450**. Alternatively, small width and small thickness attachments can be made to provide the same effect. The attachments may be permanently attached or removable. The shape and length of ribs or attachments can vary depending on the application. For example, the size of such ribs and attachments must be determined to avoid impeding heat transfer and creating undue flow resistance in the intended flow path of flow media. Such separator ribs and attachments, e.g., ribs **425**, **430**, **435**, may be formed at any point where there is large flat-to-flat contact.

[0047] Turning now to FIG. **5**, is a flow chart of a method of forming a plate heat exchanger in accordance with an embodiment of the present invention is depicted. A method **500** of forming a double-walled plate heat exchanger **100** includes forming a first plate (step **510**), e.g., plate **110***a*, including forming a first skin **301**, including forming a gasket **120**, and forming at least one leakage orifice **315** (step **520**). The method **500** further includes forming a second skin **302** (step **530**). The leakage orifice **315** is provided as a partial an escape path for leakage between the first and second skins **301**, **302**. The method **500** further includes forming a second plate in contact with the first skin of the first plate (step **540**). The second plate may be similar to the first plate **110***a*, and will be similarly denoted below as second plate **110**.

[0048] In one embodiment encompassed by the present invention, the method **500** further includes forming at least one depression, e.g., indentation **420**, in the second skin **302** of the first plate **110***a*. Said indentation **420** at least partially surrounds the at least one leakage orifice **315** in the first plate **110***a* such that the first and second skins **301**, **302** are separated near the at least one depression (e.g., indentation **420**) and the leakage orifice **315** (step **550**). Forming the second plate **110***b* may further include forming a first skin, e.g., first skin **301** and forming a second skin, e.g., second skin **302**. Forming the second plate **110***b* may also include forming at least one separator, e.g., ribs **425**, **430**, **435**, configured to provide separation between the first and second plates **110***a*, **110***b* near the at least one separator (step **560**). Step **560** may further include providing the at least one separator as part of the escape path for leakage between the first and second skins **301**, **302** of the first plate **110***a*.

[0049] Referring now to FIG. **6**, a flow chart of another method of forming a plate heat exchanger in accordance with an embodiment of the present invention is illustrated. A method **600** of forming a double-walled plate heat exchanger includes forming a first plate (step **610**), e.g., plate **110***a*, including forming a first skin **301**, including forming a gasket **120** (step **620**), and forming a second skin **302** (step **630**). The method **600** further includes forming a second plate, e.g., plate **110***a*, in contact with the first skin **301** of the first plate (step **640**). Forming the second plate **110***b* includes forming a first skin, e.g., first skin **301** (step **650**), and forming a second skin, e.g., skin **302**, which includes forming at least one separator, e.g., ribs **425**, **430**, **435**, configured to provide separation between the first and second plates **110***a*, **110***b* near the at least one separator (step **660**). The step **660** of forming the at least one separator may include providing at least part of an escape path for leakage between the first and second skins **301**, **302** in the first plate **110***a* (step **670**).

[0050] FIG. **7** depicts a flow chart of a method of managing a leak in a double-walled plate heat exchanger. The method **700** includes allowing fluid leaked between first and second skins of a first plate in a double-walled plate heat exchanger to exit the double-walled plate heat exchanger via a leakage escape path, the leakage escape path including at least one leakage orifice in the first skin, the first skin further including first and second port holes (step **710**). An optional step **720** includes collecting the leaked fluid for analysis and/or disposal, which may be done at a predetermined location on the double-walled plate heat exchanger. The leakage escape path contacts an outer edge of the double-walled plate heat exchanger. The leakage escape path further includes at least one depression in the second skin at least partially surrounding the at least one leakage orifice such that the first and second skins are separated near the at least one depression and the leakage orifice. The leakage escape path further comprises at least one separator in a skin of a second plate configured to provide separation between the first and second plates near the at least one separator.

[0051] It should be noted that, although the methods **500**, **600**, **700** are illustrated as having steps in a particular order, the specific order is immaterial to the invention and is shown as an example of steps of forming a double-walled plate heat exchanger in accordance with the invention. Embodiments of the invention may include methods of forming or assembling any of the heat exchangers discussed herein or within the scope of the invention.

[0052] Another embodiment shown in FIG. **8** includes a double-walled plate heat exchanger **800** having a front plate **805** having a front skin **810** and a back skin **815**. Upon assembly of the double-walled plate heat exchanger **800**, the front and back skins **810**, **815** will be in contact. The front skin **810** has a small hole **820** above a bridge gasket **825** in a bridge gasket groove **826** near a first port **835**. A flow bridge **830** may have no gasket. The front plate **805** may have four ports **835**-**838** and may be a diagonal flow plate. Fluid may enter through one port, e.g., port **836**, flow through a center section **839**, and exit via a diagonally-opposite port, e.g., port **838**.

[0053] The back skin **815** may have supporting separators **840** ridges pressed into it. In one embodiment, the separators **840** may be ridges pressed upwards toward where the bridge gasket groove **826** of the front skin **810** will be when the double-walled plate heat exchanger **800** is assembled. The separators **840** may also be formed by attaching another object to the front skin **810**. These separators **840** maintain a gap between the two skins **810**, **815** when the skins **810**, **815** are pressed together upon assembly. If any puncture occurs through either the first skin **810** or the second skin **815**, fluid passes between the skins **810**, **815**. It can flow upwards, through a small inherent internal space between the skins **810**, **815**, until it reaches the bridge gasket groove **826**.

[0054] The gap forms a channel between the skins **810**, **815**, and collects fluid from a backside **870** of the front skin **810** behind the center section **839** over the entire distance of a flow width of the front plate **805**, and conducts that fluid all the way through to a depression **845** in the second skin **815**. The depression **845** may be located directly underneath the hole **820** in the first skin **810**. The backside **870** of the front skin **810** and front center **871** of the back skin **815** will be in contact upon assembly. Unless there is a leak, there will be no fluid in the space between the backside **870** of the front skin **810** and front center **871** of the back skin **815**

[0055] The fluid can rise up through the hole **820** of the first skin **805**, and then pass out through a leakage cutaway groove **848** of the gasket **850** and exit externally at an outer edge **855** of the front plate **805**. The front plate **805** may also have a groove depression **860** an outer side wall of the groove **848**, so there is a clear leakage slot allowing fluid to pass through to the outside.

[0056] Each item applied to the area near the first port **835**, e.g., the hole **820**, and the separators **840**, is also applied to the third port **837**. Fluid can emerge from the front plate **805**, either from the first leakage groove **845** near the first port **835** or a second hole **846** and second leakage groove **847** from the third port **837**. Each item described as being on the front plate **805** may be included in a back plate **880** having four ports **885-888**, except each is applied to the diagonally opposite ports, e.g., instead of to the first and third ports, they are applied to the second and fourth ports, e.g., ports **886**, **888**.

[0057] In another embodiment of a double-walled plate heat exchanger **900**, shown in FIG. **9**, the double-walled plate heat exchanger **900** includes a front plate **905** having front and back skins **910**, **915** and four ports **916-919**. The features applied in FIG. **8** to the areas near the first and third ports **835**, **837** are applied instead to areas near the second and fourth ports **917**, **919** of the plate **905**.

[0058] In this case, the front skin **910** may have at least one separator **920** formed on the flow port side of the plate in a flow bridge **925**. The separators **920** may be made by pressing into the front skin **910** or by attaching another object to the front skin **910** to maintain separation of the flow bridge **925** from its mating back skin bridge gasket **930**. Fluid may collect from a backside **970** of the front skin **910** behind a center section **939** over the entire distance of a flow width of the front plate **905**, and be conducted all the way through to a hole **935** in the second skin **915**. The backside **970** of the front skin **910** and front center **971** of the back skin **915** will be in contact upon assembly. Unless there is a leak, there will be no fluid in the space between the backside **970** of the front skin **910** and front center **971** of the back skin **915**

[0059] The back skin **915** has a leakage hole **935**. This permits liquid to flow out from between the skins **910**, **915**. Liquid may emerge and instead flow back from the back skin **915**, and leak toward the next plate **950**. The next plate **950** may have a leakage groove **955** in a gasket **960**. So again, the liquid leaks out externally. Fluid from the front plate **905** would emerge from a gasket leakage grove **955** in the next plate **950**. There may be an indentation **965** in the next plate **950** located where the back skin **915** would be upon assembly of the double-walled plate heat exchanger **900**. The back skin may have its own separators **980**, similarly to the front skin separators **920**.

[0060] The processes and devices in the above description and drawings illustrate examples of some methods and devices of many that could be used and produced to achieve the objects, features, and advantages of embodiments described herein. Thus, they are not to be seen as limited by the foregoing description of the embodiments, but only limited by the appended claims. Any claim or feature may be combined with any other claim or feature within the scope of the invention. The many features and advantages of the invention are apparent from the detailed specification, and, thus, it is intended by the appended claims to cover all such features and advantages of the invention which fall within the true spirit and scope of the invention. Further, since numerous modifications and variations will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described, and, accordingly, all suitable modifications and equivalents may be resorted to that fall within the scope of the invention.

1. A double-walled plate heat exchanger comprising:
a first plate comprising:
a first skin;
a second skin;
at least two port holes; and
a leakage escape path between the first and second skins for allowing leaked fluid to exit the double-walled plate heat exchanger, the leakage escape path being in contact with:
a leakage orifice in one of the skins; and
an outer edge of the double-walled plate heat exchanger; and
a second plate in contact with the second skin.

2. The double-walled plate heat exchanger of claim **1**, further comprising a separator configured to provide separation between the first and second skins near the at least one separator.

3. The double-walled plate heat exchanger of claim **2**, wherein:
the leakage orifice is located in the first plate; and
the second skin comprises:
a depression at least partially surrounding the leakage orifice in the first plate such that the first and second skins are separated near the depression and the leakage orifice; and
the separator.

4. The double-walled plate heat exchanger of claim **2**, wherein:
the leakage orifice is located in the second plate;
the second skin comprises the separator; and
the second plate comprises a leakage groove for allowing leaked fluid to exit the double-walled plate heat exchanger.

5. The double-walled plate heat exchanger of claim **2**, wherein the separator is provided as part of the leakage escape path.

6. The double-walled plate heat exchanger of claim **5**, wherein the leakage escape path further comprises a leakage groove.

7. The double-walled plate heat exchanger of claim **6**, wherein the gasket is recessed or eliminated at the leakage groove.

8. The double-walled plate heat exchanger of claim **2**, wherein the separator comprises at least one rib pressed into the first skin.

9. The double-walled plate heat exchanger of claim **2**, wherein the separator comprises an attachment to the first skin.

10. The double-walled plate heat exchanger of claim **9**, wherein the attachment to the first skin is removable.

11. The double-walled plate heat exchanger of claim **9**, wherein the attachment to the first skin is permanently attached.

12. The double-walled plate heat exchanger of claim **6**, wherein the leakage groove is in contact with an edge of the double-walled plate heat exchanger.

13. A method of managing a leak in a double-walled plate heat exchanger, the method comprising allowing fluid leaked between first and second skins of a first plate in a double-walled plate heat exchanger to exit the double-walled plate heat exchanger via a leakage escape path, the leakage escape path comprising a leakage orifice, the first plate further comprising first and second port holes.

14. The method of claim **13**, wherein the leakage escape path contacts an outer edge of the double-walled plate heat exchanger.

15. The method of claim **13**, wherein the leakage escape path further comprises a depression in the second skin at least partially surrounding the leakage orifice such that the first and second skins are separated near the at least one depression and the leakage orifice, the leakage orifice being located in the first skin.

16. The method of claim **15**, wherein the leakage escape path further comprises a separator in a skin of a second plate configured to provide separation between the first and second plates near the separator.

17. The method of claim **16**, further comprising collecting the leaked fluid for analysis and/or disposal.

18. The method of claim **17**, wherein the leaked fluid is collected at a predetermined location on the double-walled plate heat exchanger.

19. A double-walled plate heat exchanger, comprising:

leakage escape means for allowing fluid leaked between first and second skins of a first plate in a double-walled plate heat exchanger to exit the double-walled plate heat exchanger, the leakage escape means comprising leakage orifice means for allowing the leaked fluid to exit from between the first and second skins, the first plate having at least two port holes.

20. The double-walled plate heat exchanger of claim **19**, further comprising separating means for providing separation between the first and second skins near the separating means.

21. The double walled plate heat exchanger of claim **2**, wherein the separator is located in a heat exchanging portion of the plate.

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