Sept. 23, 1969 D. MENZE 3,468,371

HEAT EXCHANGERS

Filed Sept. 8, 1967

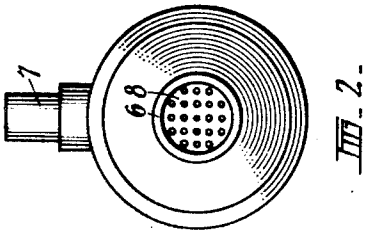



FIG. 2.

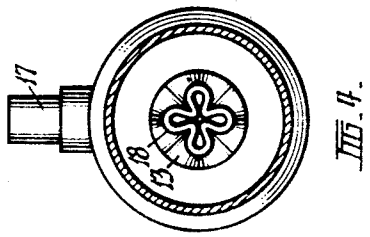



FIG. 4.

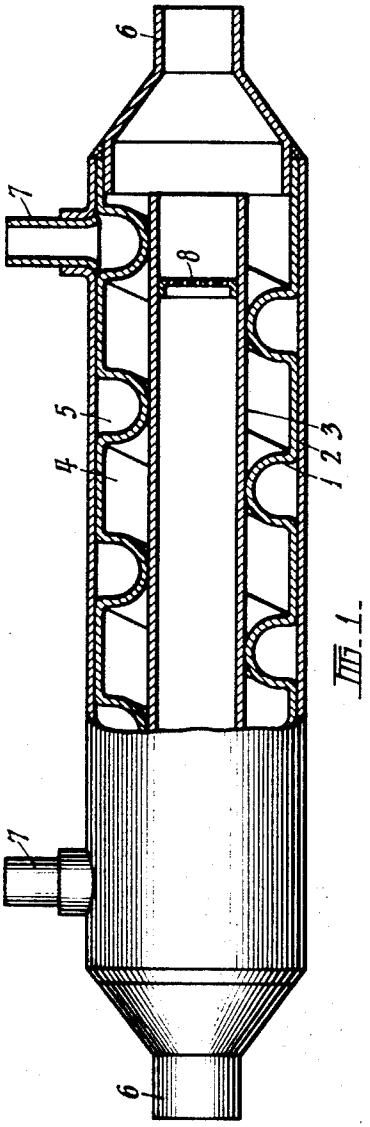



FIG. 1.

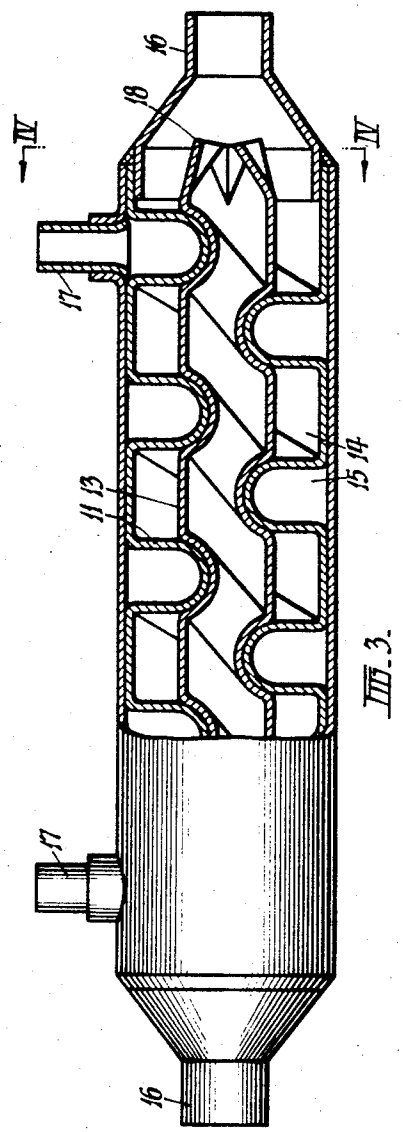



FIG. 3.

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# HEAT EXCHANGERS

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U.S. Cl. 165—156 6 Claims

## ABSTRACT OF THE DISCLOSURE

The present invention provides a novel heat exchanger which comprises three concentric tubular members, the middle one of which has a spiral corrugation therein which provides walls defining two separate passageways between the inner tube and the outer tube. The corrugation may extend into the inner tube, which is open at both ends, so that fluid flowing through the inner tube contacts a relatively large heat exchanging surface therein. Fluid inlet and outlet connections are provided for the passageways at the ends of the heat exchanger. The invention also provides a method of manufacture of the heat exchanger wherein the inner tube is supported on a mandrel and the middle tube has the spiral corrugation rolled therein to a depth so as to at least contact the inner tube, the contact being such that no further sealing between the tubes is required. The heat exchanger of the present invention is exceedingly economical to manufacture and may be made any desired length or of any suitable diameter tube.

This invention relates to an improved heat exchanger and relates particularly to an improved construction of heat exchanger and methods of making the same.

Heat exchangers are known wherein there is provided two separate flow paths therethrough, one for a hot fluid and the other for a cold fluid, heat being transferred through the walls or partitions separating the two fluids.

It is an object of the present invention to provide an improved heat exchanger of this type wherein the heat transfer capacity in relation to the physical size of the heat exchanger is increased in comparison to known heat exchangers.

It is also an object of the present invention to provide a simple method of making heat exchangers, which method may also eliminate internal welded joints.

According to the present invention, there is provided a heat exchanger comprising an inner tubular member, a second tubular member formed with a spirally extending channel means and engaged on the inner tubular member, an outer tubular member arranged on the second tubular member to form an assembly having, between the inner and outer tubular members, at least two adjacent spiral passages, and a further fluid passage through the inner tubular member, and a fluid inlet and outlet connection for each spiral passage.

The present invention also provides a method of making a heat exchanger wherein the two tubes are held, the first inside the second, and at least one spiral corrugation is press-rolled onto said second tube, the corrugation(s) being of a depth at least equal to, and preferably greater than, the difference in the radii of the two tubes to form a tight bend between the two tubes, the assembly so formed being then inserted within a third tube having an internal diameter substantially equal to the external diameter of the assembly whereby two or more spiral passages are formed between the first and third tubes, said second tube forming a partition wall between adjacent passages. Inlet and outlet connections are provided for each of the spiral passages so formed.



When the depth of the corrugations is greater than the difference in the radii of the two tubes, at least one spiral corrugation will also be formed on the internal surface of the inner tube, the corrugation(s) then acting as a baffle to any fluid flowing through the inner tube. Alternately, baffles or fins may be provided in an open-ended inner tube to cause turbulence of the fluid flowing therethrough, thus aiding in the heat exchange efficiency.

By press-rolling the two tubes together, the formation of the corrugation causes the tubes to be firmly bonded together in the region of the corrugation.

The outer or third tube is fixed and sealed to the assembly of the two tubes at its ends together with inlet and outlet connections, in a conventional manner, as by welding or brazing or the like. Alternately, the ends of the outer tube and of the second tube may be drawn together and reduced in cross-section to form the inlet and/or outlet connection for the inner tube. In such a case, the drawing action eliminates the need for welding or brazing the tubes together.

In order that the invention may be more clearly understood and readily put into practical form, two embodiments thereof will now be described with reference to the accompanying drawings, wherein:

FIGURE 1 is a longitudinal, partly sectional view of a heat exchanger in accordance with the invention,

FIGURE 2 is an end elevation of the heat exchanger shown in FIGURE 1,

FIGURE 3 is a longitudinal sectional view of a modification of the heat exchanger of FIGURE 1, and

FIGURE 4 is the section IV—IV of FIGURE 3.

Referring to the drawings, a spirally corrugated tube **1** is located between outer tube **2**, preferably the same length as tube **1**, and inner tube **3**, which is open at both ends. The internal diameter of tube **2** is equal to the outside diameter of corrugated tube **1**, while the external diameter of tube **3** is at least equal to the inside diameter of corrugated tube **1**. Thus one spiral passage **4** is located in the region bounded by corrugated tube **1** and the inner tube **3**, while the other spiral passage **5** is bounded by corrugated tube **1** and outer tube **2**. Inlet and outlet connections **6** and **7** are provided for passages **4** and **5** respectively.

A baffle **8** is provided in the inner tube **3** which restricts and turbulates the flow of fluid therethrough to assist heat transfer across the inner tube walls.

Referring to the modification of the heat exchanger shown in FIGURE 3 the corrugations are formed in the tube **11** in a manner similar to that of the tube previously described, but extend to a depth greater than the difference between the radii of tubes **11** and **13**. The tube **13** is formed initially as an open-ended tube, and subsequent to the formation of the spiral corrugations therein the ends thereof are partially closed as at **18**. The partial closure or restriction **18**, whilst permitting the flow of fluid through the inner tube **13**, controls the flow rate so that fluid also flows through the spiral corrugation **14**. The restriction **18** is formed by drawing together four points around the periphery of the inner tube **13** to present a star-like opening, as shown in FIGURE 4. The restriction retards the flow of fluid through the inner tube **13**, while the longer time thus induced and the greater area exposed by the deeper corrugations assist in the transfer of heat across the inner tube walls thereby improving the efficiency of the heat exchanger.

The assembly of the corrugated tube **11** on the inner tube **13** is arranged inside an outer tube and inlet and outlet connections **16** and **17** are attached, as by brazing, welding, or soldering, to the outer tube.

In the preferred form of the invention, the spiral corrugations are obtained by press-rolling one or more spiral channels into tube **1**. Inner tube **3** is inserted within

tube 1, and the ends of each tube are supported so that tube 3 is concentric within tube 1. A press-rolling tool, comprising a collar to support the tube 1 and an adjustable press-wheel, is used to form the spiral by virtue of relative motion between the tubes and the wheel. As the wheel is adjustable, different depths of corrugations are possible. Different pitch of spiral is obtainable by varying the angle of the wheel and the relative motion of the wheel relative to the tubes, while the width and shape of the corrugation may be varied by using varying wheel widths and shapes. The inner tube may be supported—if desired—during press-rolling on a mandrel. Once the rolling has commenced, and one spiral turn completed, the corrugation formed acts as a centering device for the subsequent action.

After press-rolling, the outer tube 2 and the connection fittings 6 and 7 are joined to the assembly in known manner, as for example by welding, brazing or soldering. The open ends of the inner tube may be drawn together, before the fitting of the connections 6 and 7 as for example shown in FIGURE 4. However, it will be obvious to those skilled in the art that other methods of constricting the open ends of the inner tube may be applied such as folding over part of the tube, or the fitting of a plug having a restricted opening in the tube ends. It is also possible to partially close off only one end of the inner tube, the constriction formed therein being sufficient to retard the flow of fluid through the inner tube.

It will be appreciated that although it is preferred that the tubes be of circular cross-section as shown in the drawings, it is possible to construct a heat exchanger according to the invention in which the tubes, or at least the inner tube, is of non-circular cross-section. Thus the inner tube may be of oval or elliptical cross-section and the depth of the spiral corrugations would be equal to or greater than one half the difference between the diameter of the spirally corrugated tube and the minimum cross-sectional dimension of the inner tube.

What I claim is:

1. A heat exchanger comprising an inner radially imperforate tubular member, a second tubular member engaged on said inner tubular member and formed with an outwardly opening spirally extending channel shaped indentation formed in a spiral around the wall of said second tubular member, the depth of said channel-shaped indentation being at least equal to the difference in radii of said inner tubular member and said second tubular member, an outer tubular member concentric with said inner tubular member and arranged contiguously on said second tubular member thus completely to cover said outwardly opening channel-shaped indentation thereby to form with said inner and second tubular members an assembly having, between said inner and outer tubular members, at least two adjacent specifically defined spiral passages, the interior of said inner tubular member defining a further fluid passage, and fluid inlet and outlet connections for each spiral passage.



2. The heat exchanger of claim 1 wherein said inner and outer tubular members are of substantially circular cross-section, at least one end of said inner tubular member having a restricted opening which communicates with one of said inlet or outlet connections of one of the spiral passages, the other end of said inner tubular member communicating with the other of said inlet or outlet connections of said one spiral passage.

3. The heat exchanger of claim 1 wherein the depth of said channel-shaped indentation is greater than the difference in radii of said inner and outer tubular members, whereby a spiral corrugation is formed on said inner tubular member, one of said spiral passages communicating with the fluid passage through said inner tubular member.

4. A heat exchanger as claimed in claim 3 wherein a restriction is provided in the inner tubular member to retard the flow of fluid therethrough.

5. A heat exchanger as claimed in claim 4 wherein said restriction comprises a star-shaped opening formed by drawing together four points around the periphery of said inner tubular member.

6. The heat exchanger of claim 1 wherein said inner and second tubular members are sealed by the engagement of the channel-shaped indentation with said inner tubular member, said outer tubular member being provided with inlet and outlet connections for the spiral passage formed by said second and outer tubular members, and end closure members sealed in the ends of the assembly and provided with inlet and outlet connections therein for the other of said spiral passages.


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