(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 485 005 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
08.08.2012 Bulletin 2012/32

(51) Int Cl.:
F28D 9/00 *(2006.01)* ***F28F 3/02*** *(2006.01)*

(21) Application number: **11175949.4**

(22) Date of filing: **29.07.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **02.02.2011 US 19576**

(71) Applicant: **Hamilton Sundstrand Space Systems International, Inc.**
Windsor Locks CT 06096-1010 (US)

(72) Inventor: **Zaffetti, Mark A.**
Suffield, CT Connecticut 06078 (US)

(74) Representative: **Tomlinson, Kerry John**
Dehns
St Bride's House
10 Salisbury Square
London
EC4Y 8JD (GB)

(54) Heat exchanger assembly with fin locating structure

(57) A heat exchanger (10) includes a core (16) with layers (18A,B) and a closure bar (14A,B). The layers are arranged in a stack and include a first layer (18A) that is separated from abutting layers (18B) by a first parting sheet (24A) and a second parting sheet (24B). Fins (20A, B) are disposed between the first and second parting sheets and form one or more tabs (26A,B,C). The closure bar interfaces with the fins and receives the one or more tabs in one or more slots (28A,B,C).

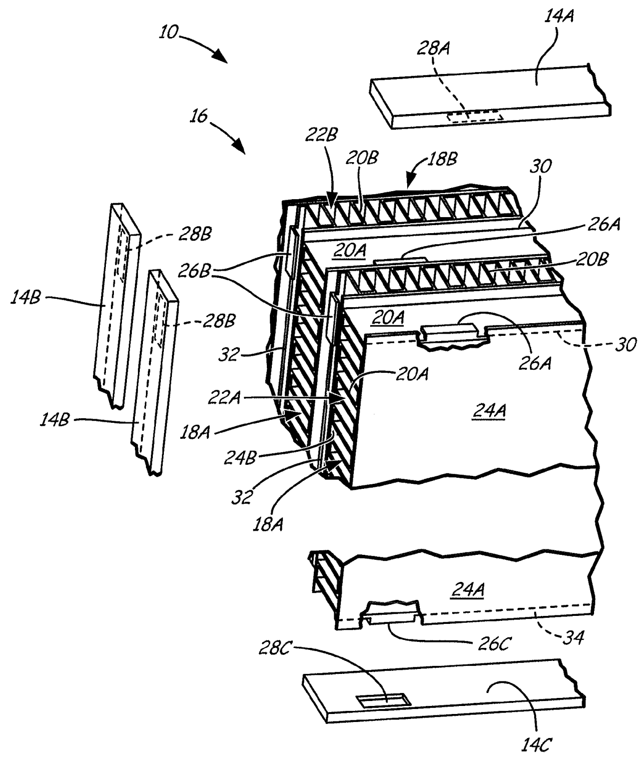


Fig. 2

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates generally to heat exchangers, and more particularly, to a structure for aligning layers that make up a core within heat exchangers.

[0002] Heat exchangers are used in a variety of applications. For example, aircraft, human manned spacecraft, and future Orion space vehicles will utilize heat exchangers as a part of systems for environmental control and life support and as a part of systems that cool electronics.

[0003] Plate-fin type heat exchangers with various fluid flow patterns are well known in the art. Typically, such heat exchangers have a core with stacked layers of corrugated fins. The corrugated fins produce geometries with extremely large surface areas. Each layer typically is mounted so that channels formed by the fins in one layer are oriented in a desired manner relative to channels formed by the fins in an adjacent layer. The orientation, geometry, and size of each layer relative to other adjacent layers is dictated by the level of heat transfer desired for a particular application. A fluid such as a coolant is introduced and flows between each of the stacked layers along the channels. Typically, the temperature of fluid introduced between a first layer in the stack differs from that of the temperature of a fluid introduced between the stacked layers immediately adjacent the first layer so as to facilitate heat transfer.

[0004] The stacked layers of plate-fin heat exchangers are typically bordered by closure bars, which act as structural members and seals to maintain fluid flow in the desired direction through the channels. Fluids are introduced to and collected from the stacked layers of the core by precisely sized and located holes which communicate with runners or a fluid manifold that may be integral to the closure bars.

[0005] Unfortunately, the typical method for assembling plate-fin type heat exchangers suffers from drawbacks that can reduce the effectiveness of the assembly during operation. In particular, the core layers must be precisely stacked relative to one another in a particular pattern so as to achieve a desired level of heat transfer. However, the assembly process is subject to error, for example, two layers of the stack with identical geometries could be placed immediately adjacent one another resulting in improper heat transfer between levels of the stack. Additionally, as the layers of the core are stacked prior to brazing the layers can shift during transport. The shifting of core layers not only can alter the geometry of the stacked layers vis-à-vis one another, but the shifted layers can also block or restrict the flow of fluid through the holes that communicate with the fluid manifold or runners.

SUMMARY

[0006] A heat exchanger includes a core with layers and a closure bar. The layers are arranged in a stack and include a first layer that is separated from abutting layers by a first parting sheet and a second parting sheet. The fins are disposed between the first and second parting sheets and form one or more tabs. The closure bar interfaces with the fins and receives the one or more tabs in one or more slots.

[0007] In another aspect, a method of aligning a core of a heat exchanger that has layers arranged in a stack. Each layer has one or more tabs formed by fins. A closure bar is also provided corresponding to each layer, each closure bar has one or more slots that receive and mate with the one or more tabs when each closure bar is assembled with each layer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Fig. 1 is a perspective view of a first embodiment of a heat exchanger with a core having a plurality of stacked layers surrounded on several sides by closure bars.

[0009] Fig. 2 is a perspective view of the heat exchanger from Fig. 1 illustrating upper, lower, and a side portion of several stacked layers with tabs formed by the fins and closure bars with slots.

DETAILED DESCRIPTION

[0010] Fig. 1 shows a portion of a heat exchanger 10 with runners 12 partially removed to reveal closure bars 14A and 14B that form outer portions of a core 16. Core 16 also includes interposed layers 18A and 18B. Layer 18A includes fins 20A that form channels 22A and shares parting sheets 24A and 24B with abutting layers 18B. Layer 18B includes fins 20B that form channels 22B and shares parting sheets 24A and 24B with abutting layers 18A.

[0011] Heat exchanger 10 has a construction and operation that is typical of cross-flow plate-fin type heat exchangers known in the art. For example, runners 12 surround portions of core 16 and act as fluid manifolds to communicate a cold fluid and a hot fluid to the core 16. Closure bars 14A and 14B are disposed inward of the runners 12 and interface with different sides of layers 18A and 18B respectively. In particular, closure bars 14A are disposed along first sides of layers 18A and act to seal layers 18A from a colder fluid introduced from runners 12 to layers 18B. Similarly, closure bars 14B are disposed along sides of layers 18B and act to seal layers 18B from a warmer fluid introduced from runners 12 to layers 18A. Additional closure bars (not illustrated) also seal opposing sides of layers 18A from colder fluid exiting the core 16 while closure bars (not illustrated) seal opposing sides of layers 18B from warmer fluid exiting the core 16.

[0012] Core 16 has layers 18A interposed with layers 18B to form a stacked arrangement. Layers 18A and 18B are connected together by known processes such as brazing. Each layer 18A or 18B has fins 20A or 20B that extend along its length in alternating arrangements. Fins 20A and 20B form open ended channels 22A and 22B that extend the length of each layer 18A or 18B. Channels 22A communicate warmer fluid through layers 18A from a first side to an opposing side of core 16 (not shown). Channels 22B communicate colder fluid through layers 18B from a third side to an opposing fourth side of core 16 (not shown). Layers 18A and 18B are separated by alternating parting sheets 24A and 24B which act to separate the warmer fluid from the colder fluid. Sheets 24A are sandwiched between and connected to both fins 20A and closure bar 14A on a first surface and fins 20B and closure bar 14B on a second surface that is opposed to the first surface. Sheets 24B are arranged in a similar manner with fins 20A and closure bar 14A and fins 20B and closure bar 14B connected to opposing surfaces thereof.

[0013] The operation of heat exchanger 10 is well known in the art. In a cross-flow heat exchanger such as heat exchanger 10 illustrated in Fig. 1, fluids such as coolant are introduced to sides of core 16 but do not mix. The fluids flow along channels 22A and 22B to opposing sides of the core 16 stack from where they were introduced. The temperature of fluid introduced to abutting layers 18A and 18B differs so as to facilitate a desired amount of heat transfer between the layers 18A and 18B from hotter fluid to the cooler fluid.

[0014] Although heat exchanger 10 is illustrated as a cross-flow plate-fin heat exchanger with fluid flow in alternating directions, in other embodiments the heat exchanger 10 can be configured in other manners known in the art such as a redundant flow, multi-pass or counterflow type heat exchanger. Although corrugated fins are illustrated in Fig. 1, other fin geometries are contemplated as desired.

[0015] Fig. 2 is a perspective view of upper, lower, and a side portion of core 16 of heat exchanger 10. Rather than showing the entire core 16, Fig. 2 illustrates several abutting repeating layers 18A and 18B that include tabs 26A, 26B, and 26C. Fig. 2 also illustrates closure bars 14A, 14B, and 14C with slots 28A, 28B, and 28C.

[0016] In Fig. 2, tabs 26A, 26C are portions of fins 20A and tabs 26B are portion of fins 20B. Although illustrated with tabs 26A, 26B, and 26C on three sides of core 16 in Fig. 2, other embodiments can have tabs extending only from single alternating sides of core 16. In Fig. 2, parting sheet 24A has been partially broken away to reveal tab 26A. Tab 26A of each layer 18A extends outward of first edge 30 of fins 20A. At an angle of substantially 90° to and offset from first edges 30 of layers 18A, each layer 18B has at least one tab 26B that extends outward of second edges 32 of fins 20B. Fins 20A have a third edge 34 that extend along an opposing side of core 16 from first edges 30. In the embodiment shown in Fig. 2, layers 18A have tabs 26C that extend outward of third edges 34 of fins 20A. Similarly, layers 18B have a corresponding closure bar 14D (not shown) are disposed along an opposing side of core 16 from second edge 32. Fins 20B can have one or more tabs that extend outward of fourth edges.

[0017] When assembled on core 16, closure bars 14A interface with and are inserted between parting sheets 24A and 24B for layers 18A in the alternating pattern shown. The connection can be accomplished by typical means, for example brazing. Closure bars 14A seal first edge of core 16 allowing warmer fluid to pass through channels 22A without mixing with colder fluid passing through channels 22B. Slots 28A are disposed in an inward interfacing surface of closure bars 14A and are configured and sized to receive and mate with tabs 26A. On an opposing side of core 16 closure bars 14C have slots 28C that mate with tabs 26C.

[0018] When assembled on core 16 closure bars 14B are at substantially 90° to and offset from closure bars 14A and 14C. Closure bars 14B interface and are inserted between parting sheets 24A and 24B in the alternating pattern shown. Closure bars 14B seal second edge of core 16 allowing colder fluid to pass through channels 22B without mixing with warmer fluid passing through channels 22A. Slots 28B are disposed in an inward interfacing surface of closure bars 14B and are configured and sized to receive and mate with tabs 26B. The slots 28A, 28B, 28C are formed only partially through the respective closure bars so as to maintain the sealing function thereof.

[0019] As illustrated in Fig. 2, stacked layers 18A are configured and arranged in a pattern such that tabs 26A of layers 18A are offset from one another but are in substantially a same position along a length of first edges 30 for each layer 18A. Slots 28A that mate with tabs 26A of every layer 18A are disposed at substantially the same location along the length of the closure bar 14A making closure bars 14A substantially identical in the embodiment shown in Fig 2.

[0020] Tabs 26B have a different size than tabs 26A and are offset from and disposed along a length of second edges 32 that is not the same as the location of tabs 26A along the first edge 30. Thus, slots 28A of closure bars 14A could not mate with tabs 26B of layers 18B if an attempt was made to improperly assemble the two pieces together.

[0021] Tabs 26C extending from third edges 34 of fins 20A are disposed at a different position along the length of fins 20A than tabs 26A on the opposing side of core 16. In the embodiment shown in Fig. 2, slots 28C that mate with the tabs 26C have a different location along a length of closure bars 14C than slots 28A of closure bars 14A. In other embodiments, tabs 26C and tabs 26A can be substantially aligned across opposing sides of layers 18A from one another and closure bars 14A and 14C can be identical.

[0022] It is to be noted that each tab 26A, 26B, 26C, is joined to its corresponding edge 30, 32, 34 of the fin via a joining portion whereby the tab which enters the slot in the closure bar is spaced apart from the fin; this provides for a fluid flow channel between the find and the closure bar.

[0023] Heat exchanger 10 benefits from the arrangement of tabs 26A, 26B, 26C and slots 28A, 28B, 28C to achieve accurate alignment of core 16 layers 18A and 18B relative to one another. For example, alignment of each layer is achieved by disposing each layer 18A and 18B into an interfacing arrangement with the respective closure bars such that tab(s) of each layer mates with corresponding slot(s). The arrangement of tabs and slots reduces alignment error when stacking layers 18A and 18B because only a specifically located and/or sized tab can fit in a correspondingly located and/or sized slot. Additionally, tabs mate with slots to restrain layers from shifting relative to one another during manufacture prior to the brazing thereby helping to maintain proper core geometry and proper communication between the fluid manifolds formed by runners 12 and channels 22A and 22B.

[0024] While the invention has been described with reference to an exemplary embodiment(s), it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment(s) disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

Claims

1. A heat exchanger comprising:

   a core comprising a plurality of layers arranged in a stack having a first layer separated from abutting layers by a first parting sheet and a second parting sheet and fins disposed between the first and second parting sheets, the fins having one or more tabs that extend from a first edge thereof; and
   a closure bar disposed parallel with the first edge to close the first layer and having one or more slots that mate with the one or more tabs.

2. The heat exchanger of claim 1, wherein the one or more tabs are disposed on a first side of the core and the abutting layers have one or more tabs disposed on a second side of the core that is substantially perpendicular to the first side.

3. The heat exchanger of claim 1 or 2, wherein one or more tabs of the first layer extend outward of opposing sides of the core.

4. The heat exchanger of claim 3, wherein the one or more tabs are in different positions relative to one another on the opposing sides of the core or have a different size relative to one another.

5. The heat exchanger of claim 1, 2, 3 or 4, wherein the stacked layers are configured and arranged in a pattern such that every other layer in the stack has one or more tabs offset from one another but in substantially a same lengthwise position along a same side of the core as each other, and wherein the one or more slots that mate with the one or more tabs for every other layer of the stack are at substantially the same location in the closure bar.

6. The heat exchanger of any preceding claim, wherein the abutting layers in the stack have fins with one or more tabs which have a different size than the one or more tabs of the first layer.

7. A method of aligning the core of a heat exchanger, the method comprising:

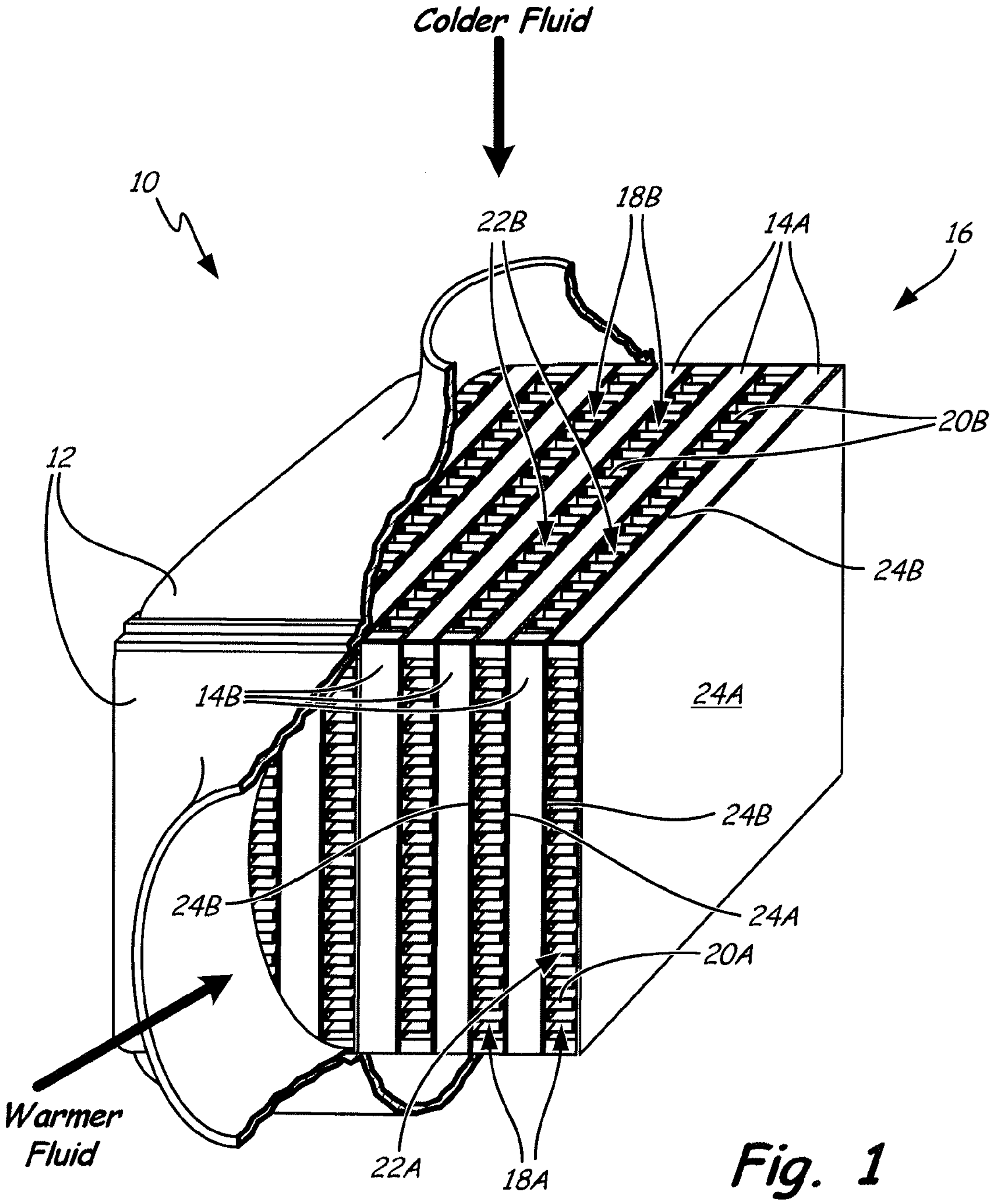
   providing a plurality of layers arranged in a stack, each layer having fins that form one or more tabs;
   providing one or more closure bars having one or more slots corresponding to the one or more tabs; and
   disposing an edge of each layer into an interfacing arrangement with the closure bars such that the one or more tabs mate with the corresponding one or more slots.

8. The method of claim 7, wherein each fin has tabs that extend from two opposing edges thereof.

9. The method of claim 7 or 8, wherein abutting layers of the stack have one or more tabs extending from a different side of the core from one another.

10. The method of claim 7, 8 or 9, wherein the stacked layers are configured and arranged in a pattern such that every other layer in the stack has one or more tabs offset from one another but in substantially a same lengthwise position along a same side of the core as each other, and wherein the one or more slots that mate with the one or more tabs for every other layer of the stack are at substantially the same location in the closure bar.

11. The method of claim 7, 8, 9 or 10, wherein the at least one tab and corresponding mating slot has a different size for abutting layers in the stack.



Colder Fluid
10
22B
18B
14A
16
20B
12
24B
14B
24A
24B
24B
24A
20A
Warmer Fluid
22A
18A

Fig. 1

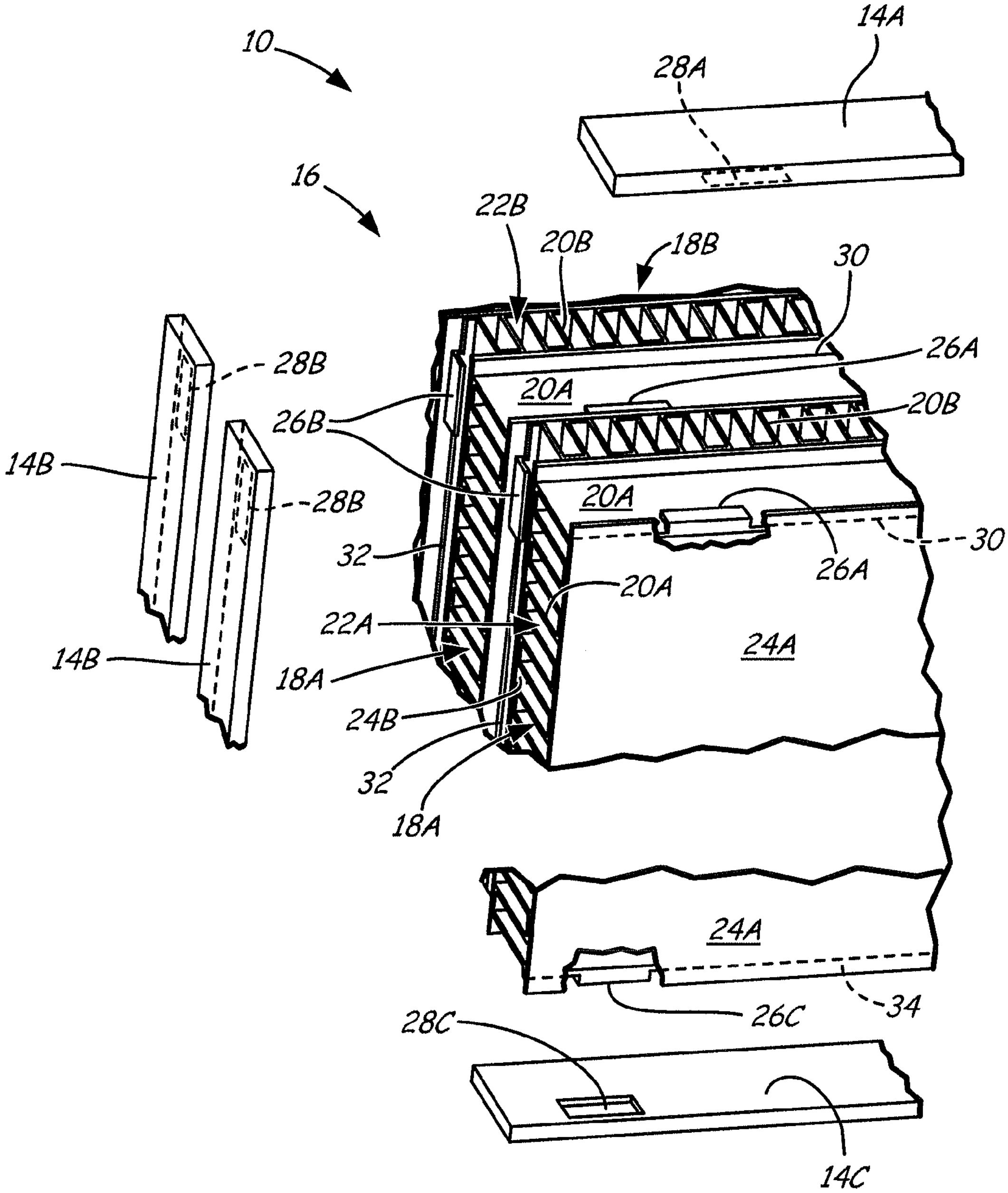

10
14A
28A
16
22B
20B
18B
30
26A
20A
20B
28B
26B
14B
28B
20A
30
32
26A
20A
22A
24A
14B
18A
24B
32
18A
24A
26C
34
28C
14C

Fig. 2