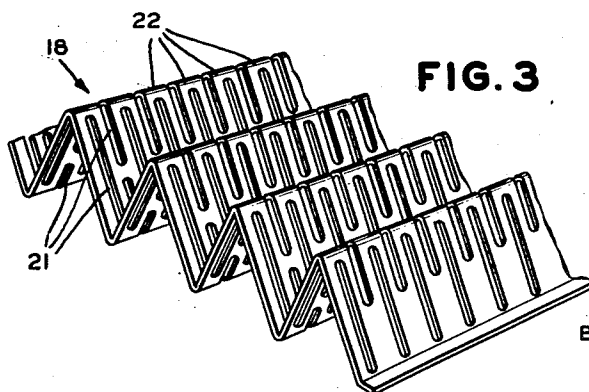
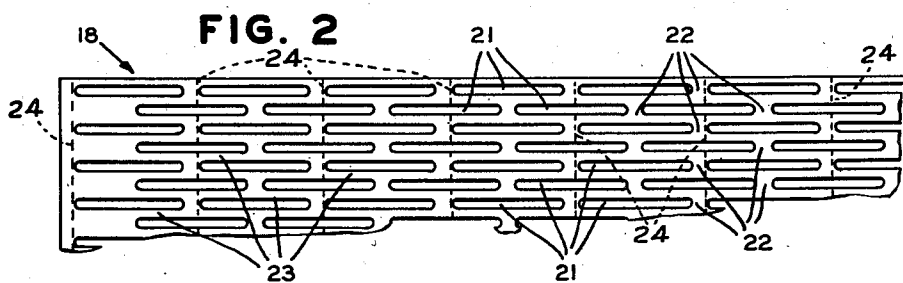
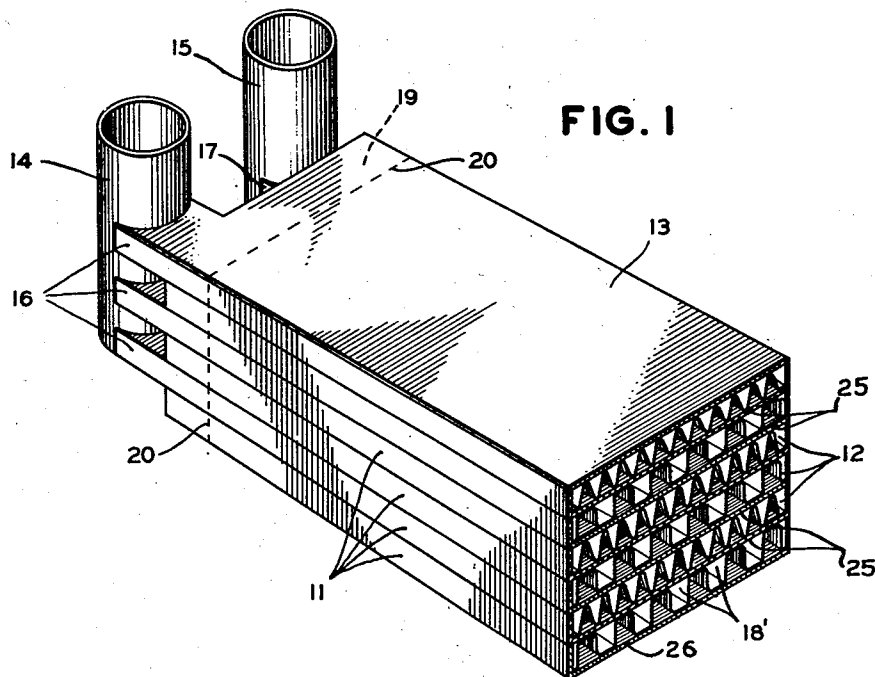


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HEAT EXCHANGE ELEMENT
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INVENTOR
PAUL R. TRUMPLER
BY E. J. Liebrecht
William Klabrunde
ATTORNEYS

UNITED STATES PATENT OFFICE

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HEAT EXCHANGE ELEMENT

Paul R. Trumpler, Ridgewood, N. J., assignor to
The M. W. Kellogg Company, Jersey City, N. J.,
a corporation of Delaware

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This invention relates to an extended surface heat exchanger, and particularly to a tray-type heat exchanger wherein one or more fluid chamber walls are provided with extended surfaces or fins for the rapid interchange of heat between the fluid and the adjacent chamber wall. More particularly, the invention relates to an improved extended surface element adapted to form a packing between opposite chamber walls of a tray-type heat exchanger.

A primary object of the invention is to provide an improved extended surface element for a heat exchanger of simple, sturdy and economical construction adapted to provide a rapid and efficient interchange of heat between one or more fluid chamber walls and the heat exchange medium within the chamber.

Another object is to provide an improved extended surface for a heat exchanger adapted to provide a multiplicity of closely spaced elongated fin members of relatively small cross-section for the rapid transfer of heat between a heat exchange medium and one or more chamber walls.

A further object is to provide a continuous corrugated packing adapted to provide extended surfaces for a fluid chamber wall of such construction as to provide a maximum of heat conductivity in a direction transversely of the direction of flow of the fluid heat exchange medium and a minimum of heat conductivity in the direction of said flow.

Heat exchangers of the type to which the present invention may be most advantageously applied are well-known in the art. They may comprise, for example, a plurality of tray-like members superimposed one adjacent the other to form a parallel series of narrow passages suitably manifolded at each end to provide countercurrent flow of the fluid heat exchange media in adjacent passages. To provide a high heat transfer rate between the fluid heat exchange media and the chamber walls dividing adjacent passages, it is a known expedient to insert in the fluid chambers a packing in the form of a continuous corrugated metal sheet, the sloping sides of which extend transversely across the fluid chamber and are bonded in mechanical and thermal connection with one or both of the opposite chamber walls.

The foregoing type of extended surface packing has been found somewhat deficient in providing maximum heat transfer between the fluid medium and the primary wall surfaces, however, since there is a lack of turbulence in the fluid heat exchange medium coursing through the narrow passages between the transverse extended surfaces, by reason of the normally smooth sur-

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faces of the corrugations. A further disadvantage has been the fact that a continuous surface of this type permits high heat conductivity along the extended surfaces or fins in the direction of fluid flow, which is considered undesirable since, there is a definite measurable loss, however, slight, in thermal performance by reason of such construction. It is one of the objects of the present invention, therefore, to provide an extended surface packing for a heat exchanger which will effectively overcome or at least minimize the deficiencies above noted in present designs.

These and other objects are effected by the invention as will be apparent from the following description and claims taken in connection with the accompanying drawing forming a part of this application, in which:

Fig. 1 is an isometric sectional view of a typical tray-type heat exchanger embodying the extended surface packing of the present invention, a half section only being illustrated because the exchanger is symmetrical with respect to the transverse section plane;

Fig. 2 is a plan view of a sheet of light-gauge metal stamped or otherwise cut in a continuous open-work pattern in accordance with the present invention and shown prior to its contraction to form a corrugated packing; and

Fig. 3 is an isometric view of a portion of perforated sheet material creased as illustrated along the dotted lines of Fig. 2 to form a corrugated sheet of extended surface packing.

Referring to the drawings, Fig. 1 shows a fragment of a heat exchanger unit preferably, though not necessarily, constructed symmetrically with respect to the section plane. Although my improved element is capable of application to various well-known tray-type heat exchanger designs, a typical unit comprises a series of tray sections 11 stacked one above the other to form a series of fluid chambers 12. The tray sections 11 may be formed by turning up two opposite sides of a wide strip of light-gauge sheet material longitudinally extended at diagonally opposite corners. In stacking the trays, as shown in Fig. 1, the bottom of a tray may form the cover for the below adjacent tray. A flat sheet 13 may be used as a top cover to complete the formation of a unit having a series of longitudinal passages. Headers 14 and 15 may be disposed at each end of the unit to provide inlets and outlets for the fluid heat exchange media. Suitable end plates may then be provided to close the ends of the passages so as to form the chambers 12 and to form connectors 16 and 17, respectively, between the headers and the

chambers since the tray assembly, which may be constructed in any well known manner, form no part of the present invention, a more detailed description of its construction is not believed necessary.

A corrugated perforate packing constructed in accordance with the present invention is provided in each of chambers 12 to subdivide each chamber into a series of parallel channels through which the heat exchange medium may flow.

The corrugated packing 18 and 18' is mechanically and thermally bonded to the opposite chamber walls by any suitable means, as by soldering, brazing, etc. The corrugations may be formed in any of a number of suitable patterns. For example, they may be V-shaped as at 18 or U-shaped as at 18', as shown in Fig. 1, and they may all be of the same shape or of different shapes, as desired. The alternating arrangement of V-shaped and U-shaped members 18 and 18' are shown in the drawing merely for the purpose of illustrating one of several possible arrangements. Depending upon the amount of extended surface desired in a particular chamber, the amount of contraction also may be varied. The packing in each chamber terminates short of the end thereof to provide a distributing space at each end of the chamber. The ends of the packing may be considered as terminating in the transverse plane indicated by the dotted line 20 in Fig. 1. If so desired, packing may be placed only in alternate chambers so that the extended surface contacts only one of the two streams.

In Figs. 2 and 3 are shown the extended surface packing 18 in various stages of fabrication. In Fig. 2 a fragment of a wide sheet of light-gauge material is shown. A series of narrow elongated slots 21 are punched or cut in the sheet in a staggered pattern, as illustrated. The slots are arranged with close end-to-end spacing, providing the narrow areas 22, and with close lateral spacing, providing the narrow elongated strips 23.

Experience has shown that a superior extended surface is provided by a packing or mat of pin members extending transversely across the fluid passage and mechanically and thermally connected to one or both chamber walls. For example, a packing of pins distributed in a uniform pattern of about 200 to 300 pins per square inch, and each pin having a diameter of about $\frac{1}{16}$ " is considered preferable for low temperature exchangers, although it is to be understood that the present invention is not limited to this particular size, nor to the exact proportions shown in the drawings.

By cutting out the sheet material in the manner illustrated, it is possible to simulate a mat composed of a parallel series of spaced, elongated narrow ribbons, strips, or wires, each ribbon connected to its adjacent ribbon at uniformly spaced points, and each pair of connected ribbons connected to the adjacent pair at points midway between the connections forming the pairs.

Preferably the slots 21 are relatively narrow and closely spaced longitudinally and laterally. For example, a suitable slot width for many applications might be $\frac{1}{16}$ ", with a slot length of $\frac{1}{2}$ ", the latter measurement depending upon the desired thickness of the corrugated packing as determined by the distance between the dividing walls of the chambers 12, that is, the primary heat exchange surfaces.

The ribbons or strips 23 may suitably be in the order of $\frac{1}{16}$ " to $\frac{1}{8}$ " with a sheet material thickness of 0.010 to 0.020 inch.

It will be obvious that design specifications will differ for various applications and may also vary in accordance with the characteristics of the sheet material and the fabrication technique.

After the sheet material is perforated in the desired pattern, it is creased along the dotted lines 24 of Fig. 2 alternately in opposite directions to form a corrugated member as illustrated in Fig. 3. Although the corrugations have been shown as V-shaped, it is to be understood that other shapes may be used, as shown in Fig. 1. By creasing the flat strip along the dotted lines, broad solid areas 22 are disposed at the extremities of the creases to provide a maximum of surface for contact with and bonding to the primary heat exchange surfaces, that is, to the internal surfaces of the partitions 25 separating the chambers 12 and the top and bottom walls 13 and 26, respectively.

The packing 18 and 18' is placed in the trays before they are stacked. A sheet of suitable bonding material may be placed beneath and on top of each strip of packing, or a coating of suitable bonding material may be applied to the top and bottom surfaces of the partitions 25. To complete the bonding of the secondary heat exchange surfaces, that is the packing strips 18 and 18', to the primary heat exchange surfaces or partitions 25, and optionally to the walls 13 and 26, pressure is applied externally to the assembled unit in a direction normal to the primary surfaces while heat is applied in any suitable manner to the unit to fuse the bonding material to the packing and to the primary surfaces.

The packing strips 18 are disposed within the chambers 12 with the elongated slots 21 extending in a direction substantially normal to the direction of flow of the heat exchange fluids passing through the longitudinal V-shaped channels provided by the corrugations. The narrow ribbons 23 extend transversely across the gap between the primary surfaces of adjacent partitions 25 to provide, in effect, a pin-type packing.

The broken surface provided by the pin-type packing increases the turbulence of the heat exchange fluid at the transfer surfaces, so that increased heat transfer coefficients are attained.

By staggering the perforations, heat conductivity along the packing in the direction of flow of the heat exchange media is greatly reduced, because the heat of conduction through the packing material must travel back and forth in a tortuous path around the ends of the perforations 21 and across the areas 22. Obviously, losses in thermal performance by reason of such conduction are effectively minimized.

It will be apparent to those skilled in the art that the invention is susceptible of various other modifications without departing from the spirit thereof, and it is desired, therefore, that only such limitations shall be placed thereon as are specifically set forth in the appended claims.

What is claimed is:

1. In a heat exchanger for indirect heat exchange between two fluid streams flowing in adjacent passages separated by a heat conducting wall means, improved means for transferring heat from said fluids to said wall means which includes: a sheet of light gage heat conductive material, folded in said passages longitudinally with respect to said stream flow and contacting the walls of said passages along said folds, said sheet being slotted in parallel rows of elongated

slots, alternate rows of said transverse slots extending most of the distance between said folds without crossing said folds and the slots in the intermediate rows extending across said folds.

2. A heat exchange means as described in claim 1 in which the width of said material between adjacent rows of slots is not greater than the width of said slots.

PAUL R. TRUMPLER.

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