

Dec. 14, 1965

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3,223,153

FIN AND TUBE TYPE HEAT EXCHANGER

Filed May 21, 1962

2 Sheets-Sheet 1

Fig. 1.

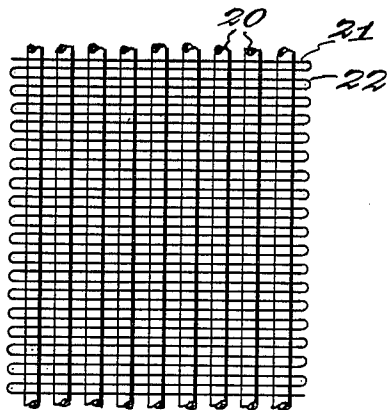


Fig. 7.

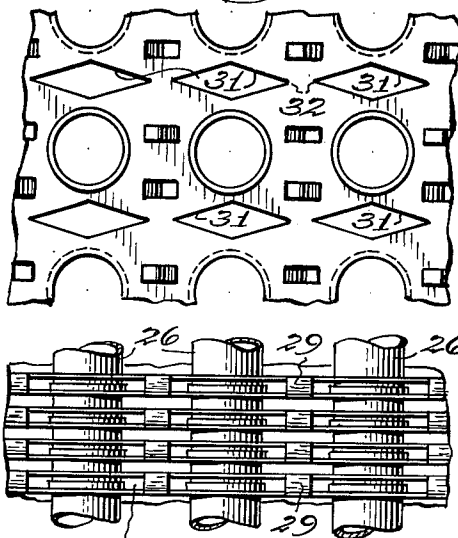


Fig. 2.

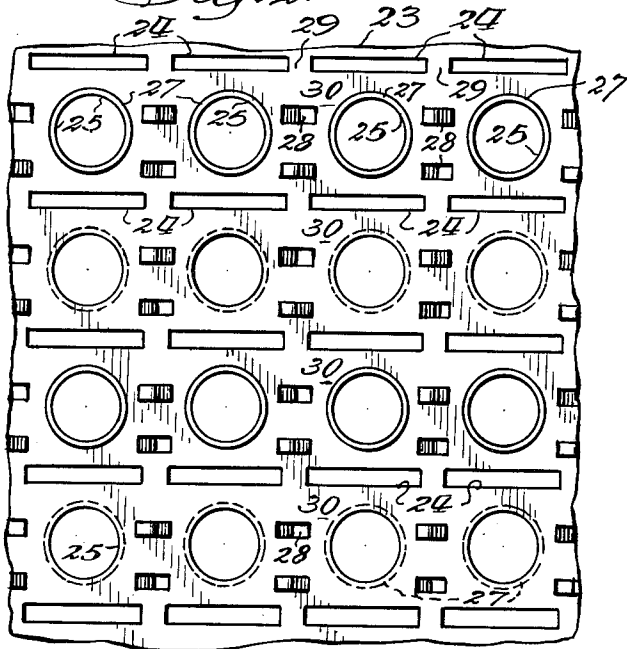


Fig. 6.

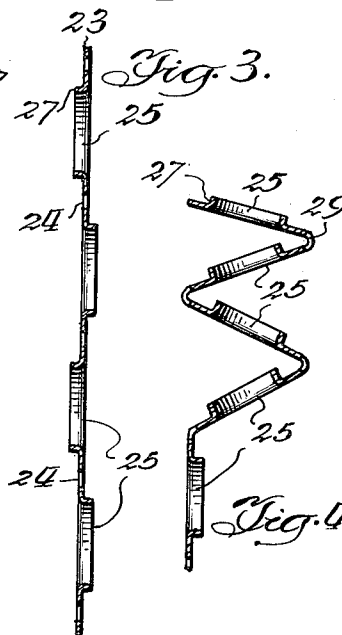


Fig. 3.

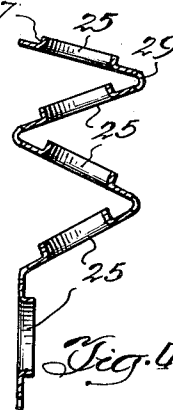


Fig. 4.

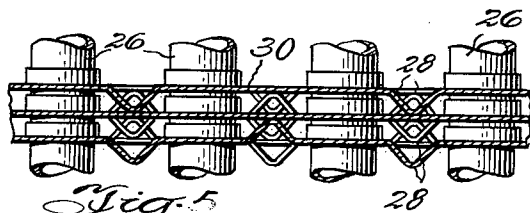


Fig. 5.

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FIN AND TUBE TYPE HEAT EXCHANGER

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2 Sheets-Sheet 2

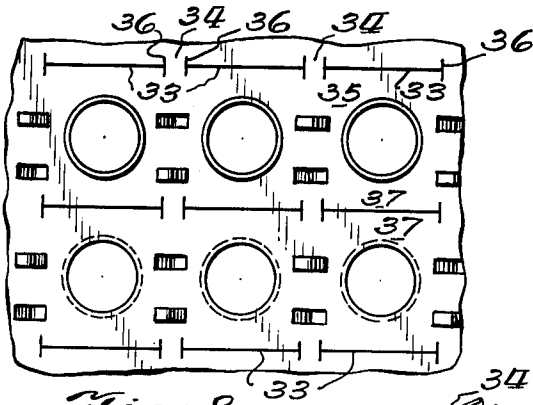


Fig. 8.

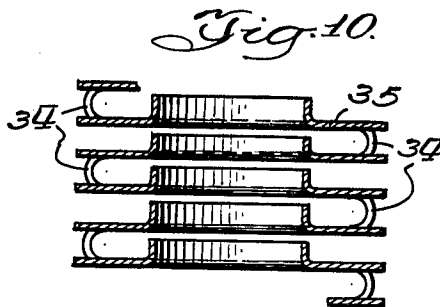


Fig. 10.

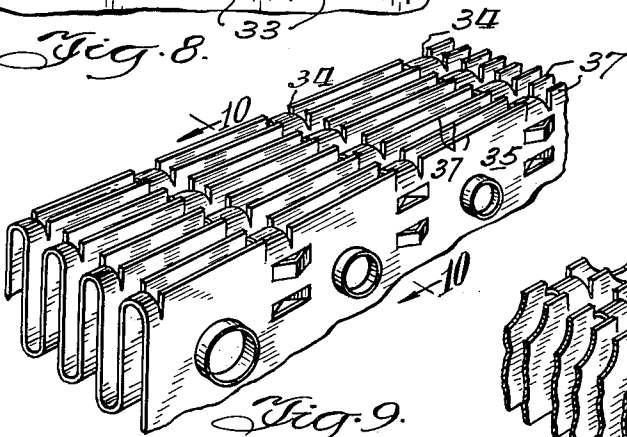


Fig. 9.

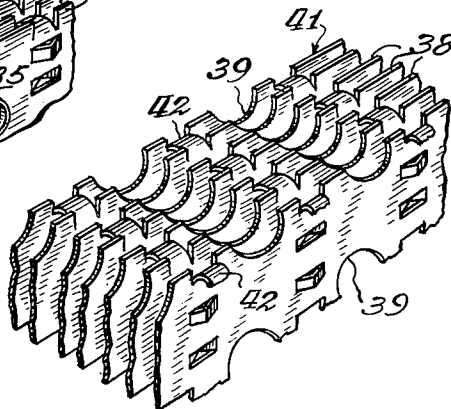


Fig. 12.

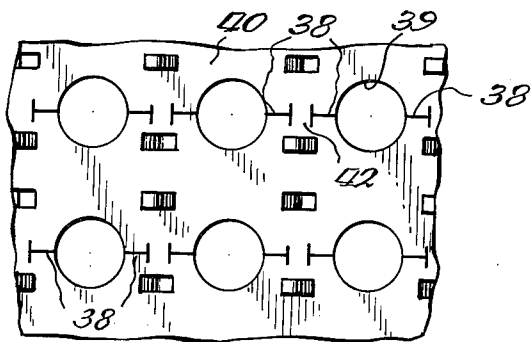


Fig. 11.

FIN AND TUBE TYPE HEAT EXCHANGER

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Filed May 21, 1962, Ser. No. 196,114

5 Claims. (Cl. 165-152)

This is a continuation-in-part of application Serial No. 115,234, filed June 6, 1961, and now Patent No. 3,106,958.

This invention relates to a heat exchanger particularly of the fin and tube type wherein one fluid is confined within a conduit or tube which has attached thereto spaced fins for heat exchange with another fluid passing around and between the tubes and fins.

In many types of heat exchangers it is customary to provide conduits and specifically tubes for one fluid to flow therethrough and spaced fins in contact with these conduits between which another fluid flows in order to provide heat transfer between the two fluids. In my above copending application it has been proposed to form these fins by bending a continuous metal sheet which may be in strip form in a serpentine or sinuous arrangement with adjacent portions of the metal sheet constituting the spaced fins and arranged against the outer surfaces of the fluid conduit in order to provide heat transfer therebetween and thus between the fluid within the conduit and the fluid passing between the fins.

One of the features of the present invention is to provide a heat exchanger structure comprising a sinuous continuous metal sheet arranged in adjacent pleats to form fins connected in series by side fold areas in which these fold areas have openings for permitting fluid flow through the openings to between the fins with the heat exchanger structure also including means forming aligned fin openings for receiving the fluid tubes.

Other features and advantages of the invention will be apparent from the following description of certain embodiments thereof taken in conjunction with the accompanying drawings. Of the drawings:

FIGURE 1 is a fragmentary elevational view illustrating the general type of heat exchanger with which the invention is concerned.

FIGURE 2 is a fragmentary elevational view of a metal sheet for forming one embodiment of the fins.

FIGURE 3 is a sectional view through the embodiment of FIGURE 2 with spacer projections omitted for simplicity of illustration.

FIGURE 4 is a view similar to FIGURE 3 illustrating the folding of the metal sheet into adjacent pleats preparatory to forming the fin structure with spacer projections omitted for simplicity of illustration.

FIGURE 5 is a fragmentary sectional view through a completed heat exchanger utilizing the fin structure of this first embodiment.

FIGURE 6 is a side elevational view of the heat exchanger of FIGURE 5.

FIGURE 7 is a view similar to FIGURE 2 showing a metal sheet used in forming a second embodiment of the fin structure.

FIGURE 8 is a view similar to FIGURE 2 but showing a metal sheet used in producing a third embodiment of the fin structure.

FIGURE 9 is a perspective view illustrating the fold form of the embodiment of FIGURE 8.

FIGURE 10 is a sectional view taken substantially along line 10-10 of FIGURE 9.

FIGURE 11 is a view similar to FIGURE 8 but illustrating a fourth embodiment of the invention.

FIGURE 12 is a view similar to FIGURE 9 but employing the fin structure of this fourth embodiment.

FIGURE 1 illustrates the type of heat exchanger uti-

lizing the present invention. Such a heat exchanger has many uses such as for condensers for refrigeration systems. The heat exchanger comprises a plurality of fluid tubes 20 connected by closely spaced fins 21. In the type of fin structure contemplated, these fins are made up of adjacent pleats of a metal sheet or strip folded to lie substantially parallel to each other so that the adjacent pleats constituting the fins are connected in series by side fold areas 22.

In the embodiment of FIGURES 2-6 inclusive the metal sheet 23 is provided with parallel series of aligned but spaced slots 24 with the distance between two adjacent sets of aligned slots 24 determining the width of the fin. Between each adjacent pair of series of aligned slots is arranged a series of openings 25 for receiving the tubes 26 of this first embodiment. Each opening in this embodiment is surrounded by an annular flange 27 that is struck from the sheet metal.

Between the openings 25 and the slots 24 are projections 28 struck from the sheet metal and arranged in pairs with one projection of each pair extending away from one side of the metal sheet and the other projection extending away from the other side.

In order to produce the adjacent pleats constituting the spaced fins the metal sheet 23 is folded as illustrated in FIGURES 3 and 4 with the parallel series of aligned slots 24 determining the fold lines. As can be seen in FIGURE 2, adjacent slots 24 are connected by relatively thin sections 29 of the sheet metal and these become the relatively narrow arcuate connections of one pleat or fin to its neighbor. Because these sections 29 are thin, folding is easily accomplished at the sections so that, in effect, each series of slots 24 determines a fold area for the sheet metal. As can be seen in FIGURE 5 the adjacent fins 30 which are the same, of course, as the pleats are spaced from each other by the projections 28. When the metal sheet is thusly folded the openings 25 are in aligned series for receiving the fluid conduit tubes 26.

As can be seen from the above description the provision of spaced series of slots 24 aids in determining the fold areas for folding the metal sheet in sinuous fashion so that the adjacent pleats form the fins. As the adjacent fins are connected only by the relatively narrow metal sections 29, the folding is relatively easy. Furthermore, adjustments are easily made in the fold because the folding takes place at these narrow sections to align each set or series of tube openings 25 for receiving the tubes 26. A very important function of these slots 24 besides locating the fold areas is to permit fluid flow through the slots into the spaces between the fins and around the tubes 26. Thus, it has always been possible to attain fluid flow, of course, between the fins at right angles to the plane of the view of FIGURE 1, for example, and parallel to the fins. Now, in addition to this direction of flow, fluid flow is also achieved in additional directions through the slots (which would be at right angles to the plane of FIGURE 6) with the folded arrangement providing substantially no interference to this flow.

The provision of the slots 24 has the further advantage of providing openings for drainage of liquid such as condensate from an evaporator surface or cooling water from a condenser. This is particularly important where the heat exchanger would be so constructed that the fold areas are on the bottom. It is preferred for efficient fluid flow between the fins that the length of each slot 24 be at least 90% of the fin width.

The embodiment shown in FIGURE 7 is quite similar to the embodiment of FIGURES 2-6 inclusive. In FIGURE 7, however, each slot or opening 31 is of generally diamond shape with the long axis of each set of diamonds being aligned so that the sharper points 32 of the di-

amonds are adjacent each other. In all other respects, this embodiment is the same as the previous embodiment. In this construction the diamond formation locates somewhat more precisely the fold line which will be essentially the aligned long axes of each set of diamond slots.

In the embodiment of FIGURES 8, 9 and 10 aligned slits 33 are used instead of the previous slots. Each set of slits is aligned with one end of one slit being spaced from the adjacent end of the other in order to provide the connecting bridges or metal sections 34 which will connect the adjacent pleats or fins 35. The metal sections 34 are defined on each side by substantially parallel short slits 36 so that one slit 33 and its two end transverse short slits 36 form an H. In this embodiment the fins are formed by folding the metal sheet into pleats as in the previous embodiments. Here, however, the fin edges 37 formed by the sets of slits 33 and 36 lie in the planes of the respective fins 35 and are spaced from each other as shown in FIGURES 9 and 10.

The embodiment of FIGURES 8-10 has the advantages previously described and in addition has the advantage of conserving useful fin metal for heat transfer purposes. Thus, in this embodiment the slits preserve all of the metal and do not eliminate metal as is true of the slots 24 and 31 of the previous embodiments. Thus, a higher proportion of metal is available for heat transfer purposes. These resulting slit edges 37 serve as liquid drip edges such as for dripping condensate when used as a part of a condenser for hot refrigerant.

The embodiment of FIGURES 11 and 12 is similar to the embodiment of FIGURES 8, 9 and 10 in that slits 38 are used instead of the previously described slots. However, in the embodiment of FIGURES 11 and 12, each long slit 38 intersects an opening 39 for receiving tubes similar to the tubes 26. In this last embodiment the arrangement of the fins and tubes is similar to that of my prior application mentioned above. Thus, when the metal sheet 40 is folded to form the fin structure 41, as shown in FIGURE 12, the aligned openings 39 at each edge of the fin structure are adapted to receive approximately one-half of a tube similar to the tube 26. Then, another fin structure can be placed on the opposite side of the tube in the manner shown in my above-mentioned prior application. This construction is possible here, as the connecting metal sections 42 that are constructed similarly to the connecting sections 29 of the first embodiment are located inwardly of the edges of the fins formed by the slits 38. Thus, the fin structure 41 may be stacked with the slit edges of one stack against the slit edges of a similar stack without interference by the recessed curved connecting sections 42.

In all embodiments the fin structure of the heat exchanger is made by folding a metal sheet in alternate folds to provide adjacent pleats which constitute the plurality of fins. The folding is quite easily accomplished as the connecting portions of metal between the adjacent fins are relatively narrow sections. This has the added advantage of providing openings whether formed of slots where metal is actually removed or slits where the metal is cut for receiving additional fluids for the spaces between the fins. The metal sheet may be as wide or as narrow as desired to accommodate one coplanar set of tubes or a plurality of coplanar sets of tubes. Thus, in the portion of the structure shown in FIGURE 2 the fin structure will accommodate a set of four tubes. Different arrangements and different ways of bending may of course be used to produce any desired arrangement without departing from the principles

of the invention. In the embodiment shown substantially all of the fold areas on one side of the fin structure are in one plane while those on the other side are in another parallel plane. The distances between these two planes have of course approximately the width of the fin.

Although the illustrated embodiments are for fin structures each accommodating only one set of parallel tubes it is of course obvious that the fold areas as determined by the slots or slits or other openings may be arranged to provide as many passes of parallel tubes as desired. The single arrangement is illustrated for simplicity of illustration of the invention.

Having described my invention as related to the embodiments shown in the accompanying drawings, it is my intention that the invention be not limited by any of the details of description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the accompanying claims.

I claim:

1. A fin and tube heat exchanger, comprising: a sinuous continuous metal sheet arranged in adjacent pleats constituting fins connected in series by side fold areas, said sheet having means forming elongated openings substantially along said fold areas for permitting high volume flow of fluid through said openings and between said fins; means forming aligned fin openings; and a plurality of tubes in said fin openings in heat transfer relationship with said fins.

2. The structure of claim 1 wherein said fold area opening forming means comprise cut out sections in said sheet.

3. The structure of claim 1 wherein said fold area opening forming means comprise slits in said sheet.

4. The structure of claim 1 wherein said tube receiving openings are in said alternate fold areas.

5. A fin and tube heat exchanger, comprising: a sinuous continuous metal sheet arranged in adjacent pleats constituting fins having length and width connected in series by arcuately curved side fold areas and said fins being substantially parallel to each other, alternate fold areas being located on opposite sides of said fin structure with those on one side being located substantially in a first common plane and those on the opposite side being located substantially in a second common plane with the two planes being substantially parallel to each other, said sheet having means forming openings at said fold areas for permitting high volume flow of fluid through said openings and between said fins with said openings having a length along said fold areas of at least about 90% of said fin width and being arranged in alignment with one end of one opening spaced from the adjacent end of the next opening; means forming aligned fin openings; and a plurality of tubes in said fin openings in heat transfer relationship with said fins.

References Cited by the Examiner

UNITED STATES PATENTS

2,119,761	6/1938	Wentworth	165—152 X
2,788,195	4/1957	Karmazin	165—151 X
2,948,054	8/1960	Kritzer	165—181 X
2,977,918	4/1961	Kritzer	165—181 X
2,994,123	8/1961	Kritzer	165—151 X

FOREIGN PATENTS

201,934	11/1924	Great Britain.
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