

Aug. 17, 1965

ICHIZO TAKAGI

3,200,848

HEAT EXCHANGER TUBES

Filed May 29, 1963

2 Sheets-Sheet 1

FIG. 1

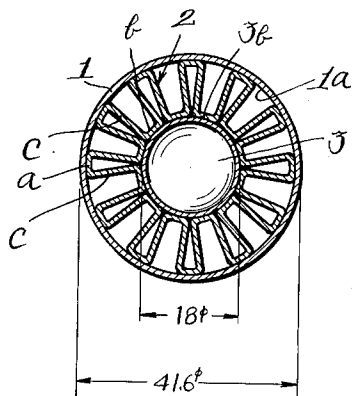


FIG. 2

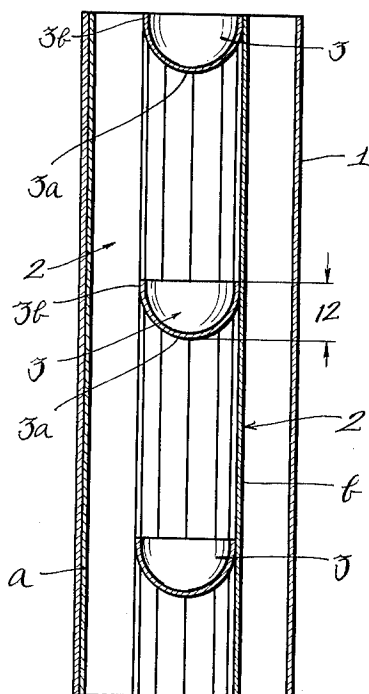
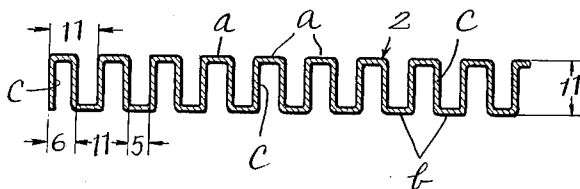


FIG. 3



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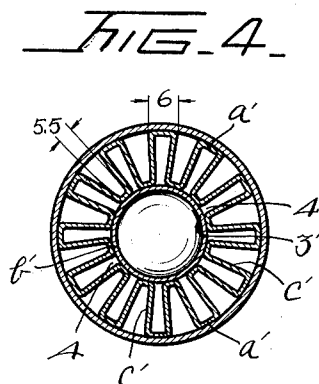
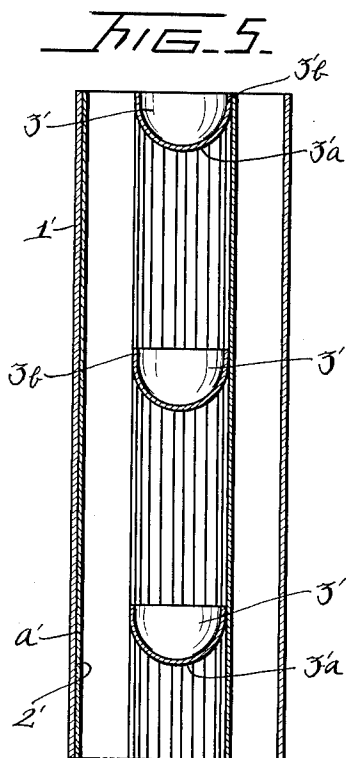
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HEAT EXCHANGER TUBES

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1 Claim. (Cl. 138—38)

The present invention generally relates to improved heat-exchanger tubes, and more specifically to heat-exchanger tubes in which improved type of fins are provided.

Heretofore, various types of metallic heat-exchanger tubes have been proposed, and among them there are the types of metallic heat-exchanger tubes in which fins are secured to the outer periphery or inner periphery of the tubes at right angles or in parallel with respect to the axis thereof. Thus, the fins are initially formed separately from the tubes and then secured to the tubes. Another type of known metallic heat-exchanger tube is provided with the fins formed integrally therewith as defined by projections on the tube wall.

The separate-outer-fin-type heat-exchanger tube is produced by the process which comprises the steps of disposing a plurality of fins around the outer periphery of said tube, and expanding the tube diameter by any suitable means so as to tightly fit the inner peripheral surfaces of the fins on the outer peripheral surface of the tube. However, according to the process, since the tube is to be expanded, the material for the metallic tube should be formed by a soft metal. And therefore, the manufacture of such a type of heat-exchanger tube is rather complicated and in addition, this type of heat-exchanger has inherent disadvantages in that the fins often fail to be firmly secured at predetermined proper positions on the outer peripheral surface of the tube and they tend to be dislocated from the anchoring positions while in use of the heat-exchanger tube, and as a result good heat conductivity will not be provided by such a type of heat-exchanger tube.

The integral fin-type-heat-exchanger tube is advantageous over the separate fin-type-heat-exchanger tube in that the integral fin-type-heat-exchanger tube provides a better heat conductivity than the separate fin-type-heat-exchanger tube and the integrally formed fins will not be dislocated in any way while in use. However, the integral fin-type also has to be formed from a soft metal and the production efficiency of such a heat-exchanger tube is quite low as in the case of the separate fin-type-heat-exchanger tube.

An object of the present invention is to provide improved metallic heat-exchanger tubes which eliminate the above-mentioned disadvantages attendant upon the prior art metallic heat-exchanger tubes, and which have a broader heating surface, better heat conductivity, and simpler construction as compared with any of the prior art heat-exchanger tubes.

The novel metallic heat-exchanger tube according to the present invention is characterized in that said heat-exchanger tube comprises a metallic tube, a corrugated metallic plate of copper or the like metal of round contour having good heat conductivity disposed within said metallic tube and having a plurality of alternately different-sized and alternately directed bends extending in the longitudinal direction thereof, and a plurality of cup-shape anchor means press-fitted within said bent metallic plate to firmly hold said metallic plate within said tube, the edges of the inwardly directed bends of said bent metallic plate abutting against the outer peripheral surfaces of said anchor means, the edges of the outwardly directed bends of said metallic plate abutting against the inner peripheral surface of said metallic tube, and the sides common to adjacent inwardly and outward-

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ly directed bends radially extending with respect to the axis of the metallic tube.

The other objects, features and advantages of the present invention will become apparent to those skilled in the art from a reading of the following detailed description of two preferred embodiments of the present invention.

In the accompanying drawings:

FIG. 1 is a cross sectional view of a preferred embodiment of heat-exchanger tube constructed in accordance with the present invention;

FIG. 2 is a longitudinal sectional view of the embodiment of FIG. 1;

FIG. 3 is a front elevation view of the portion of a fin suitable to be used in the heat-exchanger tube according to the present invention and which illustrates the fin in its extended state prior to the installation thereof into the tube;

FIG. 4 is a cross sectional view of a modified embodiment of heat-exchanger tube according to the present invention; and

FIG. 5 is a longitudinal sectional view of the modified embodiment as shown in FIG. 4.

Preferring now to the accompanying drawings, and especially to FIGS. 1 and 2 in which the first embodiment of heat-exchanger tube by the present invention is shown, the novel heat-exchanger tube comprises a metallic tube 1 of such as a copper tube, which tube has an outer diameter of 41.6 mm. and a wall thickness of 0.8 mm. and a corrugated metallic fin 2 curved to provide a round contour disposed within said tube, which may be formed from a sheet metal such as copper or the like metal having good heat conductivity and has a thickness of 0.5 mm.. The corrugated sheet metal 2 has been bent so as to have a plurality of alternately different-sized and alternately different-directed bends as illustrated in FIG. 1. The heat-exchanger tube has also hemisphere cup-shape anchor means 33, which are formed of stainless steel and have an outer diameter of 18 mm. and a height of 12 mm.

In the formation of the above-mentioned novel heat-exchanger tube, the metallic plate 2 as shown in FIG. 3 (which may be described as a corrugated plate in which the corrugations have flat tops and flat bases), is first deformed into a round shape or contour relative to its longitudinal direction so as to provide a plurality of uniformly sized and differently directed bends. The edges of the inwardly directed bends have a width of 6 mm. and the edges of the outwardly directed bends have also a width of 6 mm. The pitch of a pair of inwardly and outwardly directed bends and the height of each bend is 11 mm. respectively. Thus deformed, metallic plate 2 is then inserted into the metallic tube 1. After the insertion of said corrugated bent metallic plate 2 into the metallic tube 1, several hemispherical cup-shape anchor means 3 (FIG. 2) are press-fitted with their curved surfaces 3a disposed at the side within the bent metallic plate 2 by the use of any suitable means. Thus, the sides c common to adjacent inwardly and outwardly directed bends are radially disposed with respect to the axis of the metallic tube 1 as shown in FIG. 1. On the other hand, the edges a of the outward bends abut against the inner peripheral surface of the metallic tube 1 while the edges b of the inward bends abut against the outer peripheral surfaces 3b of the cup-shape anchor means 3 whereby the metallic plate 2 which constitutes the fin can be firmly held within the metallic tube 1.

Next, referring to FIGS. 4 and 5 which illustrate a modified embodiment of heat-exchanger tube according to the present invention, in this embodiment the metallic tube 1 and cup-shape anchor means 3 are formed by the same materials as those employed in the first embodi-

ment and their dimensions are also the same as those of the corresponding parts in said first embodiment. Therefore, the corresponding parts are given the same numerals as those in FIGS. 1 and 2 with "alpha" added thereto. However, the width of the edges b' of the inward bends are selected as 5.5 mm. shorter by 0.5 mm., than that of the edges of the outward bends a' which have a width of 6 mm. whereby a clearance 4 through which fluid can pass may be formed between adjacent edges b' of the inward bends.

Thus, according to the present invention, there are provided improved heat-exchanger tubes having a much broader heating surface as compared with any of the known heat-exchanger tubes. By the mere insertion of the cup-shape anchor means into the interior of the metallic plate which constitutes the fin, the metallic plate or fin can be firmly held within the metallic tube. The production of the novel heat-exchanger tubes is quite simple when compared with the afore-mentioned prior art heat-exchanger tubes. Furthermore, since the fluid flowing within the tube is caused to impinge against the cup-shape anchor means and to produce a turbulent flow, the heat-exchange efficiency of the heat-exchanger tube may be further improved, and especially, since the metallic tube may be equally formed from either soft or hard metal, the present invention has provided practical heat-exchanger tubes which possess many advantages over the prior art heat-exchanger tubes.

It will be understood that minor modifications and changes may be made on the foregoing embodiments by those skilled in the art without departing from the scope and spirit of the present invention. Accordingly, the invention is not to be limited to the precise embodiments illustrated therein, but only by the scope of the appended claim.

What claimed is:

A heat exchanger tube comprising
an outer metallic tube

a corrugated metal sheet formed of a metal having good conductivity, the corrugations of said plate having flat tops and flat bases and the distance between the tops and bases of said corrugations being less than the radius of said outer metal tube,

said corrugated metal sheet being curved to form a tube of round configuration and being fitted within said outer tube with the flat tops of the corrugations thereof in contact with the inner surface of said outer tube,

the width of the flat tops of said tube being sufficiently greater than the width of the flat bases thereof to provide spaces between adjacent flat bases when said corrugated metal sheet is curved to fit within said outer tube, and

a plurality of spaced cup-shaped anchor means press fitted within said curved corrugated sheet with the flat bases of said corrugations abutting against the outer peripheral surface of said cup-shaped anchor means.

References Cited by the Examiner

UNITED STATES PATENTS

1,394,311	10/21	Lang	138—38
2,386,159	10/45	Elder	138—38
2,608,968	9/52	Moseley	138—38
2,756,032	7/56	Dowell.	

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