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Satchwell et al.

[11] **3,893,509**

[45] **July 8, 1975**

[54] **LAP JOINT TUBE PLATE HEAT EXCHANGER**

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[21] Appl. No.: **459,250**

[52] **U.S. Cl.** **165/166**

[51] **Int. Cl.** **F28f 3/10**

[58] **Field of Search** 165/151, 166, 167

[56] **References Cited**

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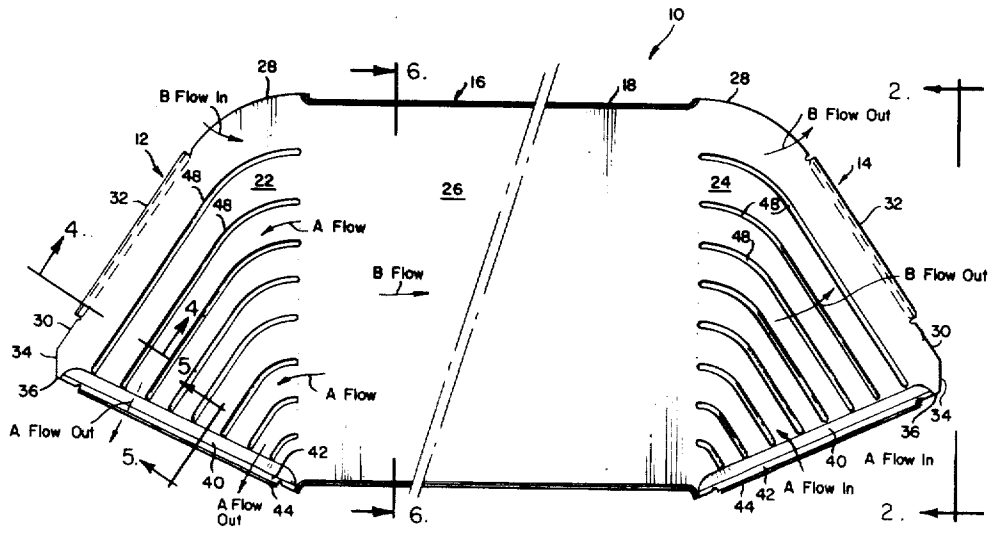
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[57] **ABSTRACT**

A heat exchanger formed of a series of plates which are spaced apart to form adjacent flow passages for conducting hot gas through passages and cold gas through adjacent alternate passages. Intermediate portions of the plates have opposing edges bent in overlapping relation with adjacent plates so that the bent edges not only seal the spaces between adjacent plates, but also serve to maintain the spacing between the plates at the intermediate portion of the heat exchanger. Manifold portions of the plates at one end of the heat exchanger are joined together to form inlet passage portions for the hot gas alternate passages and outlet passage portions for the cold gas alternate passages. Similarly, at the other end of the heat exchanger manifold portions of the plates are joined together to form outlet passage portions for the hot gas alternate passages, and inlet passage portions for the cold gas alternate passages.

9 Claims, 8 Drawing Figures



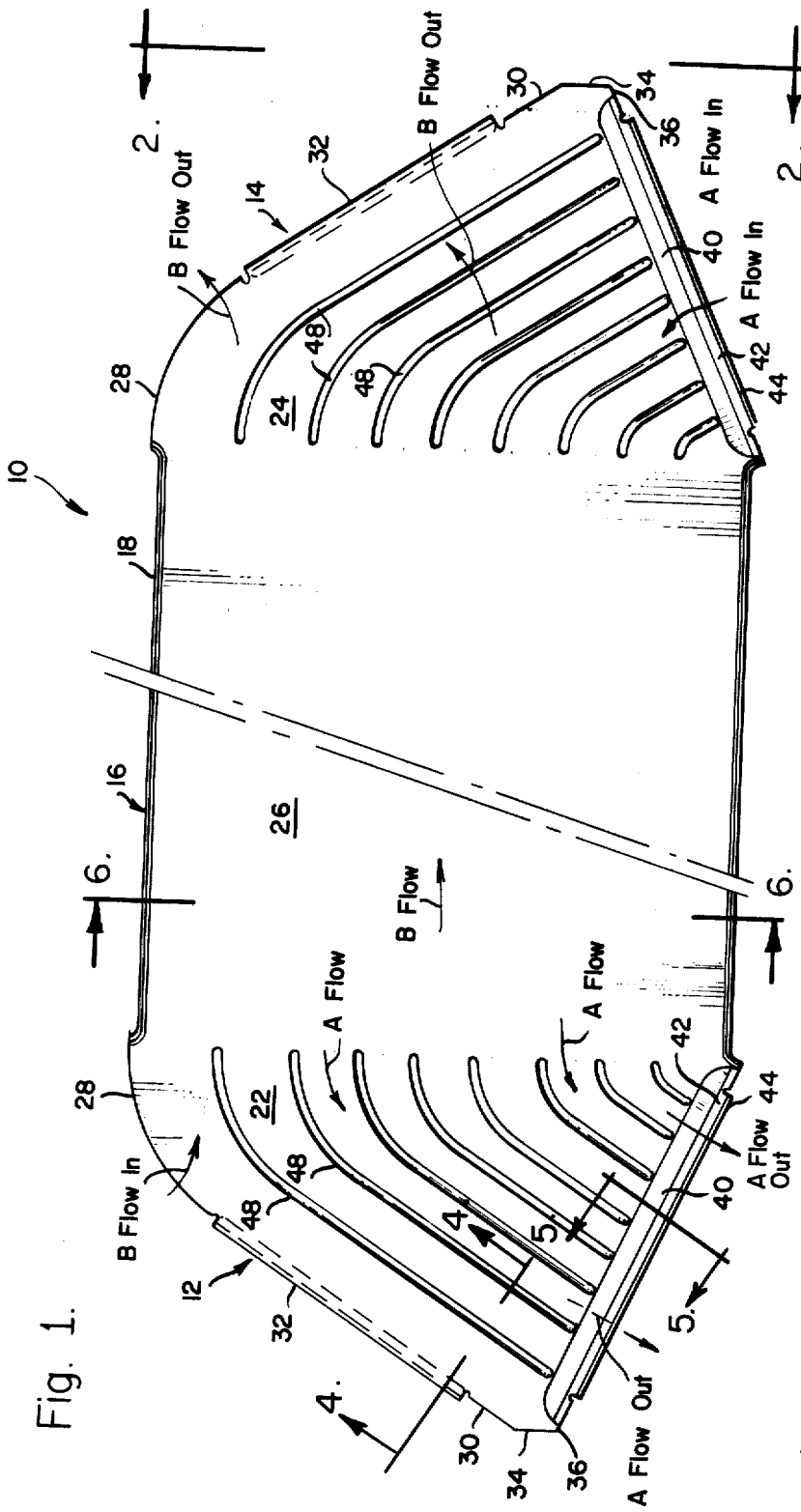

10
12
14
16
18
22
24
26
28
30
32
34
36
40
42
44
48
B Flow Out
B Flow In
A Flow In
A Flow Out
A Flow
B Flow
2.
3.
4.
5.
6.

Fig. 1.

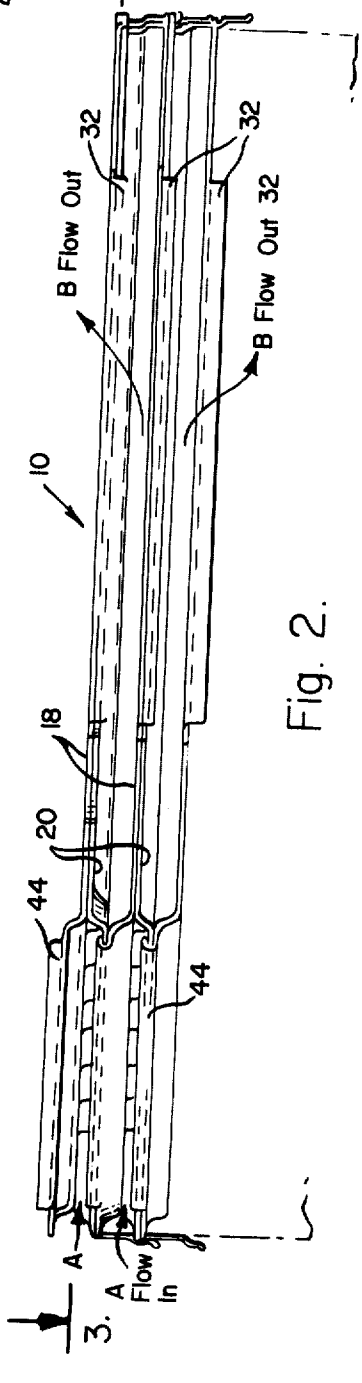

10
18
20
32
44
B Flow Out
A Flow In
2.
3.

Fig. 2.

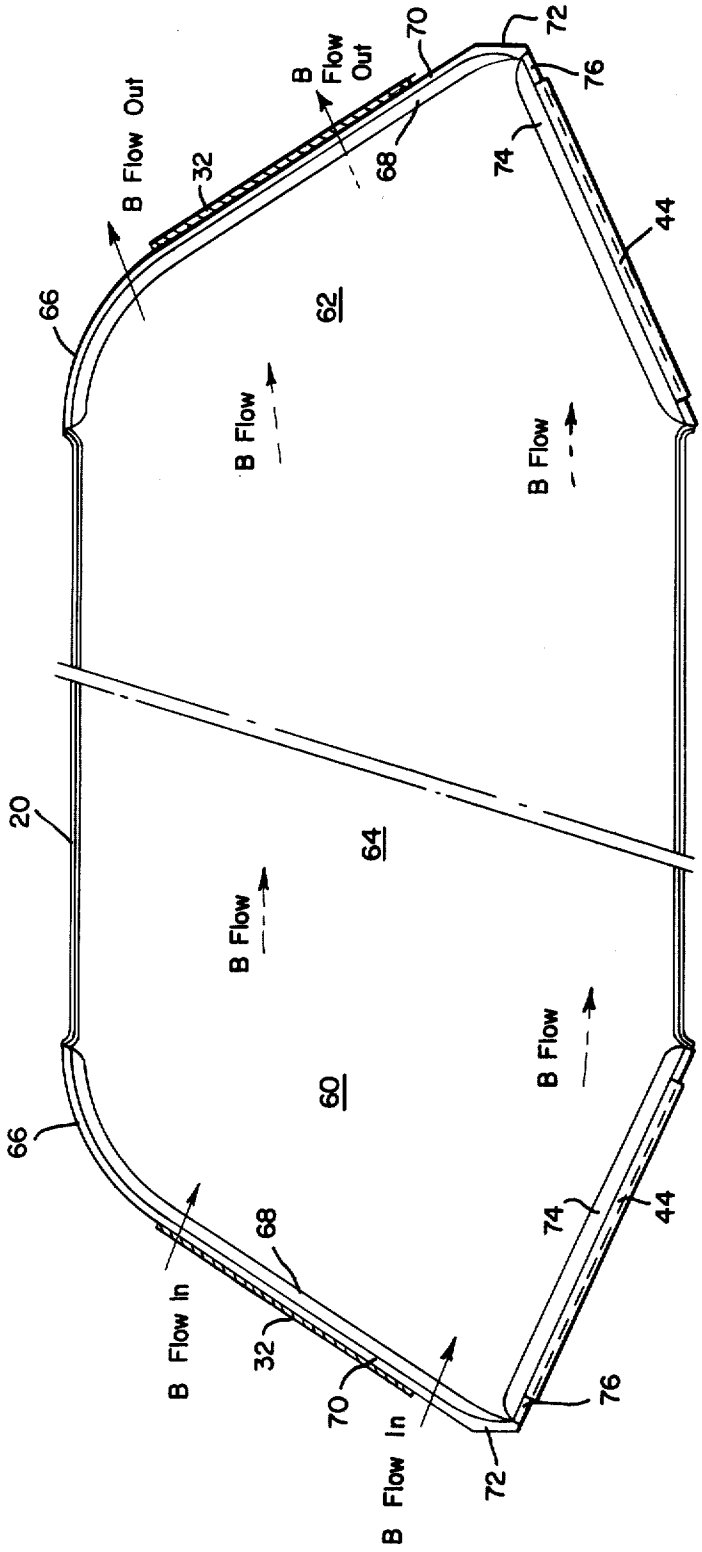

B Flow Out
B Flow Out
32
68
70
72
76
74
44
66
62
B Flow
B Flow
20
64
B Flow
B Flow
60
66
68
74
44
B Flow In
32
70
76
B Flow In
72

Fig. 3.

Fig. 4.

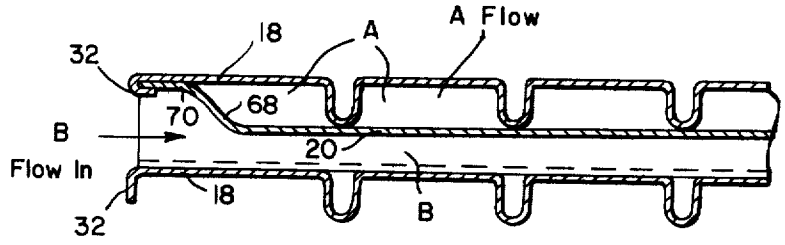


Fig. 7.

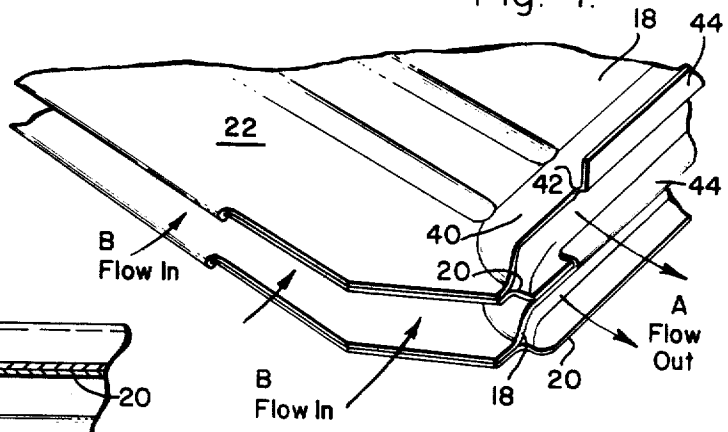


Fig. 5.

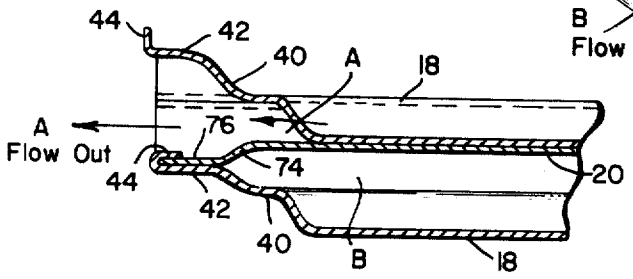
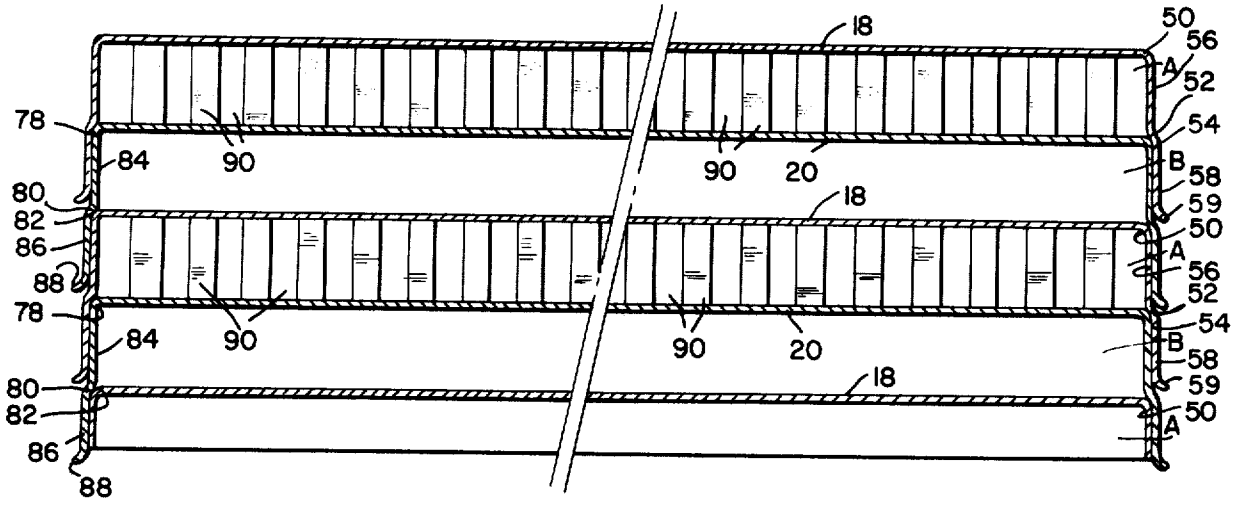


Fig. 6.



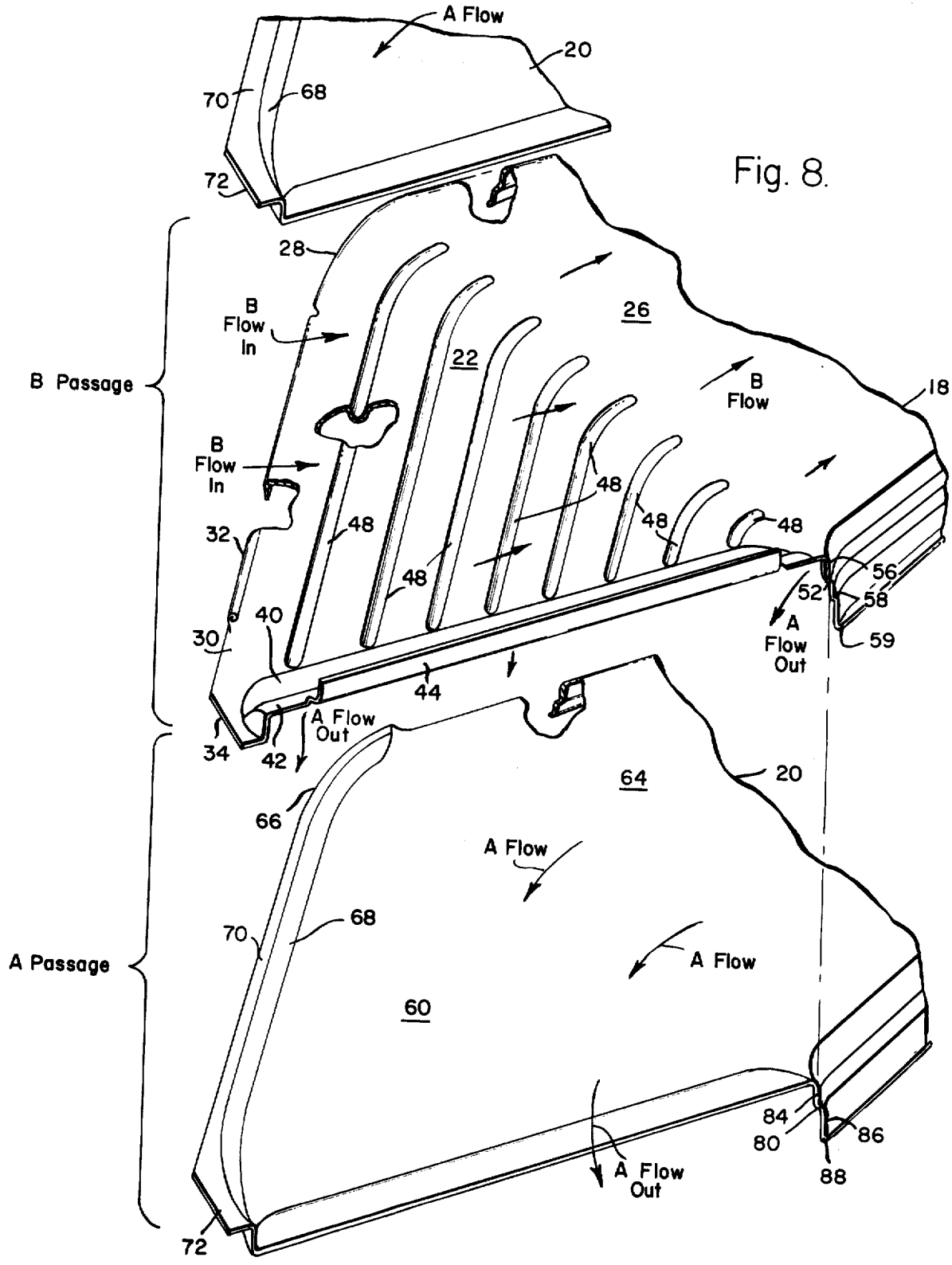

A Flow
20
70
68
72
28
B
Flow
In
26
22
B Passage
B
Flow
18
B
Flow
In
48
32
48
48
48
48
56
52
58
30
40
A
Flow
Out
59
44
A Flow
Out
34
42
64
20
66
A Flow
70
68
A Passage
A Flow
60
84
80
86
A Flow
Out
88
72

Fig. 8.

LAP JOINT TUBE PLATE HEAT EXCHANGER

BACKGROUND OF THE INVENTION

This invention relates generally to plate type counter-flow heat exchangers wherein there is provided a plurality of spaced heat transmission plates with alternate passages for the flow of two different heat exchange media. In particular this invention is concerned with structure for uniformly spacing apart the plates at their edges, and eliminating leakage between the edges of adjacent media passages to avoid any obviously undesirable mixing of the media.

Difficulties have been encountered in uniformly spacing the plates, as well as sealing the passages between these plates in prior art heat exchangers of the plate type, and many attempts have been made to solve these difficulties but with little success.

Examples of prior art heat exchangers are found in the following U.S. Pats: No. 1,935,332 to Quarnstrom; No. 2,131,265 to Bichowsky; No. 2,595,308 to Simpelaar; 2,596,008 to Collins; No. 2,663,550 to Hammond et al.; No. 2,728,561 to Hager; No. 3,255,816 to Rosenblad; and No. 3,360,038 to Stampes.

SUMMARY OF THE INVENTION

A counter-flow plate type heat exchanger for two fluid media wherein there is provided stacked first and second plates, each having end portions interconnected by an intermediate portion. Sealing is provided opposing edges of adjacent intermediate portions of adjacent plates to dispose the plates in predetermined spaced relationship and form successive fluid passages, alternate passages constituting paths for opposite flow of the fluid media. Sealing is also provided for adjacent end portions of the first plates and second plates to form successive fluid inlet passage portions for one fluid medium alternate passages and outlet passage portions for the other medium alternate passages. Also provided is sealing for the first plates and second plates at the other end portion of the heat exchanger to form successive fluid outlet passage portions for the one fluid medium alternate passages, and inlet passage portions for the other fluid medium alternate passages.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of the heat exchanger of the present invention;

FIG. 2 is an end view of the heat exchanger of FIG. 1 along the lines 2—2;

FIG. 3 is a cross-sectional view taken along the lines 3—3 of FIG. 2;

FIG. 4 is a cross-sectional view taken along the lines 4—4 of FIG. 1;

FIG. 5 is a cross-sectional view taken along the lines 5—5 of FIG. 1;

FIG. 6 is a cross-sectional view taken along the lines 6—6 of FIG. 1;

FIG. 7 is a perspective view of one corner of the heat exchanger of FIG. 1; and

FIG. 8 is an exploded view of a portion of the heat exchanger of FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, and in particular to FIGS. 1, 2, and 3, the reference 10 numeral generally designates the counter-flow heat exchanger of the present

invention which has end manifolds 12 and 14 of generally triangular shape, each having fluid inlet and outlet portions and an intermediate heat exchanger portion 16 of rectangular shape interconnecting the manifolds 12 and 14. Reference letters A designate passages through intermediate heat exchanger portion 16 and manifolds 12 and 14 within heat exchanger 10 through which, for example, a cold gaseous heat exchanger medium has a direction of flow, as indicated by arrows, and designated A flow. Reference letters B designate the passages of the heat exchanger 10 through which, for example, a hot gaseous heat exchange medium has a direction of flow, as indicated by arrows, and designated B flow. Passages A and B are defined by a plurality of equally spaced first and second plates 18 and 20, which are fashioned from sheet metal.

First plates 18, best illustrated in FIGS. 1, 2, and 4–8, are generally triangular in shape at their media inlet and outlet end portions 22 and 24, and of rectangular shape in the intermediate heat exchanger portions 26 interconnecting the end portions.

Triangular portions 22 and 24 of plate 18 each has a first side provided with an arcuate edge portion 28, an intermediate straight edge portion 30 with a fold over tab 32, and an angled portion 34, best shown in FIG. 8. The second sides of triangular end portions 22 and 24 are provided with short straight edge portions 36, up-slope portions 40, and level portions 42 with fold over tabs 44, best illustrated in FIG. 5. Triangular end portions 22 and 24 are also provided with spaced ribs 48 stamped in the plate metal to project below plates 18. Ribs 48 are curved in the region beginning adjacent to where the third sides of triangular portions 22, 24 and rectangular plate portions 26 generally intersect, and straight thereafter, substantially parallel to tabs 32 until they reach the vicinity of up-slope portions 40, substantially perpendicular to tabs 44.

The rectangular, of generally U-shaped cross section, portions 26 of plates 18 are best illustrated in FIG. 6, and have opposing edges consisting of depending flanges 50. Flanges 50 are offset at 52, thus providing shoulders 54 which are intermediate flange portions 56 and 58. Each flange portion 58 is provided with an outwardly extending inversion portion 59 providing stiffness.

Second plates 20, best illustrated in FIG. 2–8, are also generally triangularly shaped at their end portions 60, 62, and rectangularly shaped in the intermediate portions 64.

Each triangular portion 60, 62 is provided with a first side having an arcuate edge portion 66, an intermediate edge portion with an up-slope portion 68, a level straight edge portion 70, and an angled portion 72, best shown in FIG. 8. The second sides of triangular end portions 60, 62 are each provided with a down-slope portion 74, and a level portion 76, best illustrated in FIG. 5.

The rectangular, of generally U-shaped cross-section, portions 64 of plates 20 are illustrated in FIG. 6, and have opposing edges consisting of similar depending flanges 78. Flanges 78 are offset at 80 to provide shoulders 82 which are situated intermediate flange portions 84 and 86. Each flange portion 86 is provided with an outwardly extending inversion portion 88 which provides stiffness, as in the case of plates 18, hereinbefore described.

As illustrated in FIG. 6, to increase the conduction of heat between plates 18 and 20, offset corrugated fins 90 are provided in the A passages between the intermediate portions 26 and 64 of the plates, which serve to increase the heat transfer efficiency of the heat exchanger 10. Similar fins 90 are provided in the B passages between the portions 26 and 64, but it is believed that they need not be illustrated for reasons of clarity.

The heat exchanger of the present invention can be assembled as follows:

First, a first plate 18 is positioned on a support with ribs 48 facing down. A second plate 20 is then positioned on top of plate 18 with its intermediate portion 64 covering intermediate portion 26 of plate 18, flange portions 86 overlapping flange portions 56 of plate 18, and shoulders 82 resting on plate 18. Next fins 90 are placed on the top side of intermediate portion 64 of plate 20. Another first plate 18 is then positioned on top of plate 20 with the bottom side of intermediate portion 26 covering fins 90, flange portions 58 overlapping flange portions 84 of plate 20, shoulders 54 resting on plate 20, and ribs 48 resting on plate 20. Tabs 32 of top first plate 18 can now be bent over straight edge portions 70 of the underlying or preceding plate 20. Similarly, tabs 44 of bottom first plate 18 can be bent over edge portions 76 of overlying or succeeding plate 20. It will be appreciated that additional plates 18 and 20, and fins 90 can be stacked in the order hereinbefore set forth to give rise to a heat exchanger of any desired size, and including a plurality of alternate fluid media passages A and B.

It will also be understood that the various contacting surfaces and edges of the plate members 18 and 20 can be coated with suitable bonding material, and the entire heat exchanger placed in an oven and heated to the required fusing temperature of the bonding material to effect sealing of the plates.

Operation of the heat exchanger of the present invention is as follows:

A gas medium of one temperature is allowed to flow into the A flow manifold 14 inlet passage portions of alternate passages A and out the A flow manifold 12 outlet passage portions. Another gas medium of a different temperature can be passed into the B flow manifold 12 inlet passage portions of alternate passages B, and out the B flow manifold 14 outlet passage portions. Thus, heat conduction can take place between the gas media through plates 18 and 20, and fins 90.

While a specific embodiment of the invention has been illustrated and described, it is to be understood that it is provided by way of example only, and that various modifications, alterations and changes can be made without departing from the invention and that the invention is not to be construed as being limited thereto, but only by the proper scope of the following claims.

What we claim is:

1. A counter-flow plate type heat exchanger for two fluid media comprising:

a plurality of alternately stacked first and second plates, each plate having substantially triangular end portions with first and second adjacent sides each defining edges, and third sides interconnected by a substantially rectangular intermediate portion having opposing edges;

depending flanges on said opposing edges of said first plates, said flanges including upper and lower first plate flange portions offset from each other to provide a shoulder;

depending flanges on said opposing edges of said second plates, said second plate flanges including upper and lower second plate flange portions offset from each other to provide a shoulder, the plurality of alternately stacked first and second plates being arranged such that second plate lower flange portions overlap said first plate upper flange portions and said first plate lower flange portions overlap said second plate upper flange portions;

means integral with each first and second plate for sealing said first side edges of adjacent triangular end portions of each first plate and one of the two adjacent second plates at each said triangular end portion to form fluid inlet and outlet passage portions for one fluid medium, and; means integral with each first and second plate for sealing said second side edges of adjacent triangular end portions of each first plate and the other of the two adjacent second plates at each said triangular end to form fluid inlet and outlet passage portions for the other fluid medium.

2. The heat exchanger of claim 1 further comprising:

outwardly extending inversion portions located on said first and second plate lower flange portions for providing stiffness.

3. The heat exchanger of claim 1 wherein said means for sealing said first side edges of adjacent triangular end portions of each first plate and one of the two adjacent second plates comprises:

up-slope and adjacent level edge portions on said first side edges of each second plate; and

a tab on each said first side edge of each of said first plates, said tab operable to be bent over said level edge portion of the one of the two adjacent second plates.

4. The heat exchanger of claim 1 wherein said means for sealing said second side edges of adjacent triangular end portions of each first plate and the other of the two adjacent second plates comprises:

down-slope and adjacent level edge portions on said second side edges of each second plate; and

up-slope and adjacent level edge portions on said second side edges of each first plate;

a tab on each said level edge portions of each first plate, said tab being operable to be bent over said level edge portions of the other of the two adjacent second plates.

5. The heat exchanger of claim 1 further comprising:

ribs on the triangular end portions of each first plate, said ribs projecting into the inlet and outlet passage portions for guiding flow of a fluid medium between regions adjacent said second and third sides of the triangular end portions.

6. The heat exchanger of claim 1 further comprising:

fins positioned between intermediate portions of adjacent first and second plates for conducting heat between the fluid media.

7. A counter-flow plate type heat exchanger for two fluid media comprising:

a plurality of alternately stacked first and second plates, each plate having substantially triangular end portions with first and second adjacent sides each defining edges, and third sides interconnected by a substantially rectangular intermediate portion having opposing edges;

depending flanges on opposing edges of said first plates, said flanges including upper and lower first plate flange portions offset from each other to provide a shoulder;

depending flanges on opposing edges of said second plates, said second plate flanges including upper and lower second plate flange portions offset from each other to provide a shoulder, the plurality of alternately stacked first and second plates arranged such that second plate lower flange portions overlap said first plate upper flange portions and said first plate lower flange portions overlap said second plate upper flange portions;

outwardly extending inversion portions located on said first and second plate lower flange portions;

up-slope and adjacent level edge portions on said first side edges of each second plate;

a tab on each said first side edge of each of said first plates, said tab being operable to be bent over said level edge portion of one of the two adjacent second plates;

down-slope and adjacent level edge portions on said second side edges of each second plate;

up-slope and adjacent level edge portions on said second side edges of each plate; and

a tab on each said level edge portions of each first plate, said tab being operable to be bent over said level edge portions of the other of the two adjacent second plates.

8. The heat exchanger of claim **7** further comprising:

ribs on the triangular end portions of each first plate projecting toward the triangular end portions of the one of the two adjacent second plates, said ribs extending intermediate said second and third sides of said first and second plate triangular end portions.

9. The heat exchanger of claim **8** further comprising:

fins positioned between said intermediate portions of said first and second plates.

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