

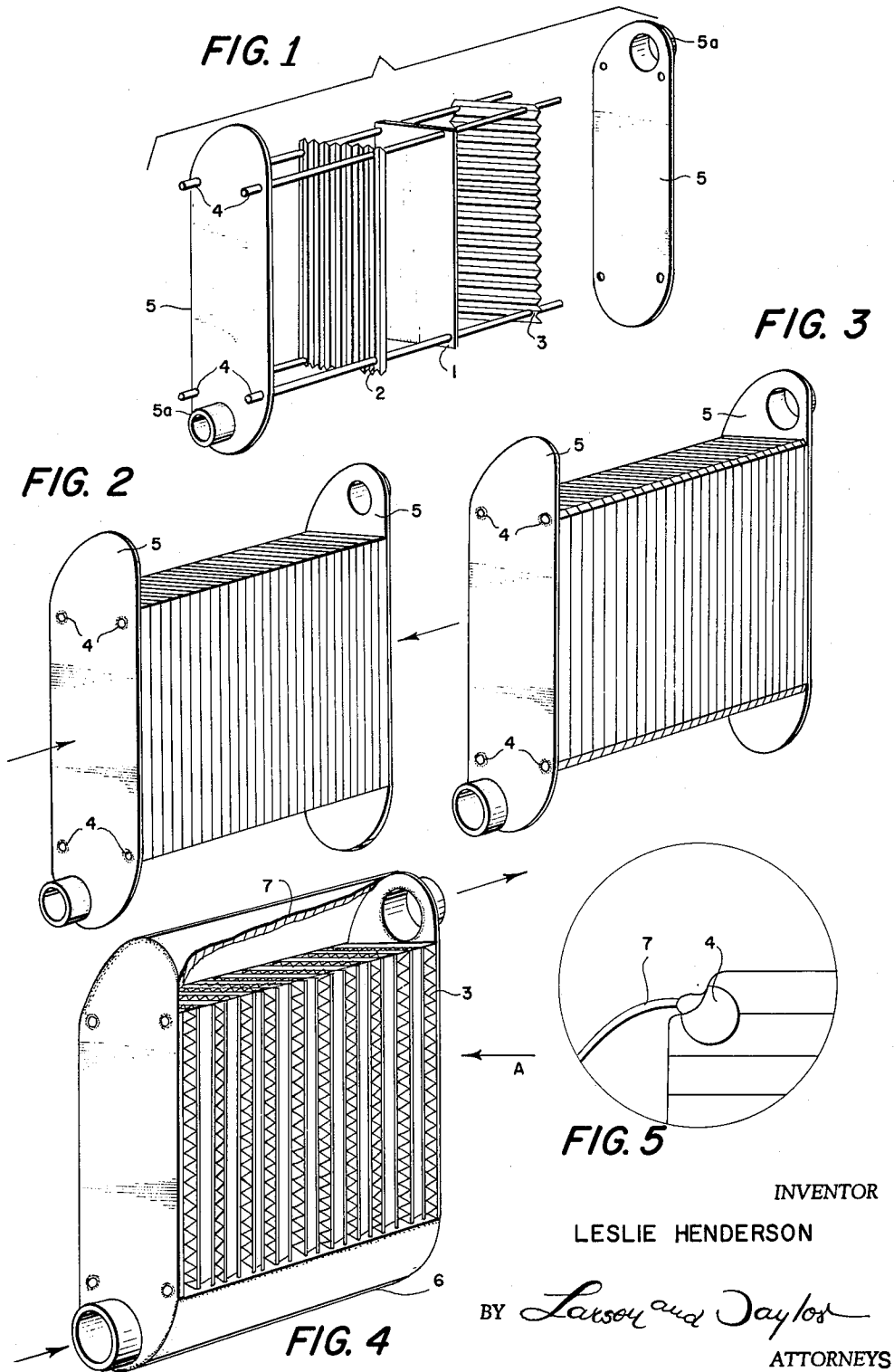
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PLATE TYPE HEAT EXCHANGERS

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PLATE TYPE HEAT EXCHANGERS

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This invention relates to plate-type heat exchangers, that is, heat exchangers of the kind in which a plurality of plates or sheets of material are stacked so that flow channels for heat exchanging fluid are formed between adjacent plates or sheets.

The plates in such heat exchangers may be flat and separated by side walls at their edges, or by corrugated sheets interposed between the sheets, or by a combination of corrugated sheets and side walls. Alternatively the plates themselves may be corrugated so that when they are stacked one upon the other the crests of the corrugations make contact with one another, and flow channels are formed between the corrugations of adjacent plates.

The thickness of plate used for such heat exchangers varies considerably, but where weight considerations are important it is necessary to use sheet material of only a few thousandths of an inch thickness, for instance, in many cases of the order of .005 inch. It is common practice with such heat exchangers to lead at least one of the heat exchanging fluids to or from the flow channels of the heat exchanger via headers which may be formed integrally with the plates or which are bonded to the heat exchanger body after the body has been assembled and bonded. Where weight considerations are important a header bonded to the heat exchanger body is usually preferred, but difficulties arise in the bonding process especially if the sheets used in the heat exchanger and the material of the headers are very thin.

The general object of this invention is to provide a plate type heat exchanger construction which facilitates the bonding of inlet and/or outlet headers to a heat exchanger block.

More specifically, it is an object of this invention to provide a plate type heat exchanger construction wherein the locating rods for aligning and stacking the various plates also function as the main elements of the heat exchanger block to which the header or headers are bonded, and are located so as to seal the flow channels defined by the outer corrugations.

With these objects in mind, the invention comprises a plate type heat exchanger comprising a plurality of substantially plate-like members stacked in spaced relation and spaced from one another by corrugated sheets to form flow channels for heat exchanging fluids, the members and corrugated sheets being assembled on locating rods which pass through the members and corrugated sheets near their edges or corners to seal the flow channels defined by the outer corrugated portions of each corrugated sheet, part of the surface of at least some of the locating rods being exposed whereby headers for the inlet or outlet or both inlet and outlet of heat exchanging fluids can be welded or otherwise bonded thereto.

The invention also comprises a heat exchanger in accordance with the preceding paragraph in which the locating rods are initially located in holes in the plates, and parts of the plates are removable to expose part of the rods prior to bonding of the inlet and outlet headers.

Other objects, advantages and features of the invention will become readily apparent from the following description with reference to the accompanying drawings,

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which show a presently preferred embodiment of the invention and illustrate one of the best modes currently contemplated for carrying out the invention.

Referring to the drawings:

FIG. 1 is an "exploded" perspective view of a cross flow plate-type heat exchanger showing the assembly of the various plates and locating rods.

FIG. 2 is a perspective view of the various plates and rods after bonding.

FIG. 3 is a perspective view of the plates and rods after portions of the plate material have been removed by machining to expose parts of the locating rod material, but before the joining of the inlet and outlet headers.

FIG. 4 is a perspective view partially cut away showing the general arrangement of the completed heat exchanger of FIG. 3 after the headers have been bonded thereto.

FIG. 5 is an enlarged view showing the details of a weld joining a header wall to the heat exchanger body in an arrangement as shown generally, for instance, in FIG. 4.

In carrying the invention into effect in the form illustrated by way of example, and referring to FIG. 1, the heat exchanger is constructed by using flat plates or sheets 1 between which are interposed corrugated sheets. The corrugated sheets are of two forms, one type of sheet 2 having its corrugations arranged generally at right angles to the other type of sheet 3. For simplicity only one sample of each sheet is shown. The order of assembly is a flat sheet, a corrugated sheet 2, then a further flat sheet, then a corrugated sheet 3, and so on. The sheets 1-3 have holes therein, and these pass over locating rods 4. The holes are located generally at the corners of the plates as shown in the drawing, so as to minimize the amount of plate material which must be cut away.

At each end of the assembly are end covers 5 with a duct 5a attached thereto or formed integrally therewith. Whether the last sheet before the end cover is a corrugated sheet or a flat sheet is not critical.

After the required number of corrugated sheets, flat sheets, and end covers have been assembled on the locating rods, pressure is applied to the ends of the assembly to ensure contact between the peaks of the corrugations of sheets 2 and 3 with adjacent flat sheets 1, and the ends of the locating rods are welded or otherwise bonded to the end covers to form a structure as shown in FIG. 2. While it is preferred that the ends of the locating rods be welded or otherwise bonded to the end covers, it will be understood that this could be accomplished in various other ways, for instance, by deforming the ends of the locating rods or by using threaded nuts on threaded ends of the locating rods. The vertical lines in FIG. 2 represent the edges of the plates, but in most cases the thickness of the plates is very much less than can conveniently be illustrated, for example .005".

The next stage in the assembly is to grind back or machine away the corners of the heat exchanger block as shown in FIG. 3 until the surfaces of the four locating rods are exposed. Inlet and outlet headers 6 and 7 are then welded to the exposed parts of the locating rods and to the end covers 5 as shown in FIG. 4, and the whole assembly is then brazed. FIG. 4 shows the corrugated sheets in some detail. One heat exchanging fluid enters corrugations 3 and flows through the element in the direction of arrow A. The other fluid enters inlet header 6, flows through the channels formed by the corrugations of sheet 2, and enters outlet header 7.

An enlarged view of the weld joining one wall of a header to a locating rod can be seen in FIG. 5.

In one particular application of the invention, a cross flow heat exchanger of the type shown in the drawings and described above was assembled using flat stainless steel sheets .005" thick. The corrugated sheets were of the same material and thickness and had corrugations

.028" high. The end cover plates were also of stainless steel and were .062" thick. The ends of the locating rods were argon arc welded to the end cover plates after end pressure had been applied to the assembly and prior to brazing. The corners were removed by grinding until the grinding plane was tangential to the locating rods and at 45° to the axis of the unit. The headers were then welded to the locating rods and to the end cover plates.

The whole structure was then degreased and subjected to a HF/HNO₃ acid dip to remove oxide and to "activate" the surface prior to plating. A nickel phosphorous alloy composed of 8-10% phosphorous and the remainder of nickel was then deposited by chemical means over the whole unit to form a coating .0005" thick. The structure was then dry hydrogen brazed at a temperature of 1010° C. for one hour.

In heat exchangers where it is desired to prevent any intermixing between the heat exchange fluids, and where corrugated sheets of the type shown in the drawings are used, it will be noted that unless the corrugated passages at the extreme ends of the corrugated sheets are closed to flow, there may be some intermixing of the fluids in the heat exchanger headers. For instance, referring to FIG. 4, in such applications the wall 7 of the outlet header could extend downwardly for a sufficient distance to cover the horizontal passageways formed by the upper corrugations which are open to the outlet header. Usually it is sufficient if the wall 7 extends downwardly to cover the first angled arm of the corrugations of corrugated sheets 3. Where the locating rods are arranged at the corners of the sheets as in the instant invention, the rods themselves take care of this by closing those extreme upper horizontal passages. This will be apparent from FIG. 5. These same considerations apply also to the extreme outward vertical passages of the heat exchanger shown in FIG. 4, for instance, but again this is usually accounted for by the locating rods 4.

The foregoing description is given by way of example only, and the invention is not to be necessarily limited to the specific process described nor to the specific heat exchanger shown and described. It will be understood by those skilled in the art that the method of the invention may be applied to any assembly of plates or sheets in a plate-type heat exchanger, and is not limited to cross flow heat exchangers, and furthermore it is not necessarily limited to the brazing or welding process nor to the type of materials and dimensions previously set forth. The basic criterion is that it be possible to machine away or otherwise remove some of the material to expose a number of locating rods to enable a good weld between header and the heat exchanger body to be obtained. For some applications, it will be understood that the plate-like members of the heat exchanger can be so preformed as to avoid or minimize the machining or material removing step after assembly.

Having thus fully described my invention in the manner required by the patent statutes.

I claim:

1. A plate type heat exchanger comprising a plurality of substantially rectangular flat sheets stacked in spaced relationship and spaced from one another by corrugated

sheets of substantially the same dimensions as said flat sheets, some of said corrugated sheets being arranged to have their corrugations extend in a direction substantially normal to the direction of the corrugations of others of said corrugated sheets, said corrugations forming flow channels for heat exchanging fluids, locating rods passing through the flat sheets and the corrugated sheets at corners thereof to seal the flow channels defined by the outer corrugations from each other, said locating rods having part of their surfaces exposed, and at least one header for fluid passing to or from some of said flow channels, said header having wall edges which extend along and are bonded to the exposed surfaces of said locating rods.

2. A plate type heat exchanger as set forth in claim 1 further comprising end cover members at opposite ends of the stack of flat and corrugated sheets, said end cover members extending beyond the area of the stacked sheets between at least two adjacent locating rods, said locating rods passing through said end cover members and securing said end cover members in position, portions of the wall edges of said header extending along and being bonded to the extended portions of said end cover members, and the other portions of the wall edges of said header extending along and being bonded to the exposed surfaces of said two adjacent locating rods.

3. A plate type heat exchanger comprising a plurality of substantially rectangular flat sheets stacked in spaced relationship and spaced from one another by corrugated sheets of substantially the same dimensions as said flat sheets, some of said corrugated sheets being arranged to have their corrugations extend in a direction substantially normal to the directions of the corrugations of others of said corrugated sheets, said corrugations forming flow channels for heat exchanging fluids, locating rods passing through the flat sheets and the corrugated sheets at corners thereof to seal the ends of the flow channels defined by the outer corrugated portions of each corrugated sheet, said locating rods having part of their surfaces exposed, and at least one header for fluid passing to or from some of said flow channels, said header having wall edges which extend along and are bonded to the exposed surfaces of said locating rods.

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