

Dec. 13, 1960

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2,963,779

METHOD OF MAKING HEAT EXCHANGE STRUCTURES

Filed June 30, 1958

2 Sheets-Sheet 1

FIG. 1

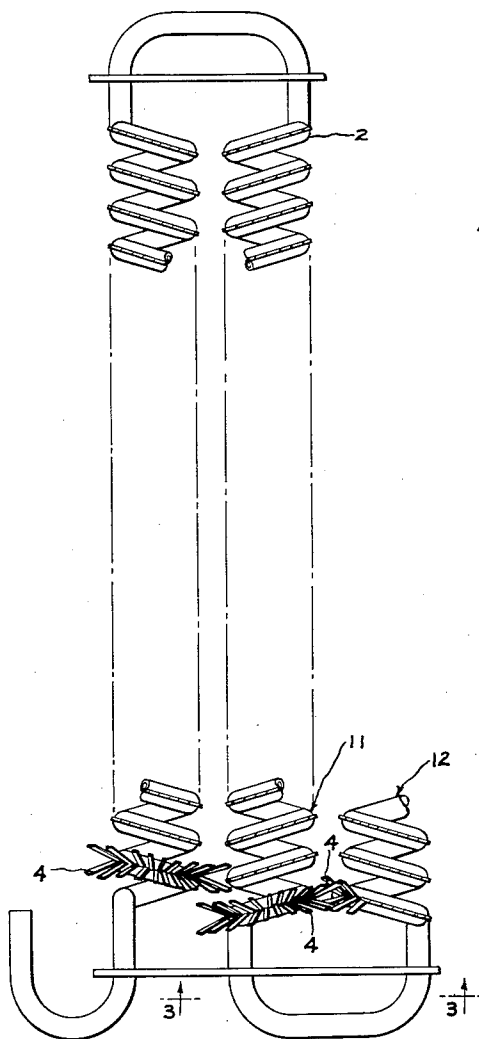


FIG. 3

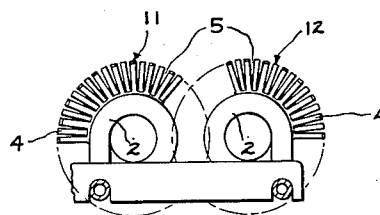


FIG. 2

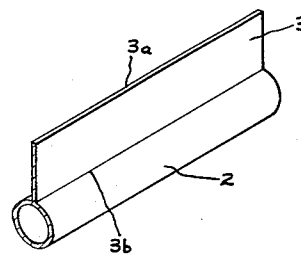
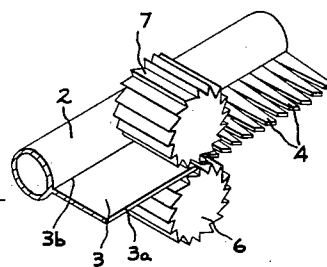


FIG. 4



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FIG. 5

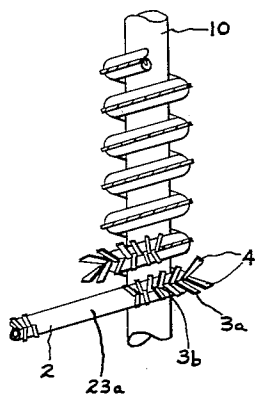


FIG. 6

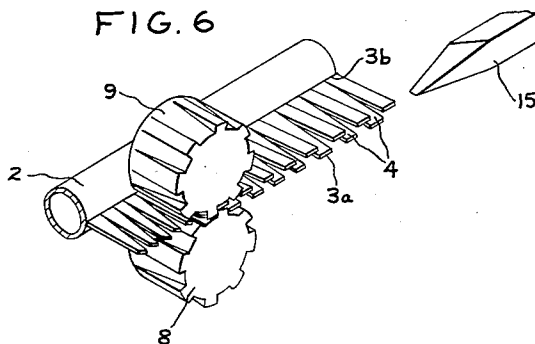


FIG. 8

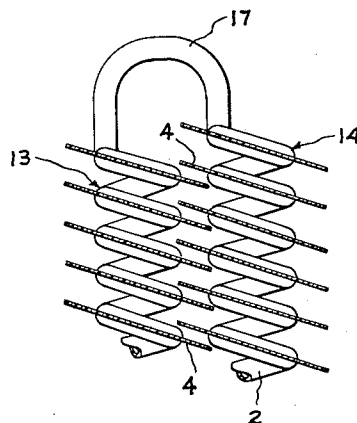


FIG. 7

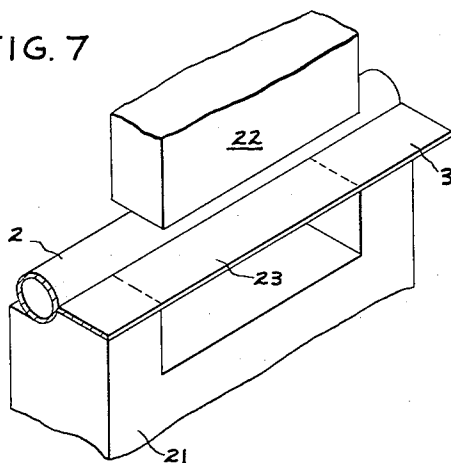
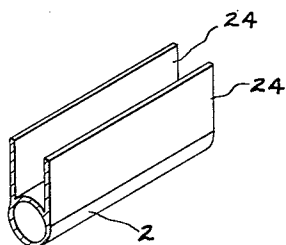


FIG. 9



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METHOD OF MAKING HEAT EXCHANGE STRUCTURES

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Filed June 30, 1958, Ser. No. 745,356

2 Claims. (Cl. 29—157.3)

The present invention relates to a heat exchange structure and more particularly to a heat exchange structure formed from a tubular member having a plurality of individual fin sections extending outwardly therefrom, and to the method of manufacturing such a structure.

It is an object of the present invention to provide an improved heat exchange structure of the type having a plurality of individual fin sections extending from a helically formed tubular member which sections are formed as an integral part of the tubular member.

A further object of the present invention is to provide an improved heat exchange structure including several passes of heat exchange tubing having a plurality of individual fin sections extending therefrom and arranged compactly to provide a large radiating surface.

Still another object of the present invention is to provide an improved method of manufacturing a heat exchange structure of the type including a tubular member having a plurality of individual fin sections extending therefrom.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In carrying out the objects of the present invention, there is provided a heat exchange structure comprising a tubular element wound into the form of a helix and having a plurality of separate fin sections extending from the tubular member outwardly from the perimeter of the helix along the length of the member. Adjacent fin sections are separated to provide a space between the adjacent sections for the flow of a heat transfer medium therebetween. Two or more passes of the helically formed tubing may be arranged parallel to each other with the individual fin sections of one pass interlaced or overlapping the fin sections of the next adjacent pass.

As a further aspect of the present invention there is provided a method of manufacturing the heat exchange structure of the above type which method includes the steps of providing a length of tubing having a fin extending lengthwise along the tubing and which is preferably integral with an homogeneously formed with the tubing by extrusion, slitting the fin transversely from its outer edge portion inwardly toward the tubing to form a plurality of individual fin sections or pins, and winding the tubing into the form of a helix with the pins disposed around the outer periphery thereof thereby causing the pins to spread apart and provide space for the flow of a heat transfer medium therebetween.

For a better understanding of the invention, reference may be had to the accompanying drawing in which:

Fig. 1 is a plan view showing a heat exchange unit including several passes of the heat transfer tubing and illustrating the overlapping of the pins;

Fig. 2 is a perspective view illustrating the tube stock with its homogeneously formed lateral fin;

Fig. 3 is a view taken along line 3—3 of Fig. 1 which

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illustrates how the pins radiate outwardly and spread apart upon the forming of the tubing into a plurality of helical loops;

Fig. 4 is a schematic perspective view illustrating the slitting operation for forming the extended fin into a plurality of pins;

Fig. 5 is a schematic perspective view illustrating the forming operation in which the tube stock is formed into a plurality of helical loops;

Fig. 6 is a schematic perspective view illustrating the displacement of the pins out of the original plane of the fin;

Fig. 7 is a schematic view showing the shearing operation for removing sections of the fin at predetermined lengths along the tube stock;

Fig. 8 is a plan view showing several passes of a heat exchange unit in which the tubular members are all helically wound in the same direction; and

Fig. 9 is a perspective view illustrating extruded tube stock having two homogeneously formed fins.

Referring to the drawing, in Fig. 1 there is shown in preferred form, a heat exchange unit having the heat transfer tubing of the present invention and adapted for use as a condenser or evaporator in a refrigeration system. As is clearly shown in the figure, the main part of the unit comprises a plurality of parallel passes of tubing 2 with each pass of tubing being formed into a helix. Extending outwardly from the periphery of the helix are a plurality of individual fin sections or pins 4, which comprise a large radiating surface for transferring heat to or from a heat transfer medium passing thereover. In order to facilitate heat transfer, the adjacent pins 4 are spread apart to provide a space between them and to cause a turbulent flow in the heat transfer medium which passes through the pins. Thus, referring to Fig. 3 it can be seen that the pins 4 radiate outwardly from the periphery of the helically formed tubing and provide a pie-shaped space 5 therebetween. In order to further increase the space between adjacent pins 4, as may best be seen in Fig. 1, they are alternately displaced in opposite directions from the original plane of the pins along the tubing 2. The details of the structure shown in Fig. 1 will be understood by following the operations in which the heat transfer tubing is given its final form.

This tubing is preferably extruded from an aluminum alloy or some other suitable material having a high coefficient of heat conductivity and which lends itself readily to extrusion and to the other operations of manufacture. The finished form of the extruded tube stock is shown in Fig. 2 and includes a tubing section or tubular portion 2 and a fin 3 extending longitudinally therefrom. The fin 3 is preferably a homogeneous part of the tube stock which extends outwardly in a longitudinal plane from the tubing. Its outer edge 3a is parallel to the axis of the tubing and it joins the tubing at its base portion 3b which also runs parallel to the axis of the tubing.

The tubing is passed through a slitting operation in which the longitudinal fin 3 is slit into a plurality of individual fin sections or pins 4. More specifically, as may be seen in Fig. 4, the longitudinal extending fin 3 passes through a pair of lancing rolls 6 and 7 which lance the fin from its outer edge 3a to a point adjacent its base 3b where it joins with the remaining portion of the tube stock.

After the fin 3 is slit into a plurality of individual fin sections or pins 4 the tubing is formed or wrapped into a plurality of helical coils, with the pins radiating outwardly from the outer periphery of the coils of tubing. This operation is illustrated in Fig. 5, in which the previously slit tubing 2 is wrapped onto a mandrel 10. In this operation the individual pins 4 spread apart because of the greater diameter of their outer edges 3a as com-

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pared to that of the base portion 3b. Thus there is provided a heat exchange tubing having a plurality of individual pins 4 with each pin separated from the next adjacent pin to provide pie shaped spaces 5 between the pins for the flow of air or some other heat transfer medium therethrough. Obviously, the shorter the radius into which the tubing is formed, the greater will be the space 5 between the adjacent pins.

In order to increase the space or opening between the adjacent pins 4 it is sometimes expedient to displace the individual pins so that they are displaced alternately in opposite directions from the original plane of the fin 3. Thus, referring to Fig. 6, the slit fin material is shown passing through a pair of rolls 8 and 9 which displace the individual pins 4 alternately in one direction and then in the other as the pins pass through the rolls. By properly forming the rolls 8 and 9 they may be made to perform both the slitting and displacing functions in the same operation. In such a case, instead of slitting the fin prior to passing it between the rolls 8 and 9, the fin is passed through these rolls both to slit and displace the individual pins 4. In order to further spread the alternate fins apart, there is provided a spreading or wedge shaped tool 15 which passes between the alternately displaced pins and spreads them to any desired angle. Obviously, other means could be used to slit and displace the pins, such as a pressing or stamping operation between a pair of dies which form a plurality of the pins simultaneously.

One advantage of having the pins 4 displaced in opposite directions from the original plane of the lateral fin is that the greatly increased distance between the pins permits better circulation of the medium passing thereover and greatly increases the heat transfer efficiency. However, the main reason for providing a plurality of individual fin sections or pins 4 is to promote a greater turbulence in the fluid media passing through the pins and to reduce the deleterious effect of the boundary layer which has a tendency to form on fins of the continuous type. In slitting these fins, the overall radiating area of the fin is also increased by the amount of area included on the edges of the pins and, since these edges are now exposed to the fluid medium passing thereover, this further increases the heat transfer efficiency of the tubing.

The helically wound tubular sections are arranged in parallel passes to form a heat exchanger for heating or cooling a fluid media which is passed through the heat exchanger. In the preferred embodiment, the parallel passes, such as passes 11 and 12 shown in Fig. 1, are arranged such that the tubing in pass 11 is helically wound in the opposite direction from the tubing of pass 12. In such an arrangement, the alternately displaced pins 4 of the adjacent passes are interlaced thereby permitting the passes to be more closely arranged. As may best be seen in Fig. 1, the individual pins 4 of the pass designated 11 interlace with the pins of the pass 12. The ends of the pins 4 actually extend beyond or overlap portions of the tubing 2. For the purpose of clarity and ease in drafting, the pins are shown in Fig. 1 only on the lowermost coils of the structure, but it will be understood that they are included along the entire length of the structure.

In Fig. 8 there is shown a second arrangement in which the parallel passes 13 and 14 are both helically wound in the same direction. In this arrangement the individual pins 4 are not alternately displaced to any great extent from each other. Instead the pins are retained in the original plane of the extruded fin 3 or only slightly displaced from each other, and extend into the space between adjacent coils of the individual passes. Thus the pins 4 of pass 13 all extend into the openings between the adjacent coils of pass 14.

In forming the heat exchange structures shown in Figs. 1 and 8, the individual passes of the heat exchange tub-

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ing are arranged closely together in parallel relationship and are connected by end turns 17 to make a continuous length of tubing. The end turns 17 may be brazed or soldered onto the ends of the heat exchange tubing in any manner well known in the art. However, since it is desirable to eliminate as many welding operations as possible when forming heat exchange structures, such as those used for refrigeration purposes, it is desirable to form the entire heat exchange structure using a continuous length of tubing 2. In order to accomplish this, the tube stock must have the longitudinal fin 3 sheared therefrom at intervals along its length, which sheared portions form the end turns of the structure. Normally, it is desirable to shear the fin to form the end turn portions of the tube stock prior to lancing the remaining fin stock into a plurality of pins. This shearing operation is illustrated schematically in Fig. 7 in which the formed shearing dies 21 and 22 are used to stamp out a length or portion 23 from the lateral fin 3. Thus a length 23 of fin corresponding to the length of the end turns is removed from each corresponding length of tubing which represents the amount of tubing in the individual passes, such as the length of tubing in pass 11 of Fig. 1.

As may be seen in Fig. 5, the sheared portion 23a of the tube stock does not interfere with the helical forming of the tubing. After a sufficient length of tubing has been helically formed on the mandrel 10, the entire length is removed from the mandrel and the tubing in the sheared area is straightened out, and then formed or reversely bent at the sheared or end turn portions 23a to provide the desired shape, such that individual passes of the heat transfer tubing are arranged closely together in parallel relationship. This is the arrangement shown in Fig. 1.

It should be noted that extruded tubing having more than one fin is now available commercially. For example, tubing, such as that shown in Fig. 9, is available on the market and the fins 24 of this tubing can easily be slit into a plurality of individual fin sections or pins 4. This can be performed in a press or stamping machine (not shown) having a properly formed die which is inserted between the two parallel fins 24. Tubing having fins of this type, which are slit into a plurality of individual pins, can also be wrapped into the helical passes of tubing and used to assemble the structures shown in Figs. 1 and 8.

By the present invention, there is provided a heat exchange structure comprising a number of passes of tubing each being wound into the form of a helix and having a plurality of pins or individual fin sections radiating outwardly from the periphery thereof with the pins of adjacent passes being interlaced or overlapping to form a large, compact radiating surface. Moreover, the present invention provides a simple and easily performed method for manufacturing heat exchange structures of this type.

While in accordance with the patent statutes there has been described what at present is considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, the aim of the appended claims to cover all of the equivalent variations as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of manufacturing a heat exchange unit comprising the steps of providing a length of extruded tubing having a longitudinally extending fin homogeneously formed as an integral part thereof, removing a portion of said longitudinally extending fin at intervals along said tubing, slitting said remaining fin at equal intervals from its outer edge toward said tubing to form a plurality of individual fin sections connected at their inner ends with said tubing, winding said tubing into

helical form with said fin sections disposed around the outer periphery thereof whereby during winding said fin sections spread apart to provide spaces between the adjacent fin sections, and reverse bending said tubing in the area where said fin has been removed thereby to form a plurality of parallel passes of helically formed tubing with the fin sections of adjacent passes overlapping each other.

2. The method of manufacturing a heat exchange unit comprising the steps of providing a length of extruded tubing having a longitudinally extending fin homogeneously formed as an integral part thereof, removing a portion of said longitudinally extending fin at intervals along said tubing, slitting said remaining fin at equal intervals from its outer edge toward said tubing to form a plurality of individual fin sections connected at their inner ends with said tubing, displacing adjacent fin sections in opposite directions from the original plane of said longitudinal fin, winding said tubing into helical form with said fin sections disposed around the outer periphery thereof whereby during winding said fin sec-

tions spread apart to increase the space between the adjacent fin sections, and reverse bending said tubing in the area where said fin has been removed thereby to form a plurality of parallel passes of helically formed tubing with the fin sections of adjacent passes interlaced with each other.

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