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2,838,830

PROCESS OF MANUFACTURING HEAT EXCHANGER

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FIG. 1

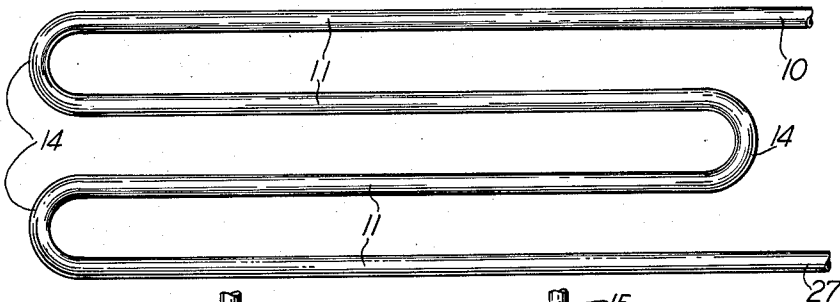


FIG. 2

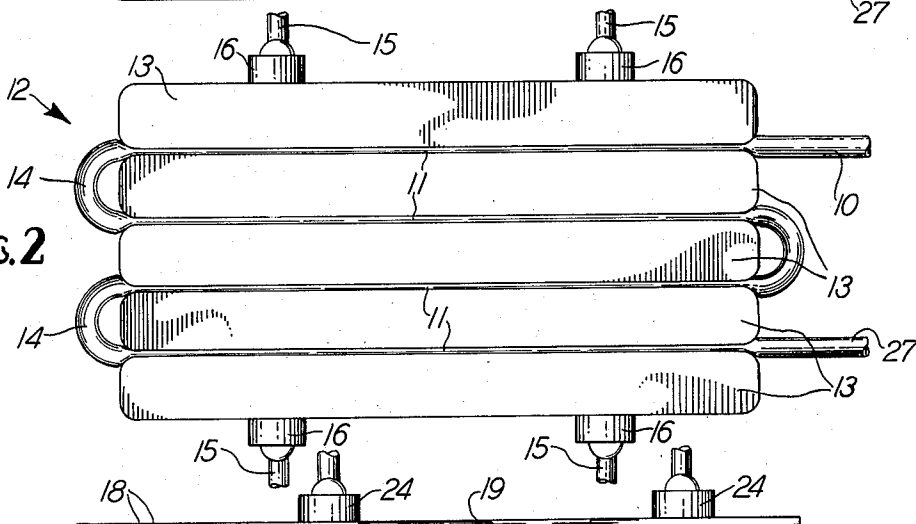


FIG. 3

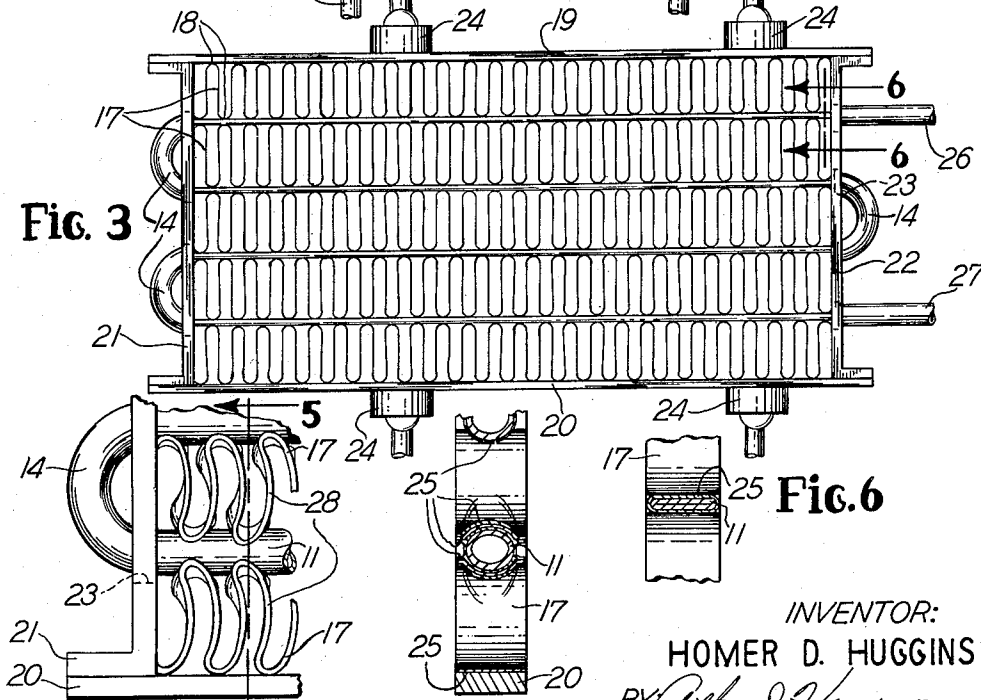


FIG. 4

FIG. 5

FIG. 6

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PROCESS OF MANUFACTURING HEAT EXCHANGER

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7 Claims. (Cl. 29—157.3)

This invention relates to a process of manufacturing a heat exchanger of the type having a tubular fluid pass section.

A common type of heat exchanger is that which is composed of two fluid pass sections, one of which is tubular and the other of which is of a serpentine shaped fin section. The tubular section is normally employed to provide the fluid pass for a liquid which is, therefore, continuously circulated within the unit while the fin section permits the free passage of air therethrough. A common example of this type of heat exchanger is found in refrigerators, and preferred applications of a heat exchanger of this invention are found in automobile air conditioning units, and residential air conditioners and the like. In the manufacture of the tube and fin type of heat exchanger, it is desired to obtain a contact between the tube and the fin to attain high heat conductivity between the tube and the fin. However, since the tube is generally circular in cross-section, and the fin is generally straight across its crest of the serpentine shape, the contact area between the tube and the fin would not be much more than a point contact unless either the tube or the fin were made to conform to the shape of the other at their points of contact.

Thus, in some units employed in refrigerators, it is common to form arcuate depressions in the crests of the fin along the length thereof so that the tube can be nested within the depressions and thereby provide the contact area required between the tube and fin. One known method of manufacture of the nested tube and fin structure is that where the fin is initially pressed by a circular rod or die to form the arcuate depressions in the fin crests, but obviously this method requires a separate set of dies to obtain the precise arcuate shape which must conform to the shapes of various tubes. Naturally each tube size would require a corresponding size in the die for the fin. Also, the fin must be constructed and sufficiently sturdy to withstand the force necessary to form the arcuate depressions since the fin must not collapse under the force and, therefore, it appears that the prior art fin must be a specially designed fin, or the fin must be specially supported when the depressions are formed.

Previous methods of manufacturing a heat exchanger with the features mentioned are known to be expensive and yet not produce a heat exchanger having certain of the features which a heat exchanger of this invention does have. Therefore, it is an object of this invention to provide a process of manufacturing a heat exchanger of the tube and fin type wherein the required contact between the tube and fin is attained and, in accomplishing this object, the exchanger is inexpensive.

Another object of this invention is to provide a process of manufacturing a tube and fin type heat exchanger wherein the desired fluid pass areas of the tube and fin sections may be easily and readily proportioned and controlled.

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Still another object of this invention is to provide a method of manufacturing a tube and fin type heat exchanger wherein the method is simplified with respect to previously known methods.

5 Still a further object of this invention is to provide a method of manufacturing a tube and fin type heat exchanger wherein a stronger fin structure is produced, and also the fin structure provides for turbulization of the air or other gases passing through the fin section.

10 Other objects and advantages will become apparent upon reading the following description in conjunction with the accompanying drawings, wherein:

Fig. 1 is a side view of a tube of this invention at one stage of tube formation.

15 Fig. 2 is a side view of the tube shown in Fig. 1, but also showing means for flattening the tube.

Fig. 3 is a side view of the tube shown in Figs. 1 and 2, but also showing the fins and the heat exchanger plates.

20 Fig. 4 is an enlarged view of a fragment of Fig. 3, but also showing the unit at a stage of the process beyond the stage shown in Fig. 3.

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 4, and also showing the preferred coating on both the tube and the fin.

25 Fig. 6 is an enlarged sectional view taken on the line 6—6 of Fig. 3.

Similar reference numerals refer to similar parts throughout the several views.

Initially, brief comment will be made about the manufacturing process of this invention. It is preferred that a circular tube 10 be formed into a serpentine shape, as shown in Fig. 1. Subsequently, the tube is flattened through certain straight sections 11, as shown in Fig. 2, and next serpentine fins 17 are disposed between the layers 11 of the tube, as shown in Fig. 3. At this stage 35 the tube and fin are essentially in full contact along the crests of the fins, since the tube has been flattened, such as shown in Fig. 6. Then it is preferred that the assembled tube and fin be bonded together at their contact areas with the bonding preferably being accomplished by subjecting the assembly to a predetermined heat which causes the tube and fin coatings to melt into a bond, while the parent metal of the tube and fin, being of a higher melting point, does not melt. Subsequently, it is preferred that fluid pressure be applied to the interior of the flattened tube to cause the tube to expand to either an oval or circular cross-sectional shape, as desired, and thus the tube and fin attain the condition shown in Fig. 4, with the contact area therebetween remaining bonded as shown in Fig. 5. It is also preferred that, when the fluid pressure is applied to the interior of the tube, the sides of the heat exchanger be restricted in their outward movement and, therefore, the fins will be distorted to allow for the expansion of the tube, and this also permits the sections of the tube to be expanded uniformly.

A more specific description of this invention is included hereinafter. Fig. 1 shows a tube 10 of a suitable heat exchanger material such as thin aluminum or steel. The tube 10 is formed into the serpentine shape shown in Fig. 1 to present a plurality of layers 11 which are the straight portions of the tube and which are all, therefore, disposed in one plane as the sheet is formed into the folded shape shown. Of course, the tube is completely open through its interior and, therefore, suitable for the continuous passage of a fluid through the tube. Fig. 2 shows the tube 10 disposed within a fixture or press 12 comprised of a plurality of blocks 13 which are preferably of a height equal to the distance between the sections 11 of the fin shown in Fig. 1. It will be noted that the blocks 13 extend along only the straight portions of the tube so that the end turns 14 of the tube

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are not disposed directly between two of the blocks 13. Suitable arms 15 abut the upper and lower ones of the blocks 13 through plates 16, and it should be understood that the arms 15 transmit a compressing force to the sections 11 of the tube 10. It is preferred that the tube 10, therefore, be compressed uniformly through the sections 11, and thus the sections are collapsed or flattened until the opposite walls or sides of the tube are in contact with each other. Subsequently, fins 17 are disposed between the tube flattened sections or portions 11 so that the crests 18 of the fins 17 are in line contact with the flattened walls of the tube, as shown in Fig. 6. The height of the fins 17 is, therefore, substantially the same as the height of the press blocks 13 of Fig. 2.

Fig. 3 shows the fin and tube assembly with the tube providing one of the heat exchanger fluid pass sections and the fin providing the other of the fluid pass sections in the common arrangement of a heat exchanger. Also, Fig. 3 shows side plates 19 and 20 enclosing the opposite sides of the assembly while angled end plates 21 and 22 enclose the opposite ends of the assembly with the plates 21 and 22, of course, having suitable openings 23, shown dotted, through which the curved portions 14 of the tube 10 can project. The assembly is next preferably disposed in a furnace or salt bath to be heated for bonding the tube and fins together along their lines of contact, such as the lines shown in Fig. 6 along the opposite flattened sides of the tube. For this purpose it should be understood that it is preferred to have the tube and fins coated with a bonding material 25, shown in Fig. 5, but bonding material could be on the tube only or the fins only. It should be understood that Figs. 5 and 6 are exaggerated views of the coating in order to show the existence of the coating, as both the coating and also the tube and fin thicknesses are exaggerated in the drawings. In the bonding step of the process, the assembly is heated to the melting point of the coating material, and that melting point is lower than the melting point of the parent or base metal forming the tube and fins. This condition will cause only the coating material to melt and bond at all points of contact while the base metal of the assembly will not melt. Since the bonding is a standard procedure in the manufacture of heat exchangers, no further description thereof is deemed to be necessary.

The assembled heat exchanger, as shown in Fig. 3, can then be disposed between the limiters or restraining members 24 so that the assembly is retained in its dimension from top to bottom and side to side between the members 24. While the assembly is thus retained, fluid pressure is applied at either or both open ends 26 and 27 of the tube 10, and the pressure is, therefore, applied to the interior of the tube to cause the flattened sections 11 to expand and assume a cross-sectional shape of an oval or circle, whichever is desired. Of course, the resulting cross-sectional shape of the tube sections 11 will depend upon the application of the fluid pressure, which can be controlled to produce a degree of oval shape, or it can produce the original circular shape of the tube. In the tube expansion steps, the bonding between the fin and the tube remains and, therefore, the fin assumes the arcuate shape shown at the bonded area in Fig. 5. At this bonded area, the fin and tube then have the required contact area between them to insure the required heat conductivity therebetween. The expansion of the tube will also cause the fins to distort or bow at intermediate sections 28, as shown in Fig. 4. This is true since the assembly is held within the members 24, which retain its overall dimension, and the expansion of the tube must, therefore, cause the fins to be compressed or shortened in their overall height. Also, the control of the fluid pressure within the tube thus controls not only the shape of the tube but the shape of the fins 17 and, therefore, the friction loss of the fluid flowing through either section of the exchanger can be controlled

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by the degree of the expansion of the tube 10. Two desirable results are accomplished because of the distortion of the fins 17. The bowed edge 28 of the fin causes the fin to be stronger in its resistance to a striking force inflicted by foreign objects, such as bugs or stones, which might be encountered when the heat exchanger is used in an automobile. With regard to this result, it will be obvious that the fins 17 are stronger in both side directions, as viewed in Fig. 4, because of the bowed shape which is commonly known to produce a stronger member. The second desirable result obtained by virtue of the distorted fin is also apparent in Fig. 4 which shows that air flowing through the fin will be turbulized because of the bowing and bulging of the fin. Of course, the turbulizing of the air provides the greatest heat transfer between the air in the fin section and the fluid in the tube section.

While specific steps of this process have been described, it should be obvious that certain of the steps can be altered or eliminated and, therefore, the scope of this invention should be limited only by the appended claims.

I claim:

1. In a process of manufacturing a heat exchanger having two fluid pass sections, the steps comprising forming a tube of one of said fluid pass sections of said exchanger into a plurality of folds, compressing said folds of said tube in a direction and until said tube is collapsed in its cross-section, disposing the other of said fluid pass sections intermediate said folds of said tube so that said tube and said other of said sections are in contact, bonding together said folds of said tube and said other of said sections at their points of contact, applying pressure to the interior of said tube to at least partially restore the uncollapsed condition of said tube.

2. In a process of manufacturing a heat exchanger having two fluid pass sections, the steps comprising forming a tube into a serpentine shape to form a plurality of overlapping sections, compressing the intermediate portions of said sections of said tube in a direction and until said portions of said tube are flattened in their cross-section, disposing a heat exchanger fin intermediate said portions of said sections of said tube so that said fin is in contact with the flattened said sections of said tube, bonding together said sections of said tube and said fin at their contact area, applying pressure to the interior of said tube to at least partially restore the unflattened condition of said tube.

3. In a process of manufacturing a heat exchanger, the steps comprising forming a tube into overlapping sections disposed in a single plane, compressing said sections of said tube in the direction of said plane for flattening the opposite walls of said tube to dispose said walls transverse to said plane, disposing a heat exchanger fin intermediate said sections of said tube, bonding said tube and said fin together, restraining said tube and said fin at the two limits of their extent in said plane, applying pressure to the interior of said tube for moving said walls thereof toward each said fin in contact with said walls while restraining said tube and said fin.

4. A process of manufacturing a heat exchanger of the type having two fluid pass sections with one fluid pass section made of a tube, comprising the steps of forming said tube into a serpentine shape, flattening the cross-sectional area of said tube, positioning a fluid pass section in contact with said tube at the flattened side thereof and thereby provide the assembled two sections of the heat exchanger, disposing said sections of said heat exchanger between spaced apart limiters for the latter to abut the two opposite sides of said sections, pressurizing the interior of said tube for expanding said cross-sectional area of said tube from its flattened condition while said limiters abut said opposite sides of said sections.

5. In a process of manufacturing a heat exchanger, the steps comprising flattening the opposite sides of a heat exchanger tube to form flattened walls at said opposite

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sides, positioning a heat exchanger fin in contact with said flattened walls of said tube, bonding said tube and said fin together at the contact therebetween, applying fluid pressure to the interior of said tube for expanding said tube toward said fin, and restricting the combined outward movement of said tube and said fin in the direction transverse to said flattened walls.

6. In a process of manufacturing a heat exchanger, the steps comprising flattening the opposite side walls of a heat exchanger tube, positioning a heat exchanger fin in contact with each of said walls of said tube, applying pressure at the interior of said tube for expanding said tube toward said fin, and retaining the combined dimension of said tube and said fin while said tube is being expanded.

7. In a process of manufacturing a heat exchanger having two fluid pass sections, the steps comprising forming a tube into a serpentine shape to present a plurality of layers and with said tube to be used as one of said

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fluid pass sections of said exchanger, flattening the opposite sides of said tube in a direction and until said sides of said tube are in contact with each other, disposing a serpentine and heat exchanger fin intermediate said layers of said tube so that said tube and said fin are in contact at a plurality of points along said fin and with said fin to be used as the other of said fluid pass sections, bonding together said tube and said fin at their points of contact, applying fluid pressure to the interior of said tube to at least partially restore the unflattened condition of said tube, and restraining the movement of said sections of said heat exchanger against the influence of said fluid pressure.

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