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K. McCREARY

2,553,142

METHOD FOR MAKING HEAT EXCHANGERS

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Fig. 1.

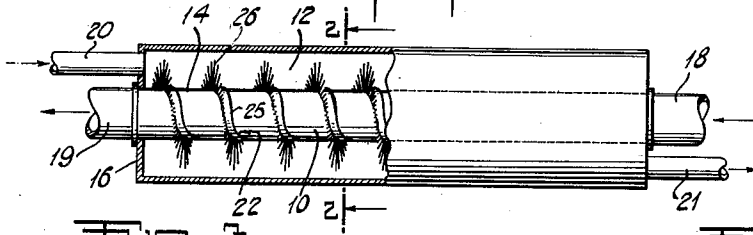


Fig. 3.

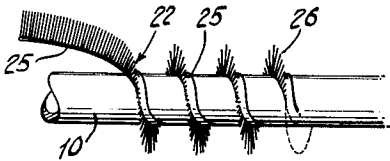


Fig. 2.

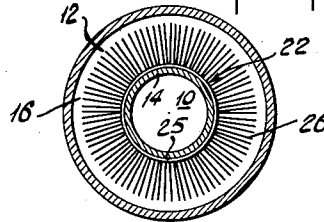


Fig. 5.

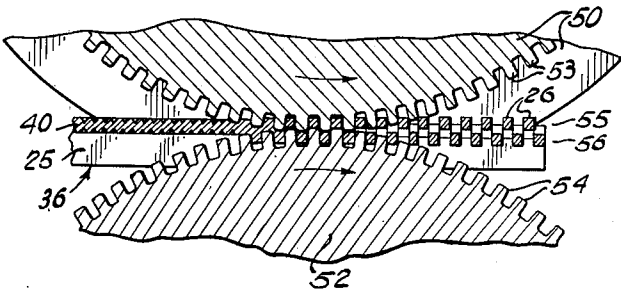


Fig. 4.

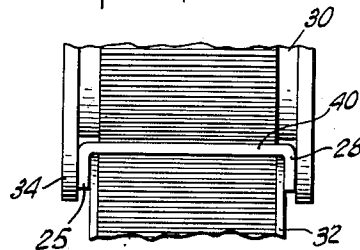


Fig. 7.

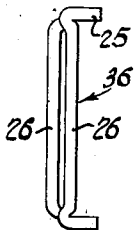


Fig. 8.

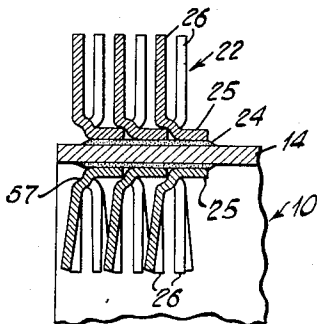
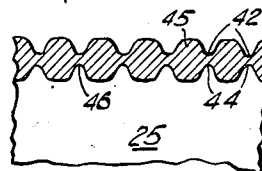


Fig. 6.



INVENTOR
KENNETH McCREARY.
BY *Nirgil C. Kline*
ATTORNEY

UNITED STATES PATENT OFFICE

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METHOD FOR MAKING HEAT EXCHANGERS

Kenneth McCreary, Plainfield, N. J., assignor to
Johns-Manville Corporation, New York, N. Y.,
a corporation of New York

Application May 29, 1947, Serial No. 751,188

1 Claim. (Cl. 29—157.3)

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This invention relates to heat exchange units, and is particularly directed to an improved finned tube heat exchanger and method of manufacturing the same.

The heat exchange unit which forms the subject of the present invention represents a modification of and improvement on the heat exchanger which is described in the copending joint U. S. patent application of Kenneth McCreary and Otto Hoheisel, Serial No. 743,296, filed April 23, 1947, for Heat Exchanger. The heat exchanger which is disclosed in said joint application consists essentially of two fluid flow chambers of substantially rectangular cross section, said chambers being separated by a metal partition which constitutes the primary heat transfer element for indirect heat exchange between the two fluids. A means for extending the surfaces of the partition consists essentially of closely nested assemblies of substantially rigid shallow channel shaped fin members disposed in each fluid chamber in contact with the metal partition. Each channel shaped fin comprises a base fin portion disposed at substantially right angles to the partition surface, and two narrow offset flanges, one of which parallels the partition surface and is bonded thereto with solder, while the other flange is bonded to the opposite wall of the fluid chamber. The base fin portion of the channel section consists of two parallel rows of spaced straight pins, adjacent pins being joined at their ends to each other and to the channel flanges. The channel flanges are shaped for close nesting, with the channels extending longitudinally within the fluid flow chambers in the direction of fluid flow. The bonding of the channel sections to opposite chamber walls provides a strongly reinforced heat exchanger unit.

A primary object of the present invention is to provide a simple and economical design of finned tubular heat exchanger.

Another object is to provide an improved flexible sheet metal fin of extended surface area suitable for easy assembly to form a finned tubular heat exchange unit.

A further object is to provide an improved method of making an extended surface tubular form of heat exchanger unit.

With the above objects in view the invention consists in the improved extended surface heat exchanger unit and method of manufacture which is hereinafter described and more particularly defined by the accompanying claim.

In the following description, reference will be made to the attached drawings, in which:

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Fig. 1 is a diagrammatic view in side elevation of an extended surface coaxial tube heat exchange unit representing an illustrative embodiment of the present invention, a portion of the outer tube being broken away to show multiple spaced radial pins disposed in helical series in the outer chamber of the heat exchange unit.

Fig. 2 is an enlarged cross section taken on the plane 2—2 of Fig. 1.

Fig. 3 is a view in side elevation illustrating one method of assembling a flexible spaced pin type flanged strip in helical series on the tubular primary heat transfer diaphragm.

Fig. 4 is a view in end elevation of toothed press rolls for initially shaping and indenting the base portion of a strip of heat conductant sheet metal for producing channel shaped heat extender fin elements.

Fig. 5 illustrates somewhat diagrammatically in longitudinal section toothed press rolls for shearing the indented channel shaped strip and offsetting in two directions, to form two rows of staggered pin type fins between the end flanges.

Fig. 6 is an enlarged fragmentary view in longitudinal section of an indented flanged strip such as operated on by the rolls of Fig. 5.

Fig. 7 is an end elevation of one of the channel shaped fins turned out by the operation portrayed in Fig. 5.

Fig. 8 is an enlarged fragmentary view in longitudinal section, with parts in elevation, showing close helical nesting of pin type extender fins on the outer and inner walls of a tubular heat transfer diaphragm.

Referring to the drawings, Figs. 1 and 2 portray a finned coaxial tube heat exchanger constructed in accordance with the present invention. Essentially such heat exchange unit consists of coaxially arranged tubular fluid flow chambers 10 and 12. The wall 14 of the inner tube 10 forms the primary heat transfer diaphragm between the chambers. In the heat exchanger unit shown, end walls 16 serve to support the tubes in coaxial alignment. Fluid supply and removal pipes 18 and 19 develop flow of one heat transfer fluid through the inner tube 10, while pipes 20 and 21 develop flow of a second heat transfer fluid through the outer chamber 12 of the heat exchange unit.

The heat transfer surface of diaphragm 14 which is presented to the fluid flowing through the outer chamber 12 is extended by a flexible fin strip 22 which is wrapped helically in close thermal conductive contact about the tube 10, and preferably bonded thereto by means of solder or

equivalent heat conductant bonding medium 24 (Fig. 8). The bonding material may be applied as a liquid coating to the tube wall 14 at the time that the fin strip is being wound on the pipe, or the bonding material may be wrapped around the walls of the pipe as a thin foil, which is later fused by heat after wrapping with the flanged fin strip.

Fin strip 22 has a narrow offset flange 25 along the full length of one longitudinal edge thereof, while the strip is slit transversely inwardly at closely spaced points along its opposite edge to form parallel rows of staggered spaced pins 26. In the assembled unit the strip is wound in a circular ring or helical coil, with its offset flange against the tube and with its pins 26 extending radially to the main axis of the tube, so that adjacent rings or coils of the strip may lie in closely spaced relation around the outer surface of tube 14 throughout the length of chamber 12. As illustrated in Fig. 8, the heat extender unit may also include a second set of rings or helically wound radial pin strips inserted within the tube 10, with the flanged edge 25 of the strip in good heat conductant abutting relation to the inner surface of the tube wall 14. The heat extender strips may be mounted within the inner and outer chambers 10 and 12 in such closely nested relation as to provide pin type fin elements having a combined cross sectional area which may occupy a large part of the total void space within the fluid flow chambers. As shown in Fig. 8, the free ends of some of the pins 26 may be offset from true radial relation with the axis of tube 10 to avoid interference when strips 22 are mounted inside the tubes.

One suitable way of manufacturing the flexible extender strips 22 has been illustrated in its various stages, and will now be described by reference first to Fig. 4.

A flexible sheet metal strip 28 of copper or other easily worked metal of good heat conductivity, is first passed between pressure shaping and scoring rolls 30 and 32. The upper roll 30 is provided with flanges 34 at either side which are spaced a distance somewhat less than the width of the metal strip 28. The lower roll 32 is mounted between the flanges 34 of the upper roll, and each end of the lower roll is spaced from the inner face of the adjacent flange a distance equal to the thickness of the strip 28, so that in passing between the rolls the edges of the strip are turned down to shape the strip into a shallow channel 36 having narrow side flanges 25 and a base fin portion 40. The rolls 30 and 32 have identically spaced and shaped milled scoring teeth at their peripheral surfaces, and the rolls are closely spaced during the initial forming operation on the strip 28, so as to deeply indent or score the inner and outer surfaces transversely of the base or fin portion of the channel, as portrayed in Figs. 5 and 6. The teeth of the oppositely disposed shaping and scoring rolls 30 and 32 should be in register or only slightly out of register, so that the indentations 44 at the inner face of the channel are directly opposite or slightly offset with respect to the indentations 42 on the outer face of the channel. In this manner, evenly spaced staggered sections 45 of roughly hexagonal cross section are formed in the channel 36 along the entire length of the channel. Adjacent sections 45 are joined by connecting joints 46 of reduced cross section. The longitudinal spacing of adjacent indentations is preferably substantially equal to the thickness of the original metal strip.

After shaping and scoring the sheet metal strip to form the indented channel 36, this channel is subjected to a shearing and offsetting operation between another pair of toothed shearing rolls 50 and 52 (Fig. 5). The shearing teeth 53 and 54, respectively, of rolls 50 and 52, have the general shape of spur gear teeth, with the teeth at the bite of the rolls partially meshing. Teeth 53 and 54 are circumferentially spaced so that in contacting the channel strip each tooth of a roll engages alternate strip sections 45 between the indentations 42 and 44. Since the teeth are partially in mesh the channel strip is sheared at joints 46, and the sheared sections 45 are spread in opposite directions away from the original plane of the channel base, by alternate contact with opposite staggered teeth of the two rolls 50 and 52. This shearing operation produces two parallel rows 55 and 56 of staggered pins 26 alternately displaced outwardly and inwardly from the original plane of the channel base. At the completion of this operation the individual pins are roughly square, circular or hexagonal in cross section.

Each comparatively rigid channel fin 36 (Fig. 7) which results from the foregoing operations is split longitudinally by transversely shearing the pins forming the channel base along a line approximately paralleling and equally spaced from each of the side flanges, to thereby form from each channel two approximately equally dimensioned flexible strips 22 (Fig. 8). Owing to the initial offsetting operation whereby adjacent pins 26 are displaced inwardly and outwardly from the plane of the original channel base to form two parallel rows of pins, the offset shoulder bases 57 of the pins, where their ends join the integral offset flange 25, naturally hold the pins in spaced staggered relation, and the pins have sufficient resilience so that they naturally spring back to this offset spaced position after the channels have been subjected to the longitudinal shearing operation.

In assembling the flexible flanged strips 22 into a tubular heat exchange element, a continuous straight strip 22 may be shaped either manually, or by wrapping about a shaping mandrel of suitable dimension, into the form of a helical coil. The spacing between adjacent helical series of spaced pin members can be adjusted by varying the width of the flanges 25, or the spacing between flanges. The flexible fin strips may be assembled directly on the primary heat exchanger tube to which they are joined by soldering, or they may be assembled separately into a helical coil and then slipped over or inside the tube and joined thereto by soldering. The individual coil strips are sufficiently flexible so that a helical series can be readily adjusted as to diameter to fit pipes of different sizes.

From the foregoing description it will be evident that the present invention provides a simple and highly efficient finned tube heat exchanger, and an advantageously flexible flanged radiating pin type extender fin strip adapted for helical wrapping to form a tubular heat exchanger of extended heat transfer surface. The method described provides a way of converting a thin flat metallic strip of heat conductive metal into two identical and flexible heat exchanger fin strips 22 each having a narrow flange 25 along one longitudinal edge and having its main fin portion 40 slit transversely and offset into parallel rows of spaced staggered straight pins 26 having a total cross sectional area equal to that of the original

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sheet, and having a total heat transfer contact area much greater than that of the original sheet. Fin strips 22 may be produced by any method whereby a flat strip of sheet metal is deformed to produce a narrow offset flange along one longitudinal edge thereof, while the main body of the strip is slit transversely inwardly at closely spaced points along the opposite edge and adjacent slit pin portions are offset to form two parallel rows of staggered straight pins all joined to the flange at their base ends.

The invention which has been thus described by detailed example is not limited as to such details and it is to be understood that variations, changes and modifications are contemplated within the scope of the invention as defined by the following claim.

What I claim is:

In manufacturing extended surface heat exchange elements the steps comprising, deforming a strip of flexible sheet metal to produce an elongated channel having a relatively broad main body and a narrow upturned flange at each longitudinal edge thereof extending at substantially right angles to the main body of the strip, deeply scoring the inner and outer surfaces of said main body transversely at uniformly spaced intervals approximating the thickness of the body to form closely spaced oppositely disposed transverse grooves providing zones of reduced

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cross section between opposite grooves, slitting the main body of the strip along each of said zones and offsetting adjacent slit portions to form two parallel rows of straight spaced pin type fins integrally attached to the flanges, and transversely shearing the pins forming the channel base along the approximate center line thereof to form two flexible pin strips.

KENNETH McCREARY.

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