Aug. 10, 1965 C. A. HEUER 3,199,584

HEAT EXCHANGER

Original Filed Sept. 29, 1958 2 Sheets-Sheet 1

FIG. 1

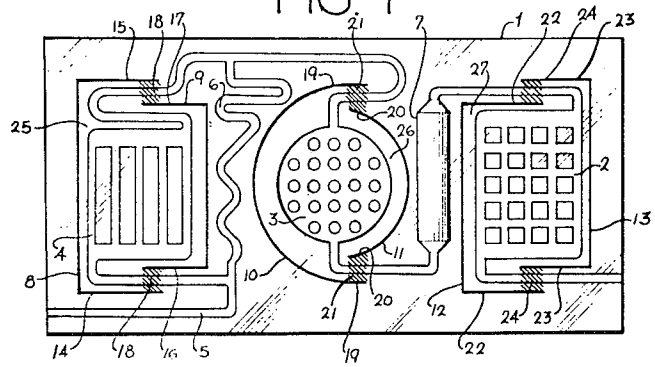


FIG. 2

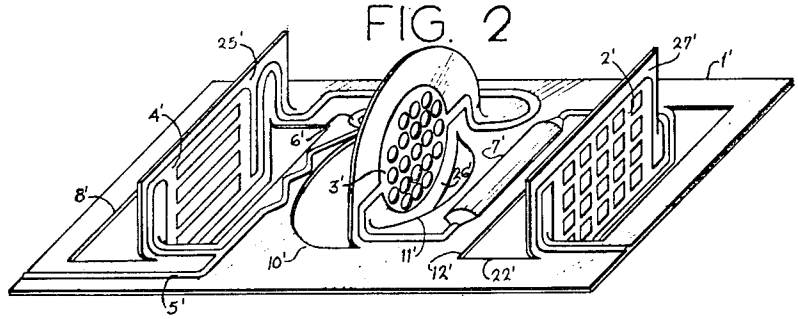


FIG. 3

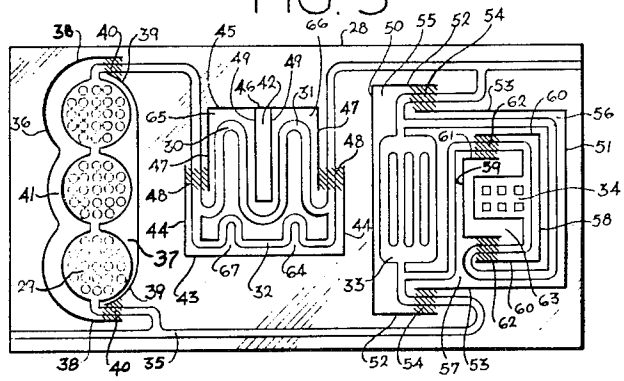
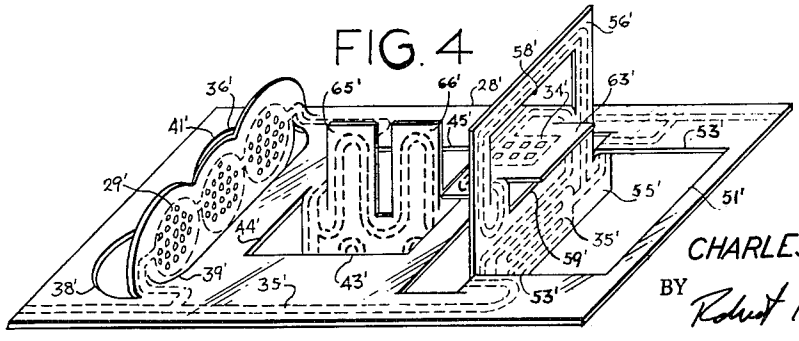


FIG. 4



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HEAT EXCHANGER

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FIG. 5

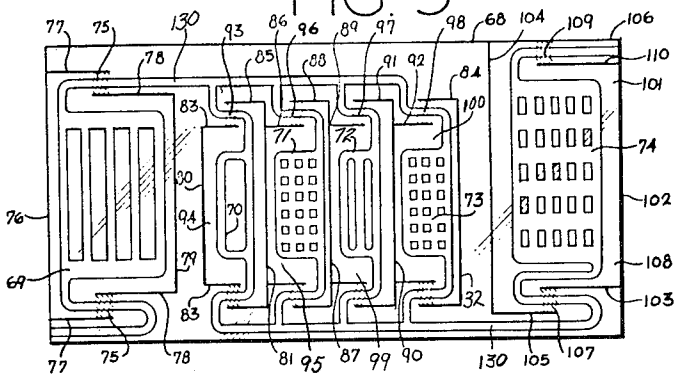


FIG. 6

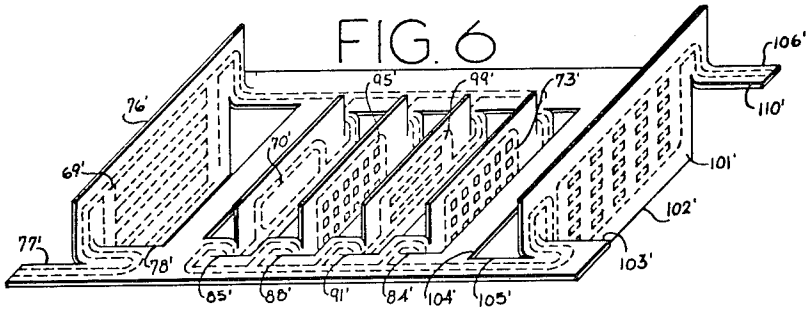


FIG. 7

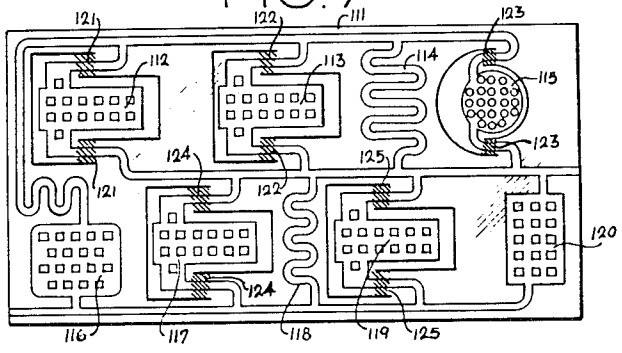
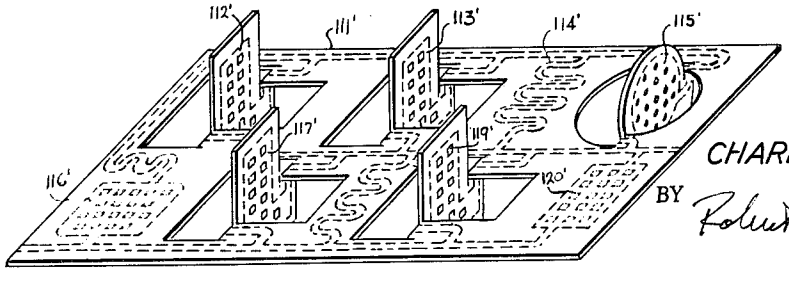


FIG. 8



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3,199,584

HEAT EXCHANGER

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Original application Sept. 29, 1958, Ser. No. 763,877, now Patent No. 3,089,225, dated May 14, 1963. Divided and this application Feb. 8, 1963, Ser. No. 264,994

3 Claims. (Cl. 165—144)

This application is a division of copending application Serial Number 763,877, filed September 29, 1958, now United States Patent 3,089,225, issued May 14, 1963.

This invention relates to the fabrication of heat exchange units, and more particularly to a finned heat exchanger.

Heretofore in the fabrication of finned heat exchangers from flat rectangular panels, it has been proposed to slit the panel of the exchanger in the configuration desired to be imparted to the fin and bending the cut portion out of the plane of the panel. However, this form of slotting forms fins which extend from only one side of the panel, and does not provide for fabrication of a fin unit integral with the panel which extends through, and outwardly from both surfaces of the panel.

An alternate proposed procedure to the above is to provide parallel slits between adjacent passageways, and to twist the portion of the panel between adjacent cuts into the desired spatial relationship to each other. This, of necessity, requires the inclusion of a large portion of the panel as a part twisted portion connecting the fins and the panel in order to prevent tearing or ripping, with the additional danger of the tear or rip continuing into a passageway to open it, unless extreme caution is exercised. The requirement of a large twisted portion to avoid the aforesaid dangers reduces the area between the plates for the insertion of secondary heat dissipating fins if the corrugated unit is intended for application in radiators for automobiles and the like. This reduction in available secondary fin area is caused by the turn between the panel and the plates required to twist the plates, or fins, into position.

Accordingly, it is the object of this invention to eliminate disadvantages of the prior art.

Another object of this invention is to provide a finned heat exchange unit, from a flat rectangular panel, containing a plurality of fins extending from both surfaces of the panel.

Another object of this invention is to provide a finned heat exchange unit from a flat rectangular panel with a plurality of fins containing tubular circuits interconnected to the passageways of the panel, and extending from both surfaces of the panel.

The above objects are obtained in accordance with this invention by a special method of cutting which provides a common hinge portion, in a panel, for a pair of integral tab portions forming a fin or plate integral with the aforesaid panel. More specifically the invention relates to transversely slitting a fin portion between adjacent passageways of a heat exchange panel to provide at least one pair of adjacent cuts having terminal portions longitudinally extending toward and coextensive with each other in spaced relationship, and rotating the portion encompassed by the adjacent pair of cuts and the outermost terminal portions about a common hinge portion between the terminal portions of the cuts. The flat rectangular heat exchange panel, provided with suitably interconnecting patterns of passageways may be obtained by any method known in the art.

One particular method suitably adapted to the invention is a well known process of fabricating hollow panels such as refrigerator heat exchanges and the like, is fully

disclosed in a patent to Grenell, U.S. 2,690,002, granted on September 28, 1954, in which a pattern of weld-inhibiting material is applied to a clean surface of a sheet of metal. A clean surface of a second sheet of metal is superimposed on this surface and the two sheets are secured to prevent relative movement and are welded together by hot rolling in the adjacent areas thereof which are not separated by the weld-inhibiting material. Hot rolling of the sheets results in reducing the thickness of the two sheets and elongating the resultant blank in the direction of rolling while the width of the resultant blank remains substantially the same as the initial width of the sheets. Following the hot rolling operation, the resultant blank is usually softened as by annealing to make it more pliable and if desired it may then be cold rolled and again softened as by annealing. The weld-inhibiting material results in an unjoined portion between the outer surfaces of the blank. After softening the blank, the unjoined portion is expanded by injecting therein a fluid pressure of sufficient magnitude to permanently distend the blank in the area of the unjoined portion.

The flat rectangular heat exchange panels may also be obtained by stamping suitable passageways in sheets of metal which are superimposed together and brazed in the undeformed area, the stamped passages of which are in cooperating alignment with each other to form conduits for the flow of a suitable heat exchange fluid.

The particular pattern which is to be employed in the panel and in the various fins extending through and from both surfaces of the panel will be determined by the specific application intended for the unit, selection of which will be apparent to those skilled in the art.

The manner in which the above objects and other objects and advantages are achieved will become more apparent in the following description and drawings in which:

FIGURE 1 is a plan view of a blank illustrating an embodiment of the invention for making the unit of the following figure shown in a relatively flat condition with passageways which may be dilated or ready to be dilated prior to subsequent corrugation;

FIGURE 2 is an isometric view illustrating a heat exchange unit fabricated from the blank illustrated in FIGURE 1;

FIGURE 3 is a plan view of a blank illustrating an embodiment of the invention for making the unit of the following figure;

FIGURE 4 is an isometric view of a heat exchange unit fabricated from the blank illustrated in FIGURE 3;

FIGURE 5 is a plan view of a blank illustrating another embodiment of this invention for making the unit of the following figure;

FIGURE 6 is an isometric view of a heat exchange unit fabricated from the blank illustrated in the preceding figure;

FIGURE 7 is a plan view of a blank illustrating another embodiment of this invention for making the unit of the following figure; and

FIGURE 8 is an isometric view of a heat exchange unit fabricated from the blank of FIGURE 7.

In accordance with the invention, a plurality of tubular circuits are provided in spaced relationship to each other, and are suitably interconnected to each other by tubular passageways. These tubular circuits are provided to be included within the area of the panel from which the fins, or the plates, are to be formed in the final assembly. The tubular circuits and the interconnecting tubular passageways are so arranged as to provide continuous solid web portions between them at points where the desired slit of the invention is to be made. As noted above, the specific pattern of the tubular circuits will be dependent upon

and governed by the specific application contemplated for the final unit.

Portions of the panel between adjacent circuits and connecting passageways are then transversely slit to provide a pair of adjacent cuts having terminal portions extending toward each other in spaced relationship overlapping a longitudinal portion of the panel which is common to each terminal portion. This, in effect, provides two tab portions, cut in the panel, which terminate within each other. The overlapping of the terminal portion of the transverse cut forms, from the overlapped longitudinal portion, a hinge common to the aforesaid tabs about which the portion of the panel encompassed within the adjacent cuts are rotated out of the panel into the spaced relationship desired. The amount of overlapping by the terminal portions with each other determines the amount of the panel which will serve as the hinge portion for the rotation of the fin, or plate.

By selection of the arrangement of the tubular conduits contemplated for the specific application, the transverse cuts can be made to have their terminal portions terminating within the panel, or wherein one of the terminal portions terminates at an edge of the panel.

The number of adjacent transverse cuts can be as large as desired limited only by their size and relation to the area of the panel, in any arrangement, such as aligned, staggered, and/or to include additional pairs of adjacent cuts within one of the aforesaid pairs. These pairs of adjacent transverse cuts can be made large, small, or in combination large and small cuts, inclusive of intermediate size cuts, as desired. Accordingly, if a vertical unit is desired having horizontal shelves, the transverse cuts may be large enough to extend across the width or the length of the panel. If the unit is desired to be provided with bafflings, or fins, for heat exchange applications, the specific size of the transverse cuts can be as large or as small as desired. As will be understood, the nature and location of the transverse cuts to be provided to the panel will govern the location of the tubular conduits.

Any configuration of tubular circuits may be provided within the area encompassed within each pair of adjacent transverse cuts, and wherein each circuit is interconnected to each other by tubular passageways, which are connected into these circuits by traversing the longitudinal portion of the panel common to the overlapped terminal portions of the transverse cuts.

The invention is not restricted to the inclusion of tubular circuits in all of the contemplated fins, or plates, to be provided in the unit since, as is evident, any number of the areas between adjacent transverse cuts may be devoid of circuits, and additional circuits may be provided within portions of the panel exterior of the areas between adjacent pair of transverse cuts.

Referring to the drawings, FIGURE 1 represents a flat rectangular heat exchange panel 1 such as obtained by the aforesaid U.S. Patent 2,690,002 in which a plurality of diverse patterns or tube circuits 2, 3 and 4 are arranged in spaced relationship to each other. Each circuit is suitably interconnected to each other by tubular passageways 5 which may be arranged in a manner such as 6 to provide a maximum amount of conduiting in the panel and may include additional circuits such as 7. The aforesaid patterns of tubular circuits and passageways are arranged in a manner to provide a continuous section of webbing for series of transverse slits 8, 9, 10, 11, 12 and 13.

Transverse slits 8 and 9 have terminal portions 14 and 15, and 16 and 17, respectively, which longitudinally extend toward each other and are also coextensive with each other, in spaced relationship, to overlap a longitudinal portion of the panel shaded at 18. In the instant pair of adjacent transverse slits, terminal portions 16 and 17 of slit 9 terminate within the terminal portions 14 and 15 of slit 8. In like manner, slits 10 and 11 have terminal portions 19 and 20, respectively, which overlap a longitudinal portion of the panel shaded at 21. Transverse slits 12 and 13 illustrate a modification of the manner in which longitudinal portion of the panel 24 may be overlapped in which only one of the terminal portions 23 of transverse slit 13 terminates between the terminal portions 22 of transverse slit 12. Each pair of adjacent transverse cuts, in effect, defines two tab portions which are rotated out of the plane upon common hinge portions 18, 21 and 24 common to each of the tab portions. The two tabs portions, together, provide the completed fin, or plate, 25 between slits 8 and 9, 26 between transverse slits 10 and 11, and 27 between slits 12 and 13.

The overlapped longitudinal portions 18, 21 and 24 also provide a convenient section of the panel through which the interconnecting passageways 5 may traverse to connect with the tubular circuits encompassed within each pair of adjacent cuts. Although the circuits between adjacent transverse cuts are shown connnected at each end by tubular passageways extending within each of the longitudinal portions 18, 21 and 24, the terminal portions of the transverse cuts may be spaced at a sufficient distance from each other to accommodate two tube passages serving as inlets and outlets for the encompassed tubular circuits.

FIGURE 2 shows the completed unit with the encompassed areas 25, 26 and 27 rotated out of the plane of the panel on hinge portions 18, 21 and 24, respectively, to form fins, or plates, 25', 26' and 27'. Although these fins, or plates, may be rotated to any spatial configuration desired, they are shown rotated to a position normal to the plane of the panel, and may be employed as shelving for any desired heat exchange appplication such as evaporator panels in refrigerators, or heaters in various types of drying ovens. It is to be understood that this invention is directed to the provision of a hinge portion to both tab portions of the fin unit to extend from both sides of the surfaces of the panel. Both tap portions of the fin need not be maintained within the same plane, as illustrated above, since after rotation of the finned unit out of the panel, the tab portions may be further bent relative to each other at any angle desired as a result of the common hinging of both tab portions.

If the interconnected system of passageways in blank 1 has been distended preceding fabrication in accordance with this invention, the unit is ready for any application desired as noted above. The twisting of the aforesaid fins, or plates, of FIGURE 1 may be accomplished by injecting water into the passageways, freezing the liquid, and rotating the fins, or plates, to prevent collapse of the passageways in hinge portions 18, 21 and 24. After rotation, the congealed fluid may be thawed, drained from the unit, and the unit suitably dried. However, if the system of passageways of blank 1 is undistended, the panel may, after rotation of the fins, or plates, be expanded by introduction of fluid pressure into the passageways.

FIGURE 3 illustrates modifications of the invention. A blank 28 is provided with a series of tubular circuits 29, 30, 31, 32, 33 and 34 interconnected to each other by a system of passageways 35. Circuits 29 is encompassed by a pair of adjacent transverse cuts 36 and 37 having terminal portions 38 and 39, respectively, longitudinally extending toward and in spaced relationship with each other to overlap a longitudinal portion 40 which is the hinge portion common to the tabs, formed by cuts 36 and 37, about which fin, or plate, 41 may be rotated out of the plane of panel 28. Transverse cut 36 in the instant embodiment is shown in a waved form as illustrative of the various configurations that the transverse cut may take.

The middle portion of the panel 28 illustrates a modification, of the invention to encompass a cutout section of the panel 42 contained between circuits 30 and 31. In this modification, a longitudinal cut 43 has terminal portions 44 which extend in a direction lateral of the plate and encompasses tubular circuits 32 and portions of circuits 30 and 31. The other transverse cut of the adjacent pair constitutes a longitudinal cut 45 through the edge 46 of cutout 42 and has terminal portions 47 extending laterally

within terminal portions 44 of transverse cut 43 to encompasses a lateral portion 48. The lateral sides 49 of cutout 42 provide additional terminal portions for transverse cut 45 and extend within the terminal portions 44 within transverse cut 43. In this modification, transverse cut 43 defines a tab portion 64 while transverse cut 45 defines two tab portions 65 and 66 which together comprise the fin, or plate, 67.

This specific configuration not only serves as an illustration of various modifications that the invention may take, but is intended to show the relative meaning of the terms transverse and longitudinal used herein. Thus, if one makes the transverse cuts to extend between lateral sides of the panel in the direction relative to the longest length of the panel, the longitudinal portion of the panel which the terminal portions must overlap will be in the elongated direction of the panel. However, if the transverse cut is made between the lateral sides relative to the shortest length of the panel, the longitudinal portion of the panel overlapped by the treminal portions of the transverse cut will be in the shortened direction of the panel. The terms are used herein merely to describe the relative position of each individual pair of adjacent transverse cuts.

The remaining portion of panel 28 illustrates a pair of adjacent transverse cuts contained within another pair of adjacent transverse cuts. A pair of transverse cuts 50 an 51 having terminal portions 52 and 53, respectively, which encompass the two tubular circuits 33 and 34 and overlap a longtiudinal portion 54 which is to serve as the hinge common to tab portions 55 and 56 defined by the two transverse cuts 50 and 51. These two tab portions 55 and 56 comprise the fin, or plate, 57. A second pair of transverse cuts 58 and 59 are contained within the transverse cuts 50 and 51 and encompass tubular circuits 34. These secondary transverse cuts 58 and 59 have terminal portions 60 and 61 extending in spaced relationship toward each other to overlap a longitudinal portion of the panel 62 which will serve as a hinge portion common to the tab portions defined by these secondary transverse cuts and comprising the finned portion 63.

FIGURE 4 illustrates the panel with fins, or plates, 41, 57 and 67 rotated out of the plane of the panel on their respective hinge portions. In addition, plate 57 has a secondary plate 63 rotated out of its plane on hinge portion 62.

FIGURE 5 illustrates other modifications of the invention provided in blank 68 containing tubular circuits 69, 70, 71 72, 73 and 74 interconnected by tubular passages 130. Circuit 69 is encompassed by a pair of adjacent transverse cuts which overlap a longitudinal portion 75 of blank 68 utilizing longitudinal edge 76 of the blank as one of the transverse cuts with terminal portions 77 extending toward in overlapping and spaced relationship with terminal portions 78 of a transverse cut 79.

Heretofore in the modifications described, the fins, or plates rotated out of the plane of the panel were provided with an intervening portion of the panel between them. However, the modification depicted in the central portion of panel 68, illustrates a modification of the invention with the absence of any intervening portions of the panel between adjacent fins, or plates.

A series of transverse cuts 80, 81 and 82 are provided for circuits 70, 71, 72 and 73 with cuts 80 and 82 having terminal portions 83 and 84 extending toward each other, however, separated by a relatively large longitudinal portion of the panel. Four pairs of adjacent transverse cuts are provided for the various circuits by providing transverse cuts 81, 87 and 90. Transverse cut 81 has primary terminal portions 85 and secondary terminal portions 86. Transverse cut 87 is provided with primary terminal portions 88 and secondary terminal portions 89. Transverse cut 90 is provided with primary terminal portions 91 and secondary terminal portions 92. Terminal portions 85, of transverse cut 81, extend toward terminal portions

83, of transverse cut 80, in overlapping coextensive relationship to each other to overlap a longitudinal portion 93 to serve as a hinge portion common to the tabs defined by transverse cuts 80 and 81 comprising the panel 94. Secondary terminal portions 86, of transverse cut 81, extend toward primary terminal portion 88 of transverse cut 87 in coextending spaced relationship to overlap a hinge portion 96 for plate 95. In like manner, secondary terminal portions 89, of transverse cut 87, extend toward the primary terminal portions 91 of transverse cut 90 to overlap a hinge portion 97 to encompass circuits 72 of plate 99. The secondary terminal portions 92 of transverse cut 90 extend toward the terminal portion 84 of transverse cut 82 to overlap a hinge portion 98 of plate 100.

Although the midportion of the panel 68 to the fabrication of the fins, or plates, 94 95, 99 and 100 have been included with other forms of circuits or plates, it is to be understood that the entire plate may be limited to this specific type of fin, or plate, construction to form a plate composed entirely of fins, or plates, rotated out of the plane of the panel without any intervening portions of the panel by the adjacent plates. This type of open construction permits the use of the resultant unit in further fabrications of radiator stock for automobiles and the like by the inclusion of secondary thin corrugated heat dissipating fins between adjacent plates.

The last portion of blank 68 illustrates the encompassing of tubular circuit 74 by a fin, or plate, 101 formed by a pair of adjacent transverse cuts, in which both a lateral and a longitudinal edge of the panel are employed. A portion 102 of the longitudinal edge of panel 68 constitutes a transverse cut having terminal portions 103 and 110. A transverse cut 104 extending to a lateral edge of the panel has a terminal portion 105 and utilizes a portion 106 of the lateral edge of panel 68 for the other terminal portion. The terminal portion 103 of transverse cut 102 extends toward terminal portion 105 in coextending spaced relationship to overlap a longitudinal portion 107 as one of the hinge portions for fin, or plate 108. Although terminal portion 106 is coextensive with the length of the other terminal portion 110, of transverse cut 102, only a longitudinal portion 109 serves as a hinge portion for plate 108. Although transverse cut 104 utilizes portion 106 of the lateral edge of panel 68, such utilization complys with the requirements of the invention since portion 109 employed as a terminal portion coextends with terminal portion 110 of transverse cut 102.

In this modification, since portion 106 extends to a longitudinal edge of panel 68, terminal portion 110 of transverse cut 102 could be lengthened or foreshortened to the longitudinal edge of the panel in any manner desired since the terminal portions will continue to overlap each other. By foreshortening terminal portion 110, of transverse cut 102, plate 108 can be rotated out of the plane of the panel on hinge portions 107 and 109 on a diagonal within panel 68.

FIGURE 6 illustrates panel 68 with the various plates rotated out of the plane of the panel.

FIGURE 7 illustrates a modification of the invention wherein two rows of tubular circuits are located in a panel 111 in which portions of the circuits in each row are encompassed by pairs of adjacent transverse cuts in staggered relationship. The panel is provided with tubular circuits 112, 113, 114, 115, 116, 117, 118, 119 and 120, of which all circuits but 114, 116, 118 and 120 are encompassed by a pair of adjacent transverse cuts overlapping longitudinal portions 121, 122, 123, 124 and 125 which serve as the hinge portions for the various fins, or plates, encompassed within each of the pairs of transverse cuts. The various pairs of adjacent transverse cuts comply with the requirements of the invention since the transverse cuts in each pair have terminal portions extending to each other in coextending spaced relationship to overlap the longitudinal portion necessary to serve as a hinge

for the rotation of the plates out of the plane of the panel, in which form they are illustrated in FIGURE 8.

As can be observed, by fabricating the fins, or plates, in the manner prescribed by the invention, the final fabricated heat exchange unit is provided with fins which can extend through the panel and away from both surfaces of the panel. In the modifications described, the plane of the fin intersects the plane of the panel. In the four angles formed by the intersection of the planes, the hinge portion will normally extend within only one of the aforesaid angles, although it is to be understood that the amount of the longitudinal portion overlapped by the terminal portions can be great enough to permit its bowing out for connecting means, supporting means and the like.

Although the invention has been described with reference to specific embodiments, materials and details, various modifications and changes will be apparent to one skilled in the art and are contemplated to be embraced within the invention.

What is claimed is:

1. A heat exchange unit comprising

(A) a panel,

(B) at least one hollow tube within said panel,

(C) at least one fin extending through and integral with said panel, said fin comprising two integral tab portions rotated out of the plane of said panel on a hinge portion common to both said tab portions, and

(D) a hollow tube circuit within said fin in communication with the hollow tube within said panel.

2. A heat exchange unit according to claim 1 wherein said fin lies in a plane normal to the surface of said panel.

3. A heat exchange unit according to claim 1 wherein said fin lies in a plane intersecting the plane of said panel.

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