PLATE AND FIN HEAT EXCHANGER

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A compact heat exchanger of the plate and fin type in which a manifoldev core is constructed for multiple pass flow of at least one of the involved fluids. Manifold members have ribs achieving localized crushing engagement with the fin material providing for separation of adjacent flow passes without the use of dividing channel and like separable component parts.

5 Claims, 5 Drawing Figures
PLATE AND FIN HEAT EXCHANGER

BACKGROUND OF THE INVENTION

This invention relates to plate and fin heat exchangers, particularly of the multiple pass type.

The art pertaining to high performance, compact heat exchangers has become highly developed. The use of strip fin material as an extended surface means is an important part thereof. In one such form of device it is known to direct a fluid back and forth across a heat exchanger, in a single plane or at a single level thereof. In adjoining planes another fluid is passed. By virtue of separating, heat conducting plates and through use of inserted fin material a transfer of heat takes place between the fluids in a conduction-convection process. A multiple pass flow mode may be enforced at any or all levels. This has heretofore been achieved by a use of separable channel-like members which dispose in a side by side alternating relation to fin strips, between spaced apart plates, with all parts, after assembly, being united in a brazing or like operation. A device so constructed is quite satisfactory in operation. However, the use of separable channels or nose-pieces adds to the complexity of the article, increasing its cost and introducing a further reliability factor.

SUMMARY OF THE INVENTION

The instant invention has in view a heat exchanger more simply constructed than heretofore, with consequent improvement in fabrication costs and in the reliability factor, and to provide a device so characterized is an object of the invention.

Another and more particular object is to obviate the use of separate dividing strips in a heat exchanger providing multiple passes at a single level.

In accordance with the illustrated embodiment of the invention, multi-pass performance is achieved using a single fin strip, with the corrugations of the strip itself serving as a means to separate adjacent flow passes. Manifold members are applied to ends of the heat exchanger providing turn-around chambers at the ends of the flow passes. Between the turn-around chambers projecting ribs on the manifold members compress against portions of the ends of the fins substantially to seal adjacent chambers from one another and enforce longitudinal flow along the corrugations of the fin strip. Peaks and valleys of the fin corrugations are brazed or otherwise joined to overlying and underlaying plate members. The latter are notched at their ends to accommodate the projecting ribs on the manifold members. According to a feature of the illustrated form of the invention the overlying and underlaying plate members are integrally formed as a flattened tube, thus obviating all need for separable channel pieces, nose pieces and the like.

Other objects and structural details of the invention will appear more clearly from the following description, when read in connection with the accompanying drawings, wherein:

FIG. 1 is a view in front elevation of a heat exchange core in accordance with the illustrated embodiment of the invention, a showing of manifold means normally applied to the core being omitted;

FIG. 2 is a view in transverse section, taken substantially along the line 2—2 of FIG. 1, the manifold means being in this instance included;

FIG. 3 is a view in cross section, taken substantially along the line 3—3 of FIG. 2;

FIG. 4 is a fragmentary view in cross section, taken substantially along the line 4—4 of FIG. 2; and

FIG. 5 is a fragmentary view in longitudinal section, taken substantially along the line 5—5 of FIG. 4.

Referring to the drawings, in accordance with the illustrated embodiment of the invention, a heat exchanger comprises a pair of spaced apart header plates 10 and 11. The plates 10 and 11 are identically constructed, having in the present instance a flat rectangular configuration. Each is formed with a vertical series of laterally elongated openings 12. Upper and lower edges of each opening 12 are parallel to one another. Opposite ends are curved. The configuration conforms to that of a tube 13 which is flattened to have the laterally elongated configuration corresponding to that of the openings 12. The tubes 13 extend between and interconnect the header plates 10 and 11, opposite ends of the tubes being accommodated in corresponding openings 12 in the header plates. The tubes 13 have a closely conforming relation to the openings 12, and, as will be further described, the parts are unitarily joined to one another, as by a brazing process. At their opposite ends, the tubes 13 project through and beyond the respective header plates 10 and 11. In the projecting end of each tube is a plurality of cut-outs or notches 14. The notches appear in both upper and lower end walls of each tube and are comprised in a laterally spaced apart series of pairs of notches, aligned notches in the upper and lower end walls constituting each pair. At opposite ends of the tubes, corresponding pairs of notches are offset. Each tube 13 forms an enclosure 15 open at its opposite ends. In the enclosure 15 is a fin strip 16. The member 16 is made of a thin, ductile heat conductive metallic material gathered or crimped to the corrugated configuration illustrated.

The corrugations or individual fins of the strip 16 are of uniform height. This is by design approximately the same as or slightly greater than the internal dimension between the upper and lower walls of the tube. Upon insertion of the fin strip into the enclosure 15, therefore, the fin corrugations are in lightly compressive, substantially continuous contact with the internal tube walls. As will be later noted, in a brazing or like process, the fin peaks and valleys may be unitarily joined to overlying and underlaying tube walls by means forming a seal and a bond. The strip 16 is oriented in each tube to have its fin corrugations extend lengthwise of the tube or from end to end thereof. In length, it is substantially coextensive with the tube, portions of the fin strip tending to occupy and fill the locations of notches 14.

Disposing between the header plates 10 and 11, in an alternating relation to the tubes 13, are other fin strips 17. These are or may be constructed similarly to the strips 16, and, where positioned between adjacent tubes 13, have individual fin corrugations in contacting relation to overlying and underlaying walls as defined by wall surfaces of the tubes 13. Fin strips 17 are oriented to lie perpendicularly of or at right angles to the fin strip 16. The header plates 10 and 11 and adjacent tubes 13 form flow paths 18 occupied by the fin strips 17. At upper and lower ends of the assembly comprised...
of alternating fin strips 17 and tubes 13, core sheets 19 and 21 may be installed to complete a heat exchanger core. In fabricating the defined core, the header plates 10 and 11, the tubes 13, fin strips 16 and 17 and core sheets 19 and 21 are assembled to occupy the relative positions illustrated. The assembled core is then subjected to a brazing or like operation in which contacting parts are connected to one another by means constituting a seal and a bond. A unitary one-piece assembly accordingly is defined constructed for flow of fluids of different temperature through the tubes 13 and through the flow paths 18. A transfer of heat between the fluids takes place, utilizing a conduction-convection process. All four sides of the heat exchanger core may be manifolded for a controlled fluid flow. In the illustrated instance flow of the fluid through the tubes 13 is manifolded, while flow of a fluid through passages 18 is shown as occurring in relative unrestricted manner, as if the core were interposed in a duct wherein a flowing fluid is constrained freely to have access to and to move longitudinally through the passages 18 in a single pass.

A manifold member 22, which may be a cast metallic structure, is applied to one face of the heat exchanger core, in enclosing relation to projecting ends of tubes 13. Turned over marginal edges on an inner face of the manifold member 22 are turned over and make an abutting contact with header plate 11. A welding or like operation may be used positively to unite the cast manifold with the header plate. Also on the inwardly facing side of the manifold member 22 is a laterally disposing series of recesses 23 of vertical extent. At opposite ends of the series of recesses 23 are somewhat smaller recesses 23a and 23b which for convenience of terminology will be identified as inlet and outlet recesses respectively. The several recesses or chambers in the inwardly facing side of the manifold member 23 are separated by projecting ribs 24 of vertical extent. On its outwardly facing side, the manifold member 22 is formed with lower and upper projecting bosses 25 and 26 which are internally threaded to connect in fluid flowing lines and which serve respectively as the fluid inlet and the fluid outlet for the heat exchanger. Boss 25 communicates with a cored passageway 27 leading by way of an opening 28 to inlet recess 23a. Boss 26 communicates with a passageway 29 leading through an opening 31 to outlet recess 23b.

On the opposite face of the heat exchanger core is another manifold member 32 constructed similarly to the member 22 but without the inlet and outlet bosses and without the cored passageways 27 and 29. Marginal edges of the member 32 are turned over and welded to the header plate 12. A lateral series of recesses 33 of longitudinal extent face the core and are separated by projecting ribs 34. The manifold members 22 and 32 are in an opposing relation with, however, the respective corresponding recesses 23 and 33 being laterally offset relatively to one another. Ribs 24 and 34 are accordingly correspondingly offset and it will be understood that the spacing and locations of these ribs are such as to correspond with the notches 14 in the ends of tubes 13.

In the assembly of the heat exchanger, the core unit is fabricated as before described, a brazing or like process terminating the fabrication process and uniting the parts into an integrated structure. In the brazing process, the peaks and valleys of the fin corrugations of strip 18 are joined to overlying and underlying walls of the tube 13, forming continuous seals along the length of each fin corrugation. Also in the brazing process, tubes 13 are joined to header plates 10 and 11 in a manner to preclude an escape of fluid around the tubes and core sheets 19 and 21 are attached to header plates 10 and 11 to confine fin strips 17 and to close upper and lower ends of the core. In a subsequent assembly step, the manifold castings 22 and 32 are welded to the outer faces of header plates 11 and 10. In carrying out such method step, the manifold members are applied to a respective core face in a manner to align the ribs 24 or 34 with corresponding notches 14 in the projecting ends of tubes 13. Then, as the manifold members are pressed to a seat on the respective header plates, the ribs 24 and 34 enter notches 14, being received therein with a relatively close fit. In entering the notches, the projecting ribs compress against and crush the material of fin strip 16 disposing within the notches. An inwardly thrusting rib accordingly deforms a portion of the rib corrugations and forms therewith a substantial barrier to by-passing flow from one recess 23 or 33 around an intermediate rib 24 or 34. The ribs 24 and 34 are projected substantially to the same extent as marginal edges of the manifold members are turned over.

Accordingly, in the process of applying the manifold members to the header plates the ribs 24 and 34 seat to the header plate at the same time that marginal portions of the manifold members seat thereto. The notches 14 are predetermined to have a depth adequate to permit such simultaneous seating.

In the operation of the heat exchanger, a first fluid is directed through the passages 18, a preferred direction of flow being as indicated by the arrows 35 in FIG. 2. A second fluid, at a temperature different from the first, is brought to the inlet boss 25. There it enters passageway 27 and is conducted through opening 28 to inlet recess 23a. Here the fluid is denied by-passing flow around the adjacent rib 24 by virtue of this rib seating to header plate 11 and being at the locations of notches 14 in crushing engagement with the material of fin strip 16. The fluid accordingly is compelled to enter the communicating portion of tube 13 and flows along the fin corrugations in such portion until reaching recess 33 in the opposite manifold member 32. In the course of such flow, the fluid is restricted to paths defined by those corrugations communicating with the inlet recess 23a since the fin corrugations are joined to the tube walls and define continuous barriers to lateral flow from one side of the heat exchanger to the other. Upon reaching the opposing recess 33 in member 32, the fluid turns around or reverses therein and comes back across the heat exchanger core, using as flow path defining means the fin corrugations which are in communication with this recess 33 and with the recess 23 immediately adjacent the inlet recess 23a. In a manner believed to be obvious, and as indicated by arrows 36, flow of the second fluid continues in this manner, making multiple reverse travels across successive portions of the tubes 13 until it finally reaches outlet recess 23b and is directed from there to outlet boss 26. It will be understood that the recesses 23 and 33 are in simultaneous communication with all of the tubes 13 and that
flow through corresponding portions of the tubes occurs in unison.

It will be evident that structural modifications are possible in the invention as disclosed, without departing from the intent and spirit thereof. For example, while three tubes have been illustrated a heat exchanger with a lesser or greater number of flow paths could be constructed and made to perform in accordance with disclosed inventive concepts. Also, the tubes serve a useful purpose in helping to avoid a use of separator strips within the heat exchanger core. Thus, not only is it unnecessary to lay in strips of material to act as internal extensions of the ribs and 34 but it is also unnecessary to provide end strip means constituting side closures for the passageways. In both instances fabrication of the heat exchanger is simplified and is therefore less costly and reliability is increased since the reduction in number of parts and in the number of brazed joints reduces opportunity for failure. However, if desired, a more conventional manner of construction could be used in which the upper and lower walls of the tube were made as separate core sheets, resembling members and with side margins of such core sheets joined together by solid spacer elements. Also, fin strip material has been shown placed in flow passages, since this will conventionally be done in the making of a high performance, compact heat exchanger. It could be omitted if not needed to meet heat transfer requirements. Similarly, should it be desired to make the passages, a multi pass form, manifold members could be applied to the ends of the heat exchange core and cooperate with plate and fin portions substantially in the same manner that manifold members are applied to sides of the heat exchanger.

What is claimed is:

1. A heat exchanger wherein corrugated fin material disposes in continuous strip form between opposing plate-like members to serve as extended heat transfer surface, and wherein manifold means applies to at least one end of an assembly comprising opposing plate-like members and an immediately disposing fin strip, said manifold means having rib means to bear against edges of said plate-like members to define separate manifold chambers on opposite sides of said rib means; characterized in that said plate-like members are notched to accommodate said rib means, the insertion of said rib means crushing portions of the ends of the fin strip whereby to utilize corrugations of the fin strip to define separated flow paths through said assembly in individual approximately sealed communication with said manifold chambers, said opposing plate-like members forming a tube having a flattened configuration, opposing walls of the tube at least one end thereof being notched to receive said rib means, the fin strip being longitudinally within the tube and being substantially coextensive therewith.

2. A heat exchanger according to claim 1, characterized by a header plate having at least one through opening accommodating the projection of said one end of said tube therethrough, and means fixing said header plate to said tube with said one end of said tube projecting relatively to the plate a distance substantially equal to the notch depth in said tube end.

3. A multi-pass heat exchanger, comprising spaced apart header plates each having at least one laterally elongated opening therein, tube means interposed between said header plates including a laterally flattened tube having opposite ends projecting through respective openings in said plates, a strip of corrugated fin material disposing in said tube with its corrugations extending lengthwise of the tube substantially coextensively thereof, other strip fin material superposing above and below said flattened tubes with its corrugations extending angularly to the corrugations of the first said fin strip, manifold means for conducting a fluid of one temperature to flow through said tube in paths defined by the first said fin strip and for conducting a fluid of a different temperature to flow over said tube in paths defined by the second said fin strip material, said manifold means including a manifold member at each end of said tube and seating to a respective header plate, each manifold member having a laterally spaced apart series of vertically extending forwardly projecting ribs to seat to the header plate, corresponding ribs of the respective manifold members being laterally offset, inlet and outlet connections for flow of the said fluid of one temperature to and through said tube by way of said manifold members, and notches of substantially equal depth in the projecting ends of said tubes receiving said ribs in an intersecting relation, said ribs crushing portions of the projecting ends of the first said fin strip in said tube at said notches whereby to define a multi-pass heat exchanger where the ends of adjacent paths are effectively sealed from one another at the locations of said ribs and where corrugations of the fin strip define separated flow paths between the manifold members.

4. A multi-pass heat exchanger according to claim 3, wherein said header plates are fixed to said tubes, each plate being spaced from a respective end of the tube a distance substantially equal to the depth of said notches.

5. A multi-pass heat exchanger according to claim 4, wherein said other strip fin material is confined between said header plates, characterized by means forming a seal and a bond in the joint between said tube and said header plates denying intercommunication of the fluids through said joints.

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