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[56] **References Cited**
UNITED STATES PATENTS
2,846,198 8/1958 Sturges..... 165/70
3,451,473 6/1969 Urie et al..... 165/70
3,469,623 9/1969 Rawlings..... 165/70

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[54] **COUNTERCURRENT FLOW PLATE-TYPE HEAT EXCHANGER WITH LEAK DETECTOR**
10 Claims, 5 Drawing Figs.

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165/166
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[50] Field of Search..... 165/70, 166

ABSTRACT: A countercurrent flow plate-type heat exchanger having barrier spaces between adjoining heat exchange passage and a header conducting a heat exchange fluid other than that flowing through said passage. The barrier spaces contain a corrugated metallic fin material to impart structural continuity to the heat exchanger core and to provide the heat-conducting link between adjacent fluid-conducting passages. The various barrier spaces are placed in fluid communication with a leak detection means by way of barrier space headers.

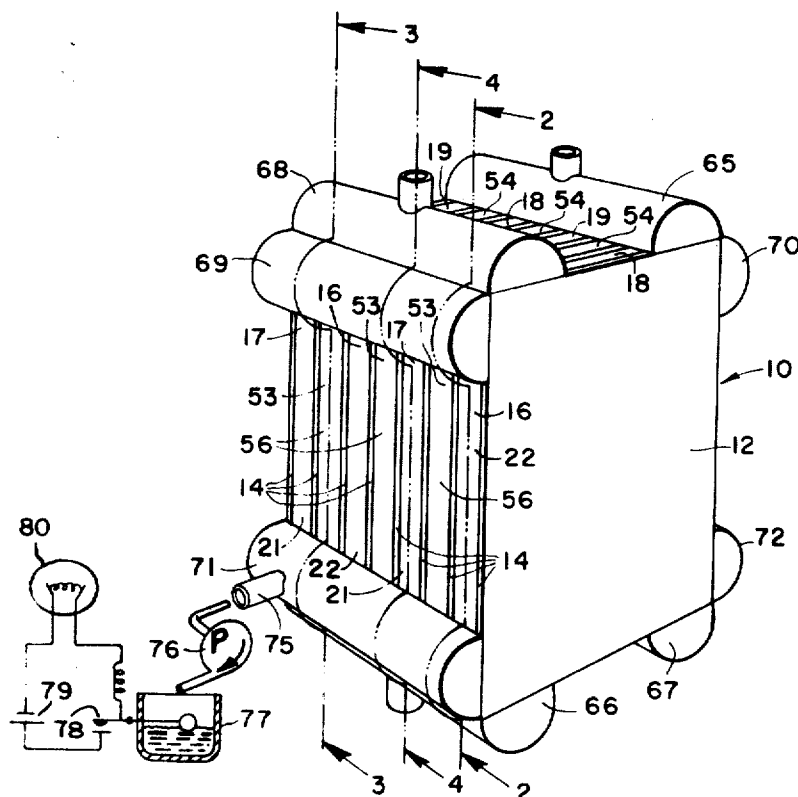


FIG. 1

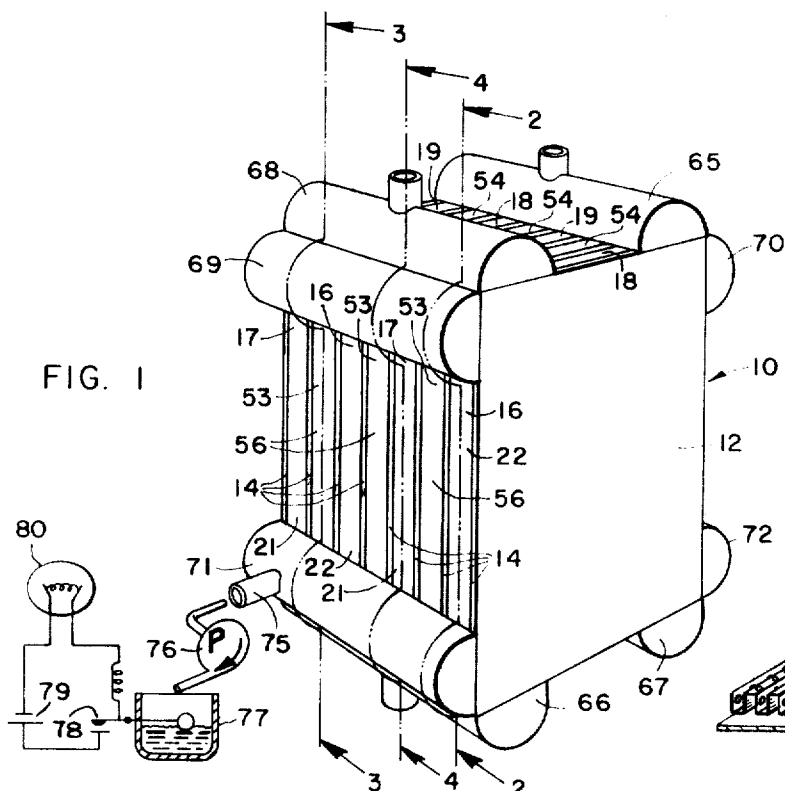


FIG. 5

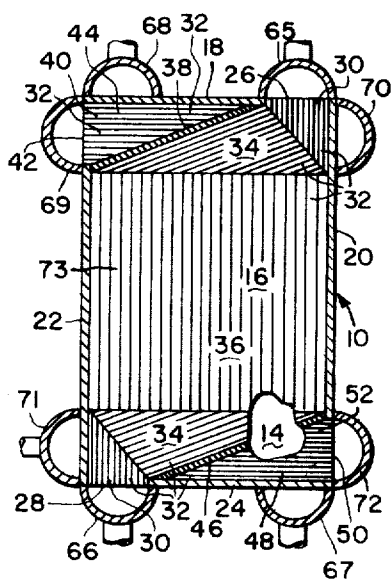
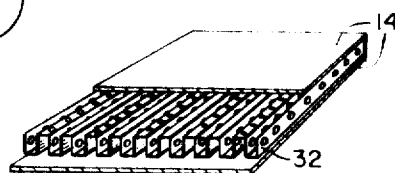


FIG. 2

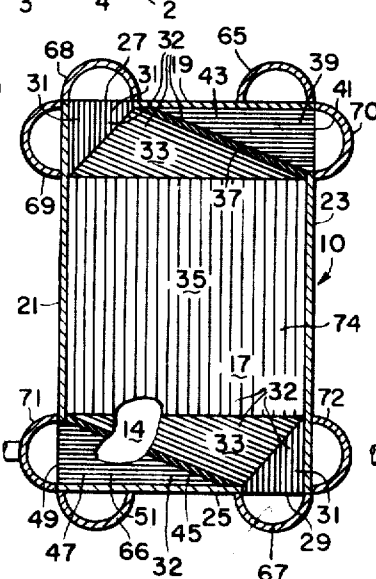


FIG. 3

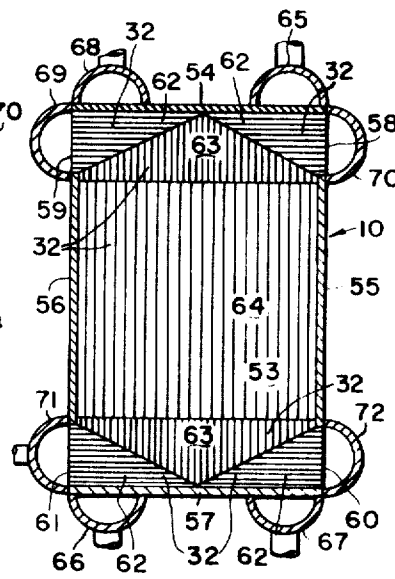


FIG. 4

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COUNTERCURRENT FLOW PLATE-TYPE HEAT EXCHANGER WITH LEAK DETECTOR

BACKGROUND OF THE INVENTION

This invention relates to metallic plate-type heat exchangers of brazed construction having fin packing within the passages thereof for conducting heat and providing structural continuity to the heat exchanger core. More specifically, this invention relates to a countercurrent flow plate-type heat exchanger for first and second heat exchange fluids wherein it is desired to maintain separation of the first and second heat exchange fluids despite leaking of one or both of the heat exchange fluid passages.

Heretofore heat exchangers have been provided with barrier spaces and leak detection means. However, the known barrier and leak detection means used on other types of heat exchangers are not readily applicable to countercurrent heat exchangers of the plate type.

SUMMARY OF THE INVENTION

The barrier spaces provided in the heat exchanger herein disclosed have the additional function of providing structural continuity and heat conductivity between the relatively thin but wide heat exchange fluid passages. The instant invention is particularly useful countercurrent flow plate-type heat exchangers.

It is thus an object of this invention to provide means for receiving heat exchange fluids which may leak from either of the heat exchange countercurrent flow passages and for preventing such fluid from leaking into the other of said such heat exchange passages. It is a further object of this invention to prevent leaks from any of the heat exchange passages into the headers conducting another heat exchange fluid.

It is still a further object of this invention to provide an integral barrier system between the heat exchange passages that can be incorporated into plate-type countercurrent flow heat exchanger which is formed by furnace or bath brazing.

It is a further object of this invention to provide a barrier system for a plate-type countercurrent flow heat exchanger which system may be connected to similar systems of other plate-type heat exchangers within a heat exchanger battery without the loss of integrity of the barrier system.

DESCRIPTION OF THE DRAWINGS

The structural means to achieve these objectives will be apparent from the detailed description of the invention with the accompanying drawing in which:

FIG. 1 is a perspective of a heat exchanger incorporating the instant invention and wherein the barrier system thereof is connected to a means for detecting the presence of heat exchange fluid within the barrier spaces;

FIG. 2 is a vertical section through one of the heat exchange fluid passages taken at line 2-2 of FIG. 1;

FIG. 3 is a vertical section through another of the heat exchange fluid passages taken at line 3-3 of FIG. 1;

FIG. 4 is a vertical section through a barrier space intermediate the heat exchange fluid passages of FIGS. 2 and 3 taken at line 4-4 of FIG. 1; and

FIG. 5 is a perspective of a portion of the heat exchanger of FIG. 1 showing a portion of the corrugated metallic porous sheet material which is disposed within the heat exchanger fluid passages and barrier spaces.

DETAIL DESCRIPTION

Referring now to the drawings it will be seen that countercurrent flow heat exchanger 10 has a core 12 comprised of a plurality of metallic plate 14 of the same peripheral rectangular configuration and contraposed in spaced parallel relationship.

The spaces 16 between certain plates 14 are bound at the edges of plates 14 by a top closing bar 18, a first side closing bar 20, a second side closing bar 22 and a bottom closing bar 24 as most clearly seen in FIG. 2. The adjacent ends of bars 18 and 20 are spaced to define a first fluid inlet 26 to space 16. The adjacent ends of bars 22 and 24 are spaced to define a first fluid outlet 28 from space 16. Disposed within space 16 adjacent each of inlet 26 and outlet 28 is a small triangular section 30 of porous corrugated metallic sheet fin material 32 having crests extending vertically. Disposed laterally of each triangular section 30 is a larger triangular section 34 of corrugated metallic sheet fin material 32 having crests extending diagonally. A large rectangular section 36 of corrugated metallic sheet fin material 32 having crests extending vertically is disposed between triangular sections 34.

Disposed within the space bounded by closing bars 18, 20, 24, and 22 is an inner closing bar 38 extending along the upper edge of upper triangular fin section 34 between the upper end of side closing bar 22 and the end of top closing bar 18 adjacent inlet opening 26. A triangular section 40 of corrugated metallic sheet fin material 32 having crests extending horizontally is disposed within the space 16 intermediate inner closing bar 38 and top closing bar 18. Closing bars 18 and 38 are spaced at their ends adjacent the upper end of closing bar 22 to provide an opening 42 communicating with the space 44 between closing bars 18 and 38.

Disposed within the space bounded by closing bars 18, 20, 24, and 22 is an inner closing bar 46 extending along the lower edge of lower triangular fin section 34 between the lower end of side closing bar 20 and the end of bottom closing bar 24 adjacent outlet opening 28. A triangular section 48 of corrugated metallic sheet fin material 32 having crests extending horizontally is disposed within the space 16 intermediate inner closing bar 46 and bottom closing bar 24. Closing bars 24 and 46 are spaced at their ends adjacent the lower end of closing bar 20 to provide an opening 50 communicating with the space 52 between closing bars 24 and 46.

The spaces 17 between certain plates 14 are bound at the edges of plates 14 by a top closing bar 19, a first side closing bar 21, a second side closing bar 23 and a bottom closing bar 25 as most clearly seen in FIG. 3. The adjacent ends of bars 19 and 21 are spaced to define a second fluid outlet 27 to space 17. The adjacent ends of bars 23 and 25 are spaced to define a second fluid inlet 29 from space 17. Disposed within space 17 adjacent each of outlet 27 and inlet 29 is a small triangular section 31 of corrugated metallic sheet fin material 32 having crests extending vertically. Disposed laterally of each triangular section 31 is a larger triangular section 33 of corrugated metallic sheet fin material 32 having crests extending diagonally. A large rectangular section 35 of corrugated metallic sheet fin material 32 having crests extending vertically is disposed between triangular sections 33.

Disposed within the space bounded by closing bars 19, 21, 25, and 23 is an inner closing bar 37 extending along the upper edge of upper triangular fin section 33 between the upper end of side closing bar 23 and the end of top closing bar 19 adjacent outlet opening 27. A triangular section 39 of corrugated metallic sheet fin material 32 having crests extending horizontally is disposed within the space 17 intermediate inner closing bar 37 and top closing bar 19. Closing bars 19 and 37 are spaced at their ends adjacent the upper end of closing bar 23 to provide an opening 41 communicating with the space 43 between closing bars 19 and 37.

Disposed within the space bounded by closing bars 19, 21, 25, and 23 is an inner closing bar 45 extending along the lower edge of lower triangular fin section 33 between the lower end of side closing bar 21 and the end of bottom closing bar 25 adjacent inlet opening 29. A triangular section 47 of corrugated metallic sheet fin material 32 having crests extending horizontally is disposed within the space 17 intermediate inner closing bar 45 and bottom closing bar 25. Closing bars 25 and 45 are spaced at their ends adjacent the lower end of closing bar 21 to provide an opening 49 communicating with the space 51 between closing bars 25 and 45.

The spaces 53 between certain plates 14 are bound at the edges of plates 14 by a top closing bar 54, a first side closing bar 55, a second side closing bar 56, and a bottom closing bar 57, as most clearly seen in FIG. 4. The adjacent ends of closing bars 54 and 55, 54 and 56, 55 and 57, and 56 and 57 are spaced to define openings 58, 59, 60, and 61 respectively into space 53. Disposed adjacent each of openings 58, 59, 60, and 61 is a triangular section 62 of corrugated metallic sheet fin material 32 having crests extending horizontally. Disposed immediately below each upper pair of triangular sections 62 and immediately above each pair of lower triangular sections 62 is a large triangular section 63 of corrugated metallic sheet fin material 32 having crests extending vertically. Intermediate upper fin section 63 and lower fin section 63 is a large rectangular section 64 of corrugated metallic sheet fin material 32.

The heat exchanger 10 has a first fluid inlet header 65 overlying inlet openings 26 and a first fluid outlet header 66 underlying outlet openings 28 to permit passage of a first heat exchange fluid to and from the core 12. Heat exchanger 10 also has a second fluid inlet header 67 underlying inlet openings 29 and a second fluid outlet header 68 overlying outlet openings 27. Heat exchanger 10 has a first leak detection side header 69 overlying openings 42 and 59, a second leak detection side header 70 overlying openings 41 and 58, a third leak detection side header 71 overlying openings 49 and 61, and a fourth leak detection side header 72 overlying openings 50 and 60.

The aforescribed closing bars, sections of porous corrugated metallic fin material and headers are brazed together as an integral unit. The closing bars thus sealingly bridge between adjacent plates 14 while the corrugated fin material provide structural and thermal ligaments connecting between adjacent plates. The corrugated fin material also provides a thermal path from the spaces 16 and 17 to the adjacent plates.

Thus during operation a first heat exchange fluid is passed from header 65 into inlet openings 26 through a first passage 73 including upper fin section 30, upper fin section 34, rectangular fin section 36, lower fin section 34, and lower fin section 30 from whence the first heat exchange fluid is discharged from outlet openings 28 into header 66. A second heat exchange fluid is conducted from header 67 through inlet openings 29 through a second passage 74 including lower fin section 31, lower fin section 33, rectangular fin section 35, upper fin section 33, and upper fin section 31 from whence the second heat exchange fluid is discharged through outlet openings 27 into outlet header 68. The first and second heat exchange passages are separated by a space 53. However, heat is exchanged between the first and second passages via a path including rectangular fin section 36, a first of plates 14, a rectangular section 64, a second of plates 14, and rectangular section 35.

Spaces 43, 44, 51, and 52 are substantially inactive areas isolated from the paths of the heat exchange fluids through the heat exchanger inner closing bars 37, 38, 45, and 46 respectively. Since these areas are not within the direct flow path between the inlet and outlet of their respective passage, it is difficult to remove residual brazing flux from these areas. Residual brazing flux in certain types of heat exchangers such as those constructed of aluminum, can cause sufficient corrosion so that the heat exchanger may develop leaks between the passages after a period of use. These leak passages, whatever their cause, may extend through the plates 14 or simply around a closing bar such as 18, 24, 19, or 25; to a header such as 68, 67, 65, or 66 respectfully.

In order to detect any interpassage leaks, that is leaks between the first passage 73 and the second passage 74, the heat exchanger 10 is provided with a complete interpassage leak barrier system. Thus it will be apparent from the structure herein disclosed that the interpassage spaces 53 are in fluid communication with the spaces 44 via header 69, with the spaces 43 via header 70, with the spaces 52 via header 72, and with the spaces 51 via header 71. Conversely, all of the spaces barrier 43, 44, 51, and 52 are in fluid communication with barrier space 53 which in turn is in fluid communication with conduit 75 via header 71.

Thus either of the heat exchange fluids which might leak into the barrier spaces is conducted through conduit 75 and pumped by pump 76 to a vessel 77 provided with a float switch 78. As the leaking fluid fills the vessel, float switch 78 is closed to energize an electric circuit including in series a potential source 79 an indicator light 80 and a switch 78. Leaking of either of the heat exchange fluids into the other of the heat exchange fluids is prevented and internal leaking from one of the passages will be indicated by light 80.

While I have disclosed only a simple leak-sensing means, it should be appreciated that the pump 76, vessel 77, float switch 78 and circuit including potential source 79 and light 80 may be replaced by any device capable of sensing the presence of one or both of the particular heat exchange fluids being conducted through heat exchanger 10.

In the alternative it will be appreciated that a fluid under higher pressure than either of the heat exchange fluids may be maintained in the barrier spaces. Leakage of this barrier space fluid into either of the heat exchange fluids may be detected by conventional means.

Having thus described one preferred embodiment of my invention, I claim:

1. A plate-type countercurrent flow heat exchanger comprising a plurality of metallic generally rectangular plates of similar peripheral configuration contraposed in substantially parallel spaced relationship thereby defining a plurality of spatial layers therebetween; first sealing means sealingly bridging between and extending along the margins of a first pair of adjacent plates to thereby define a first passage for a first heat exchange fluid in a first of said spatial layers; second sealing means sealingly bridging between and extending along the margins of a second pair of adjacent plates to thereby define a second passage for a second heat exchange fluid in a second of said spatial layers; means defining an inlet to said first passage and an outlet from said second passage at one end of said heat exchanger; means defining an outlet from said first passage and an inlet to said second passage at the other end of said heat exchanger; a third of said spatial layers being disposed intermediate said first and second pairs of plates to thereby define a barrier space between said first and second passages; a plurality of heat-transmitting metallic ligaments extending through said barrier space and each brazed to one plate of each of said first and second pairs of plates; and means for detecting the passing of a fluid between at least one of said first and second passages and said barrier space.

2. The apparatus as defined by claim 1 wherein said ligaments are the spans between the crests and valleys of a corrugated metallic sheet.

3. A plate-type countercurrent heat exchanger comprising a plurality of metallic generally rectangular plates of similar peripheral configuration contraposed in substantially parallel spaced relationship thereby defining a plurality of spatial layers therebetween; first sealing means sealingly bridging between and extending along the margins of a first pair of adjacent plates to thereby define a first passage in a first of said spatial layers; second sealing means sealingly bridging between and extending along the margins of a second pair of adjacent plates to thereby define a second passage in a second of said spatial layers; means defining an inlet to said first passage and an outlet from said second passage at one end of said heat exchanger; means defining an outlet from said first passage and an inlet to said second passage at the other end of said heat exchanger; a header, the interior of which is in fluid communication with one of said inlet and outlet of said first passage and in fluid communication with said second sealing means externally of said second passage; third sealing means sealingly bridging between the plates of said second pair of plates from a point on said second sealing means at one side of said header to another point on said second sealing means at the other side of said header to thereby define a barrier space in said second spatial layer between said second passage and said header.

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4. The apparatus as defined by claim 3 including means for detecting the passing of a fluid between at least one of said first and second passages and said barrier space.

5. The apparatus as defined by claim 3 wherein a third of said spatial layers is disposed intermediate said first and second pairs of plates to thereby define a second barrier space between said first and second spatial layers.

6. The apparatus as defined by claim 5 including a header in fluid communication with said first and second barrier spaces.

7. The apparatus as defined by claim 6 including means for detecting the passing of a fluid between at least one of said first and second passages and said first and second spaces.

8. A plate-type countercurrent flow heat exchanger comprising a plurality of metallic generally rectangular plates of similar peripheral configuration contraposed in a substantially parallel spaced relationship thereby defining a plurality of spatial layers therebetween; a first series of closing bars sealingly bridging between and extending along the margins of a first pair of adjacent plates to thereby define a first passage in a first of said spatial layers; a second series of closing bars sealingly bridging between and extending along the margins of a second pair of adjacent plates to thereby define a second passage in a second of said spatial layers; the ends of said closing bars of said first series being spaced to define an inlet and an outlet for said first passage; the ends of said closing bars of

said second series being spaced to define an inlet and an outlet for said second passage; said first passage inlet and said second passage outlet being adjacent and disposed at one end of said heat exchanger and said first passage outlet and said second passage inlet being adjacent and disposed at the other end of said heat exchanger whereby the relative flow between the fluids in said first and second passages is countercurrent; a header, the interior of which is in fluid communication with one of said inlet and outlet of said first passage and in fluid communication with a side of said second series of closing bars externally of said second passage; an inner closing bar sealingly bridging between the plates of said second pair of adjacent plates from a point on said second series of closing bars at one side of said header to another point on said second series of closing bars at the other side of said header to thereby define a barrier spaced in said second spatial layer between said second passage and said header.

9. The apparatus as defined in claim 8 wherein one end of said inner closing bar and one end of the closing bar of said second series underlying said header are spaced to provide an opening to said barrier space.

10. The apparatus as defined by claim 8 including fin packing within said barrier space intermediate said header and said inner closing bar.

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