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Description

The present invention relates to a heat exchanger in accordance with the prior art portion of claim 1.

A heat exchanger having the features indicated in the prior art portion of claim 1 is known by EP—A—44 561 (Fig. 10). This prior art heat exchanger requires complicated additional separate inlet and outlet means. The panel design comprises two different types of panels arranged alternatingly requiring the complicated inlet and outlet structure.

The plate/fin type heat exchangers are mainly of the channel and rib type construction. Countercurrent flow can be achieved. however. manifolding a plate stack which must separate the fluids at entry and exit becomes extremely complex. In that manifolding of the crosscurrent heat exchangers is comparatively simple, this heat exchanger system is more widely used although it is less efficient than the countercurrent system and it induces serious thermal and mechanical stresses.

One countercurrent system which has attempted to solve the manifolding problem of the countercurrent heat exchanger is taught by Campbell et al. U.S. Patent 3.305,010. Campbell et al teach a heat exchanger having superposed stacked plate and fin elements and complex manifolding means for introducing fluids of different temperatures into opposite ends of the assembly. However, Campbell et al do not teach a plate which serves as both the plate and the fin, nor does Campbell et al teach means for internally manifolding the plate within the plate's plane.

Another countercurrent system, Fig. 1, is that of Alfa-Laval described in the Proceedings of the 5th OTEC Conference, Miami, Florida (Feb. 1978) Pages VI 288-320. The Alfa-Laval concept consists mainly of a pack of thin metal plates, a frame and means of keeping the pieces together. The plates are suspended between horizontal carrying bars at top and bottom and compressed against the stationary frame plate by means of tightening bolts and a movable pressure plate. The frame plate is equipped with nozzles for inlet and outlet connections. Every plate is sealed around its perimeter with a gasket and cemented into a pressed track. Flow ports at each of the plate corners are individually gasketed and thus divide the interplate spaces into two systems of alternating flow channels. Through these, the two media pass, the warmer medium giving up heat to the cooler by conduction through the thin plates. This gasket arrangement eliminates the risk of media interleakage. The plate, which is the basic element of this concept, has a corrugated pattern stamped on it. These corrugations can be arranged to create an unlimited number of plate patterns. The specific pattern results from a careful trade-off between drop and convective heat transfer characteristics.

The gaskets in the Alfa-Laval system are cemented to the plates in pressed tracks, and are generally made of elastomers like natural rubber, nitrile, butyl, neoprene, viton, etc. The material selection depends upon the working conditions, however, the upper limits are about 360 PSI and about 400°F.

In view of this prior art, the present invention is based on the object of providing a heat exchanger of the above-mentioned type having a simple unitary design not requiring complicated inlet and outlet means.

This object is achieved by a heat exchanger in accordance with the prior art portion of claim 1 having the features indicated in the characterising portion thereof.

Brief Description of the Drawings

Fig. 1 is prior art. It is a top view of a prior art corrugated plate.

Fig. 2a is a perspective schematic view of the open-faced internally manifolded fin plate.

Fig. 2b is a top schematic view of the open-faced internally manifolded fin plate.

Fig. 2c is an open-end schematic view of an open-faced internally manifolded plate.

Fig. 2d is a prespective schematic view of an open-faced internally manifolded plate stack.

Fig. 3a shows an additional schematic embodiment of the internal manifold for the open-faced internally manifolded plate.

Fig. 3b shows another schematic embodiment of the internal manifold for the open-faced internally manifolded plate.

Fig. 4a is the top view of another schematic embodiment of the fin-channel configuration.

Fig. 4b is a top view of yet another schematic embodiment of the fin-channel configuration.

Fig. 4c is a third schematic top view of a fin-channel configuration.

Fig. 5 is a schematic end view of the open-faced internally manifolded fin plate showing various goemetries of channels and fins.

Fig. 6a is a schematic top view of an open-faced internally manifolded fin plate having integral external side and end manifolds.

Fig. 6b is another schematic top view of an open-faced internally manifolded fin plate having integral interior side and end manifolds.

Fig. 7a is a perspective view of a single internally and externally manifolded plate.

Fig. 7b is a perspective view of the open-faced internally manifolded plate stack having side and end manifolds integrally connected with the open-fàced internally manifolded plate.

Fig. 7c is an enlarged fragmentary perspective showing relative proportions of fins, channels and manifolding means.

Description of Preferred Embodiments

In accordance with the present invention there is provided an internally manifolded fin plate for a plate/fin-type heat exchanger. Although it is preferred that plate 10 be of unibody construction, a plurality of components may be connected to make up a single plate. Referring to Figs, 2a, 2b and 2c, there is shown the basic unibody, one piece, fin plate 10 which comprises open-face 12, and side ports 14, 14 transversely oriented through top edge 17 of fin plate 10.

Side plates 14, 14 are integral, contiguous with and connected by internal manifolding means 16 which extend the full width of the fin plate 10. Closed end 18 is adjacent to and lateral with the aft end of internal manifolding means 16. Channels 20 formed by fins 22 are contiguous with and transverse to the forward end of the manifolding means 16 and direct fluid flow to end ports 24. Flat bottom 26 provides a heat transfer surface for connecting to fins 22 of an adjacent plate, means for separating fluids, as well as a means for sealably connecting the fin plates 10 in a plate stack. It should be noted that the plate stack can be used for high or low pressure situations and that internal leakage paths are non-critical. Plate cover 15 can either be solid, as shown, or merely another basic fin plate 10. Additionally, Fig. 2b shows optional manifold fins 28. Manifold fins 28 provide added support and additional means to transfer heat.

Referring now to Fig. 2d, there is shown a schematic representation of an internally manifolded plate stack 30 comprising a plurality of internally manifolded fin plates 10. In the preferred operating condition, fin plates are stacked in a manner in alternating sequence. It should be noted, for each embodiment, that although the fins 22 are shown in a vertical line. they may be staggered, Fig. 7b. Also, although in the preferred operating conditions these fin plates are the same, the internal design on alternating fin plates may be varied to accomplish the desired thermodynamic effects. In the preferred operating sequence, a first fluid is conveyed in through side ports 14 of alternating fin plates, into internal manifold 16, along channels 20 formed by fins 22, and exits through end ports 24. A second fluid of either higher or lower temperature is similarly introduced through the side ports 14 of the next alternating fin plate resulting in countercurrent flow. Although this is the preferred direction of flow, it is within the scope of this invention to have flow in a reverse manner wherein the fluid enters through end ports 24, flows down the channel 20 into the internal manifold 16, and exits through side port 14. The flow could also be parallel by introducing one fluid through the side port 14 and the other fluid through the end port 24 of the adjacent fin plate. It should be noted that the first and second fluids may be the same or different and that depending upon thermodynamic requirements, more than two fluids may be used.

Referring now to Figs. 3a and 3b, there is shown two additional embodiments of the internal manifolding means 16. Said manifolding means 16 may have a tapered geometery as defined by an angle 33. In Fig. 3a, the internal manifold 16 has two side ports 14, 14 and the taper narrows as the fluid reaches mid-point 32. At mid-point 32 an optional barrier 34 can be inserted. In Fig. 3b, the embodiment shows internal manifold 16 having one side port 14 and the taper goes across the full width of the fin plate narrowing as it reaches the closed side 23. Although these are only three internal manifolding geometries displayed herein, any other internal manifold geometry which could channel the fluid from a side port 14 to the channel 20 is within the scope of this invention.

Referring now to Figs. 4a, 4b and 4c, there is shown additional geometries for fins 22 and channels 20. In Fig. 4a, the fins 22 and channels 20 are randomly inserted within the main channel 20 of the basic fin plate 10. In contrast to that, fin geometry in Figs. 4b and 4c shows inline intermittent fin geometries. Intermittent fin row can either be alternating as shown in Fig. 4b, or inline as shown in Fig. 4c. The channel surface may be either smooth or rough depending upon the specific design requirements, and it should be noted that no matter what fin geometry is used, the fins and channels are designed to enhance structural integrity as well as overall heat transfer performance. Also, channels may taper in both depth and width.

Referring now to Fig. 5, there is shown a plurality of channel and fin shapes. The most conventional channel and fin shape is that which is represented by channel 20 and fin 22. However, channels of different configurations such as those with rounded corners 36, U-shaped 38, V-shaped 40, and trapezoidal-shaped 42, along with their respective fin shapes are also within the scope of the invention. One critical feature of the present invention is that the channel and fins combine to enhance heat transfer and structural integrity while the channel itself is open-faced, thus allowing ease of manufacture. Additionally, it should be noted that the channels themselves may be either smooth or rough, or corrugated or have any other surface goemetry which would enhance flow and heat transfer.

Referring now to Fig. 6a, there is shown the top view of the internally and auxiliary manifolded open-faced fin plate 62. Fin plate 62 is basically the same as fin plate 10, however, fin plate 62 additionally comprises closed end external manifold 64, open end external manifold 66, and two pairs of side manifolds 68, 70. Each pair of side manifolds comprise a side inlet manifold 68 and a diagonally located side closed manifold 70. All external manifolds are integral and contiguous with fin plate 10. Although external manifolds are shown with rectangular goemetries, any geometry capable of transferring fluid to and from the fin plate will work.

Referring now to Fig. 6b, there is shown the top view of the internally and interiorly manifolded open-faced fin plate 63. Plate 63 is basically the same as fin 62, however, fin plate 63 additionally comprises closed end auxiliary manifold 64, open end auxiliarly manifold 66, two pairs of interior side manifolds 68, 70 and a pair of interior inlets 65. Each pair of interior side manifolds comprise a side inlet manifold 68 and a diagonally located side closed manifold 70.

Referring now to Figs. 7a, 7b and 7c, there is shown various views of an internally manifolded fin plate and plate stack assembly 72. In the preferred operating condition, fin plates are stacked in an opposed manner in alternating sequence. A first fluid is conveyed to inlet side manifold 68 wherein said fluid flows in through side port 14 along the internal manifolding means 16 and is turned to flow down channels 20 formed by fins 22. This first fluid then flows out end port 24 and into open end auxiliary manifold 66. From the auxiliary manifold 66 the first fluid is then conveyed to any appropriate location. A second fluid either warmer or cooler than the first fluid is conveyed into the adjacent fin plates through its respective side inlet manifold 68. Then, similarly to the flow of the first fluid, the second fluid is conveyed in through entry port 14 along the internal manifold 16, down channels 20 and along fins 22. From there the second fluid exits into its respective open end secondary manifold 66 where it would be conveyed to any appropriate location. Closed end secondary manifolds 64 and side closed manifolds 70 are used to make continuous secondary manifolds between alternating fin plates. It should be noted that although the side and end manifolds are shown to be rectangular in shape, any functional shape will have the desired effect. Furthermore, heat exchanger fluids may be liquids or gases or combinations of liquids and gases.

Depending upon the ultimate use and desired heat transfer rate, various plate thicknesses, channel and fin ratios, length and width ratios and various thermally conductive materials can be used. The following materials are. delineated by way of example; metals, ceramics polymers.

The above design is the first real automated means for manufacturing heat exchangers. This will reduce the labor manhours involved in cutting, brazing, welding, leak checking, etc., compared to tube in shell and plate/fin heat exchangers. Moreover, the scaling of the design allowed provides a wide latitude of sizes, materials and fluids.

The basic technical merit provided by the design, presented in Fig. 7c, is that it allows a fundamental counterflow heat exchange design with all working surfaces having equal ΔT to the adjacent surface. As can be seen, each passage (cold or hot) has an adjacent passage (hot or cold) on each side. Bonded joint 11 between plates 10, permits the thermal conduction from plate to plate and thereby considerably enhances heat exchanger efficiency over a non-contacting joint design such as the Alfda-Laval concept. The tailoring of the coolant passages to provide variable flow area is allowed in the design, both in width and height with an appropriate change in wall and land thicknesses. In the basic heat exchange process, the best heat exchange efficiency is provided with a pure frictional flow process. Any turbulence due to waviness, protuberances or roughness results in an inefficient pressure loss and an actual decrease in overall heat transfer. If heat exchanger compactness is basically desired, the heat exchange benefit of waviness, roughness, interrupted fins, etc., can be put into the IMPS design by coining, etching, milling, etc., at some expense to the flow pressure losses. The added advantage of a different groove size geometry with simple tooling changes becomes an added feature of the design.

The internal manifolding feature, as shown throughout the Figures, allows for both a minimum flow entrance loss and the internal manifold design provides for heat exchange within the manifold section, thus providing for the highest efficiency in a given length design.

Claims

1. A heat exchanger comprising a stack of fin plates (10), each plate being provided with a plurality of integral projecting ribs (22) defining a plurality of channels (20) and an open end port (24) therebetween, with a closed end (18) lateral to said ribs and an internal manifold (16) between said ribs and said closed end, the ribs and the closed end being of the same height, whereby further said heat exchanger is provided with two pairs of side manifolds (68, 70) for the flow of a first and a second fluid, characterized in that each fin plate has adjacent the closed end (18) and the open end port (24) a closed end external manifold (64) and an open end external manifold (66), both integral and contiguous with each of said fin plates, whereby said two pairs of side manifolds (68, 70) are located diagonally at each side of each plate, when said plates are stacked upon one another in alternating sequence.

2. A heat exchanger as claimed in claim 1, characterized in that the ends of the channels (20) remote from the end manifold (16) terminate in end openings (24) in the end plane of the panel (10) and the plate (26) and provide outlet openings.

3. A heat exchanger as claimed in claim 1 or 2, characterized in that the cross section of the end manifold (16) varies from the opening towards the longitudinal middle thereof or towards the other end (Fig. 3a, b).

4. A heat exchanger as claimed in claim 1, 2 or 3, characterized in that the manifold has only one inlet opening (Fig. 3b).

5. A heat exchanger as claimed in any of the claims 1 to 4 characterized in that the panel at the manifold end has a closed outer manifold (64) and at the channel opening end, an open, outer manifold section (66), which is connected with all end openings (24), that open, outer side manifold sections (68) are provided on the outside of the panel plate sides (62, 63) at the ends of and in connection with the inner end manifold (16) and closed outer side manifold sections (70) are provided at corresponding locations at the opposite ends of the side walls (62, 63) (Fig. 6).

Patentansprüche

1. Ein Wärmetauscher mit einem Stapel von Rippenplatten (10), von denen jede mit einer

Mehrzahl von einstückig vorstehenden Rippen (22) versehen ist, die eine Mehrzahl von Kanälen (20) und eine offene Endöffnung (24) zwischen denselben festlegen, mit einem lateral bezüglich der Rippen angeordneten geschlossenen Ende (18) und einem inneren Verzweigungsstück (16) zwischen den Rippen und dem geschlossenen Ende, wobei die Rippen und das geschlossene Ende dieselbe Höhe haben, wobei ferner der Wärmetauscher mit zwei Paaren von Seitenverzweigungsstücken (68, 70) für die Strömung eines ersten und zweiten Fluids vorgesehen ist. dadurch gekennzeichnet, daß jede Rippenplatte benachbart zu dem geschlossenen Ende (18) und der offenen Endöffnung (24) ein äußeres Verzweigungsstück (64) mit geschlossenem Ende und ein äusseres Verzweigungsstück (66) mit offenem Ende aufweist, die jeweils einstückig und angrenzend bezüglich einer jeden Rippenplatte ausgebildet sind, wodurch die beiden Paare von Seitenverzweigungsstücken (68, 70) diagonal an jeder Seite einer jeden Platte angeordnet sind, wenn die Platten aufeinander in einer alternierenden Folge gestapelt sind.

2. Ein Wärmetauscher nach Anspruch 1, dadurch gekennzeichnet, daß die Enden der Kanäle (20), die von dem Endverzweigungsstück (16) entfernt sind, in Endöffnungen (24) der Endebene der Tafel (10) und der Platte (26) enden und Auslaßöffnungen bilden.

3. Ein Wärmetauscher nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß der Querschnitt des Endverzweigungsstückes (16) sich von der Öffnung in Richtung auf dessen Mittelabschnitt in Längsrichtung oder in Richtung auf das andere Ende (Fig. 3a, b) ändert.

4. Ein Wärmetauscher nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß das Verzweigungsstück lediglich eine Einlaßöffnung (Fig. 3b) aufweist.

5. Ein Wärmetauscher nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß die Tafel an dem Verzweigungsstückende ein geschlossenes äußeres Verzweigungsstück (64) sowie an dem Kanalöffnungsende einen offenen, äußeren Verzweigungsstückabschnitt (66) aufweist, der mit sämtlichen Endöffnungen (24) verbunden ist, daß offene, äußere Verzweigungsstückabschnitte (68) an der Außenseite der Tafelplattenseiten (62, 63) an den Enden des inneren Endverzweigungsstückes (16) und in Verbindung mit diesem vorgesehen sind, und daß geschlossene äußere Seitenverzweigungsstückabschnitte (70) an entsprechenden an den entgegengesetzten Enden der Seitenwände (62, 63) vorgesehen sind (Fig. 6).

Revendications

1. Echangeur de chaleur comportant une pile de plaques à ailettes (10), dont chacune comporte une pluralité de nervures saillantes (22) formées d'un seul tenant et définissant une pluralité de profilés en U (20) et un orifice d'extrémité ouvert (24) situé entre les nervures, une extrémité fermée (18) disposée latéralement par rapport auxdites nervures et un collecteur interne (16) situé entre lesdites nervures et ladite extrémité fermée, les nervures et l'extrémité fermée possédant la même hauteur, et dans lequel en outre ledit échangeur de chaleur comporte deux couples de collecteurs latéraux (68, 70) pour l'écoulement d'un premier et d'un second fluides, caractérisé en ce que chaq'ue plaque à ailettes comporte, au voisinage de l'extrémité fermée (18) et de l'orifice d'extrémité ouvert (24), un collecteur extérieur d'extrémité, fermé (64) et un collecteur extérieur d'extrémité, ouvert (66), ces deux collecteurs étant réalisés d'un seul tenant et contigus avec chacune desdites plaques à ailettes, lesdits deux couples de collecteurs latéraux (68, 70) étant situés en diagonale de chaque côté de chaque plaque, lorsque lesdites plaques sont empilées les unes sur les autres selon une succession alternée.

2. Echangeur de chaleur selon la revendication 1, caractérisé en ce que les extrémités des profilés en U (20), qui sont distantes du collecteur d'extrémité (16), se terminent par des ouvertures d'extrémité (24) située dans le plan d'extrémité du panneau (10) et de la plaque (26) et forment des ouvertures de sortie.

3. Echangeur de chaleur selon la revendication 1 ou 2, caractérisé en ce que la section transversale du collecteur d'extrémité (16) varie depuis l'ouverture en direction de sa partie médiane longitudinale en direction de l'autre extrémité (figure 3a, b).

4. Echangeur de chaleur selon la revendication 1, 2 ou 3, caractérisé en ce que le collecteur comporte uniquement une ouverture d'entrée (figure 3b).

5. Echangeur de chaleur selon l'une quelconque des revendications 1 à 4, caractérisé en ce que le panneau au niveau de l'extrémité du collecteur comporte un collecteur extérieur fermé (64) et, au niveau de l'extrémité d'ouverture des profilés en U, une section ouverte du collecteur extérieur (66), qui est raccordée à toutes les ouvertures d'extrémité (24), que des sections ouvertes du collecteur latéral extérieur (68) sont prévues à l'extérieur des faces (62, 63) de la plaque du panneau, sur les extrémités du collecteur d'extrémité intérieur (16) et sont reliées à ce dernier, et des sections fermées du collecteur latéral extérieur (70) sont prévues en des emplacements correspondants, sur les extrémités opposées des parois latérales (62, 63) (figure 6).

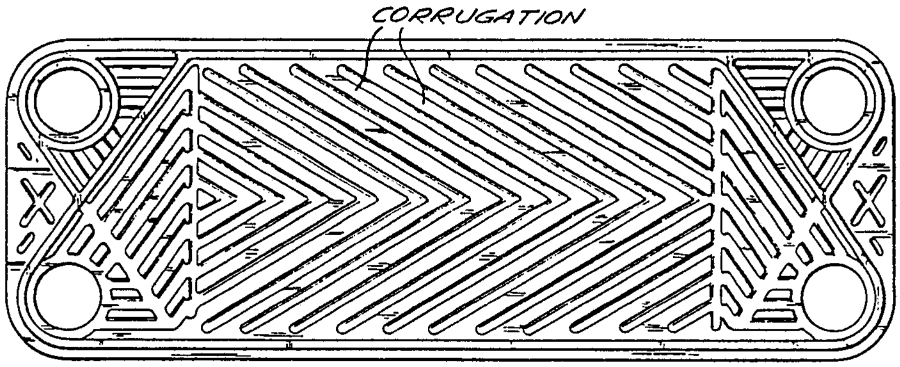
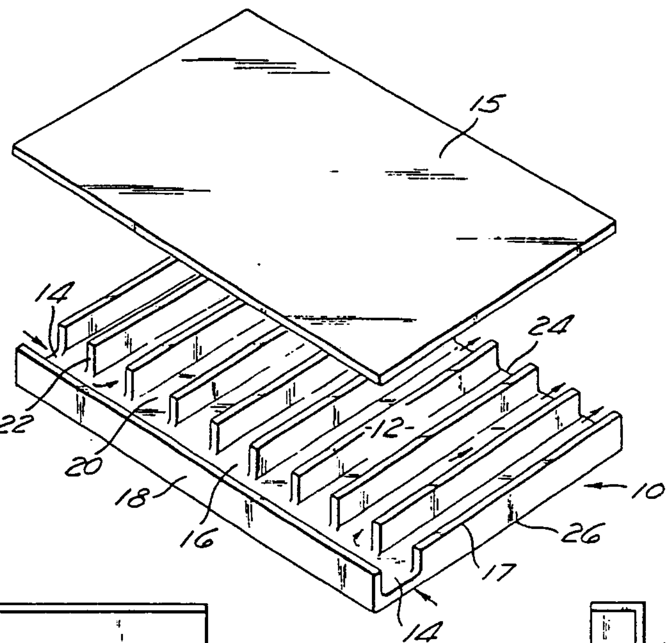


Fig. 1 (PRIOR ART)

Fig. 2a



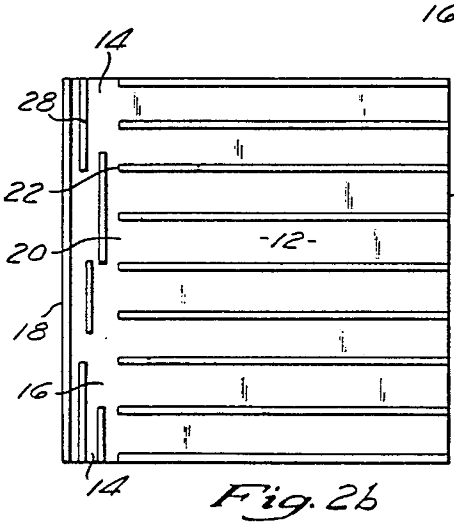


Fig. 2b

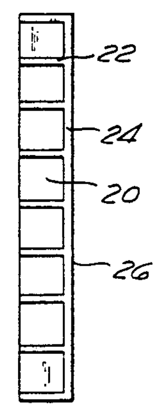
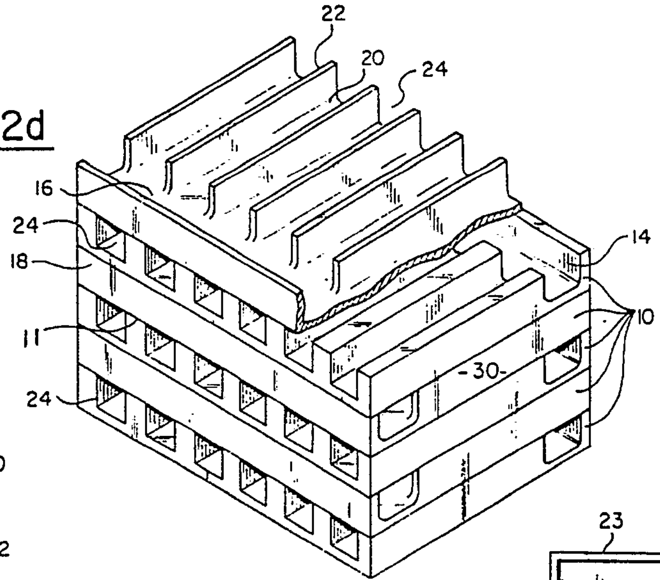


Fig. 2c

FIG. 2d



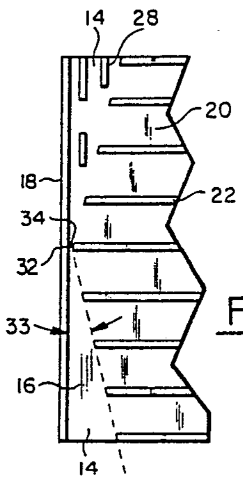


FIG. 3a

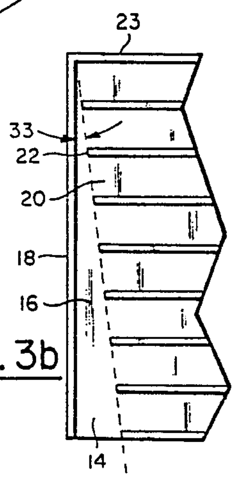


FIG. 3b

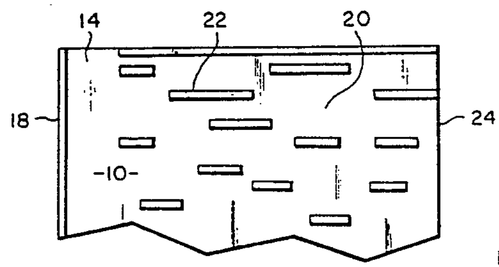


FIG. 4a

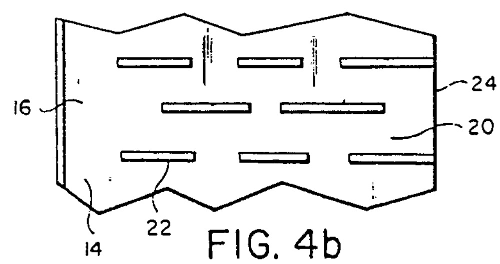


FIG. 4b

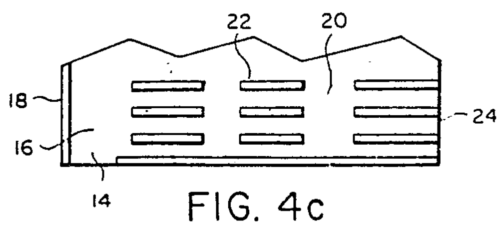


FIG. 4c

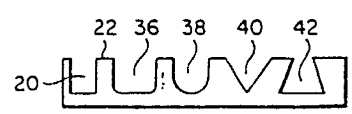


FIG. 5

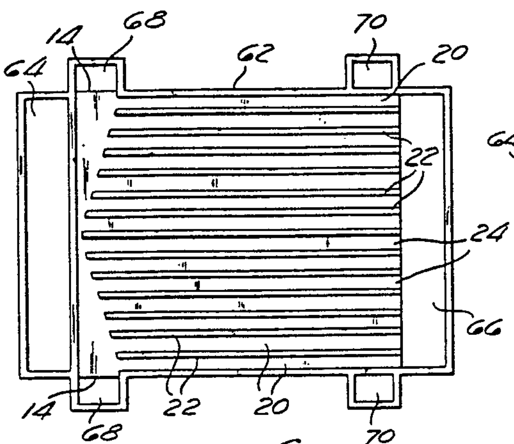


Fig. 6a

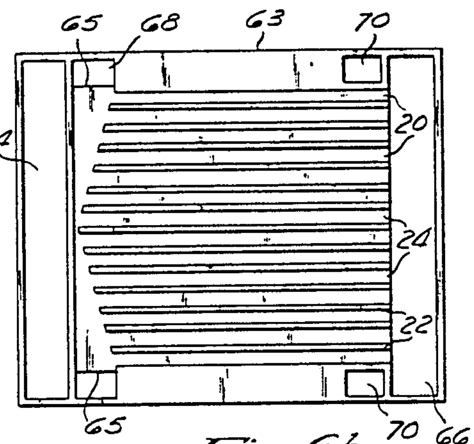
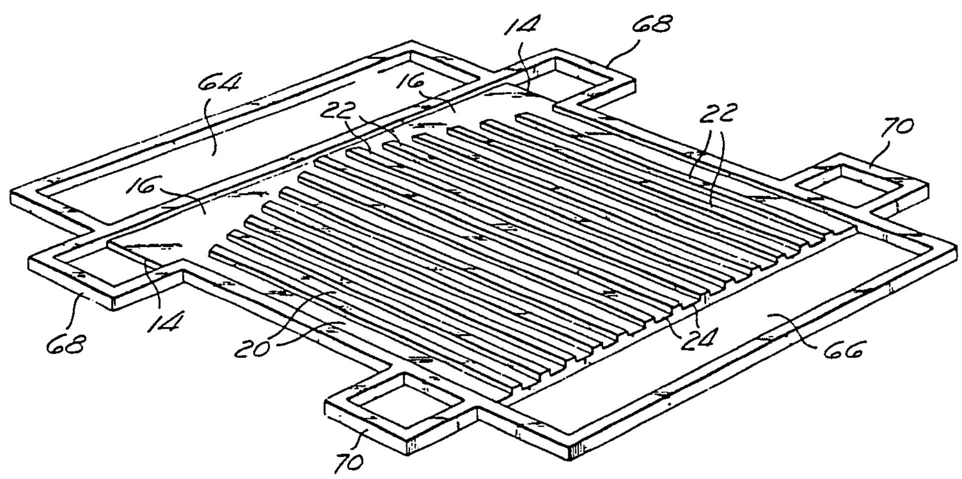
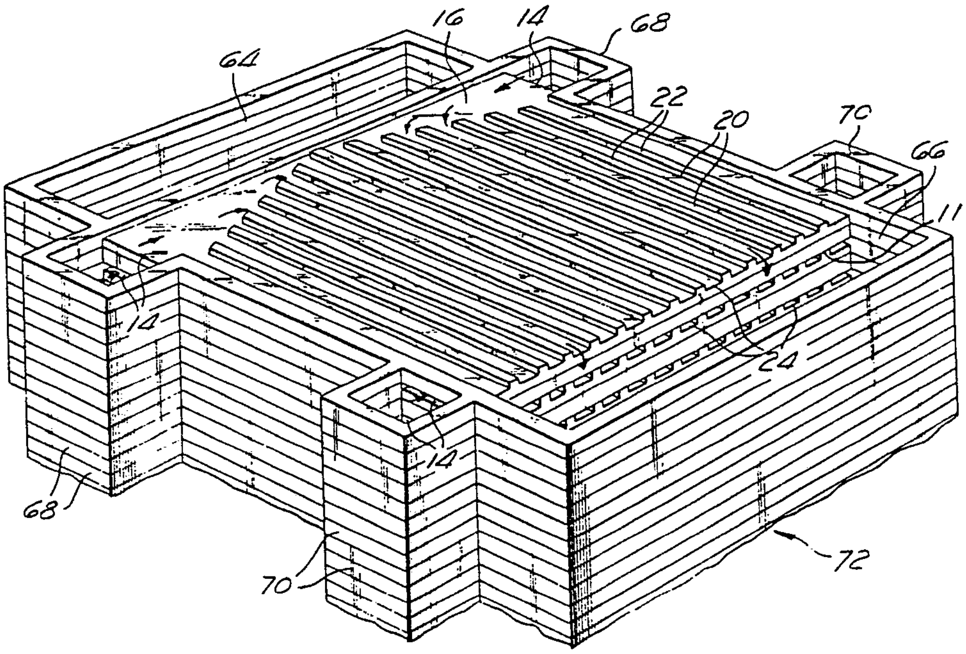


Fig. 6b

Fig. 7a




16
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72

Fig. 7b

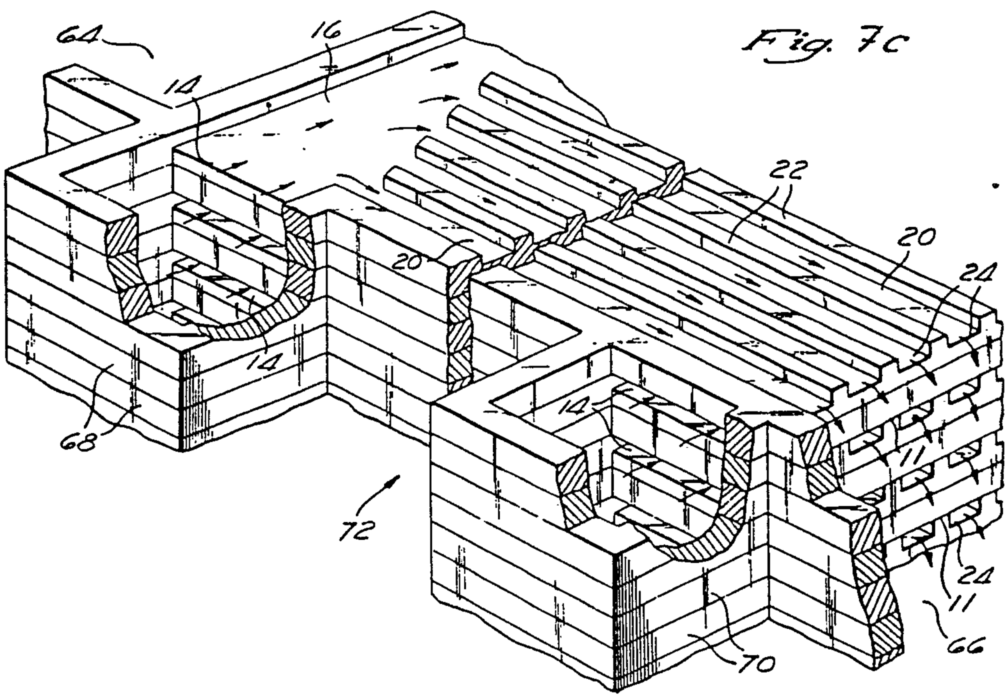
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Fig. 7c