A fin tube formed by a combination of groove forming and backfilling helically wound fins substantially integral with tubing. Groove forming and backfilling rollers are combined in cooperation with the fin forming mechanism.

BACKGROUND

The utilization of helically wound fin tubing wherein the fin stock is wrapped upon the tubing is of usefulness in the heat transfer processes wherein fluid temperatures range upward from about 350° F. Above that temperature, especially where aluminum fins are wrapped upon a steel pipe, certain limitations occur in effective heat transfer the most serious being the expansion of the aluminum fins about the tubing therefore providing ineffective heat transfer. In addition, many of the prior artisans who have heretofore formed grooves in the tubing or insertion of the fin have formed the grooves by a cutting, plowing, or gouging operation constantly requiring sharp knives and cutters. Others, such as U.S. Pat. No. 3,077,928 have taught bonding the fin with preformed and defomed grooves by extruding the soft fin foot into the groove.

SUMMARY

This invention relates to apparatus for cold rolling a helical groove substantially simultaneously with the formation of and placement of a preformed fin within said groove. The groove is then backfilled crimping and locking the fin in place as an integral part of the tubing. In typical sequence of operations this occurs within one revolution of the tubing.

DRAWINGS

FIG. 1 is a top elevational view of the apparatus of this invention.
FIG. 2 is a side view of the apparatus of FIG. 1 taken along the lines 2—2.
FIG. 3 is a sectional view taken along the line 3—3 of FIG. 2.
FIG. 4 is a partial sectional view of the fin forming mechanism and the apparatus and manner in which the groove is rolled, and backfilled to lock the fin relative to the tubing.
FIG. 5 is a partial sectional view of another embodiment.
FIG. 6 is a schematic fluid pressure and wiring diagram of the control mechanism for actuating the finning control yoke.

DESCRIPTION

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

Referring now to FIG. 1, bare tubing 10 is previously supplied, rotated and driven as shown by the arrows, utilizing substantially similar apparatus and methods found in prior U.S. Pat. No. 3,388,449 and copending application Ser. No. 717,228 filed Mar. 29, 1968, all of which are incorporated for reference herein. For example, FIGS. 2 through 8 and FIG. 11 of Pat. No. 3,388,449 depict apparatus capable of use with this invention to the extent of handling bare tubing, rotating and axially advancing the tubing and in the formation of the fin except that this invention is not related to an L-shaped fin. Instead, this invention relates to a new heat exchange finned tube article, and the process steps of grooving and inserting a formed fin within the groove and backfilling to deform and lock the fin within the groove. The bare tubing enters the groove forming, fin forming and backfilling apparatus of this invention generally designated by the numeral 12. The resultant finned tubing stock 14, with fins 13, downstream thereof is then adapted to be received and handled by equipment described in the aforesaid patents and applications.

Within the broadest aspects of this invention, this invention provides, within one-half revolution of the tubing, the forming of a groove in the bare wall of the tube by a cold rolling process which ordinarily begins with half pitch ahead of the fin forming mechanism, followed by insertion of the base of the fin within the groove. Within one-half revolution thereafter backfilling of rolled metal on each side of the fin secures the fin into place. The securing action occurs by extruding the base of the fin during the backfill so as to form, as an example, a dovetail-like interlock within the tubing.

The finning and grooving assembly 12 includes an overarm 16 which is pivotal about shaft 18 above the tubing stock 10. The shaft 18 is threaded through split mounting bracket 19 and acts to position the groove roller one-half pitch upstream of the fin forming mechanism. Because the backfilling rollers are fixed relative to the groove roller their positions are automatically adjusted simultaneously. The other end of the overarm 16 includes a clamping face 22 over which finning control yoke arm 24 pivots about shaft 26. Face 22 is offset as shown whereby the downward force of yoke 24 is substantially aligned in the same plane of the grooving and backfill rollers. Handle 28, which includes a threaded shaft 30, abuts against surface 22 to adjust the working range of yoke 24 to various sizes of tubing. Intermediate the overarm is shaft 32 which is rotatably supported within bearing sleeve 34. Attached to the same rotating shaft are groove forming and backfilling rollers 40 and 42, more aptly enlarged in FIG. 4. In a typical application roller 40 is about .115" thick whereas roller 42, which rides between the fin is about .062" thick. The overarm is supported on mounting bracket 19 which in turn is attached to the finning bridge assembly 46 by screws 48. Bracket 19 is pivotal about screw 50 during the adjustment thereof and in some instances a helix angle indicator is used as a part of bridge assembly 46 to show the correct fillet angle. Vertical adjustment of grooving and backfilling rollers 40 and 42 relative to the tubing 10 occurs using adjusting screw 52. Lateral support of the overarm is provided by screws 54 and 56. Clamping handle 60 is adapted upon rotation to squeeze the upper half 62 toward the lower half 64 of bracket 19 and hence clamp shaft 18 in the desired position.

Finning control yoke 24 is pivotally attached to lever arm 27 the outer end of which is attached to a piston rod 29 of a fluid pressure operated cylinder means shown in FIG. 6. This provides control force to the overarm 16 and associated grooving and backfilling rollers. The finning bridge assembly 46 is adapted to receive the bare tubing 10 and in a manner similarly shown...
in the aforesaid patents and copending applications performs aluminum or other metallic fin stock for application on the tubing.

Referring now to FIG. 3 a finning guide finger 70 extending toward the viewer in this figure is supported within a square sleeve 72 by bolt 74. The sleeve 72 is adapted to move along an axis parallel to the tubing 10 axis within bridge assembly 46 by rotating knob 76. A clamp 78 is provided to maintain a given position. Plate 80 supports the screw shaft 82 which moves sleeve 72. The plate 80 is retained to the assembly 46 by screws 84.

FIG. 6 depicts, schematically, the finning control system operative relative to yoke 24, that is, to extend piston rod 29 and relieve the force upon overarm 16 or retract the rod to apply force. Air or other pressure fluid cylinder 120 includes inlet and exhaust conduits 122 and 124 connected through an electrically actuated valve 126. The valve is adapted to supply pressure fluid to either conduit and exhaust through the other. Switches 128 and 130 are adjustable, positioned, and locked relative to each other by movement within slot 132 of mounting 134. The mounting assembly is movable along a track formed as a part of the overall support structure to a desired position and locked.

Electrical energy is supplied to interconnect valve 126, switches 128 and 130, and override switch 140, the latter of which allows an operator to control the action of yoke 24.

In use, switches 128 and 130 are spaced from each other at a distance equal to the total desired unfinned distance of the end of the previously finned tubing and the start of the next tube to be finned. The switches are fixed as such to the mounting and the mounting is adjusted to the desired place on track 136 relative to the end of the next bare tube 10A to be finned. As such, in use, once the end of tubing 10A passes switch 128, yoke 24 is extended, stopping the finning process. However, the fins are still forming, but are not affixed to the tubing. As the end traverses switch 130 the yoke 24 is retracted, applying force to begin the fin attaching process on tubing 10A.

In the initial start-up operation, bare tubing 10 is dispersed, oriented and positioned in its operational axis through bridge assembly 46 and adjacent the grooving and backfilling overarm and rollers. Overarm 16 is pivoted downwardly about shaft 18, while yoke 24 is out of the way. Any lateral adjustment of the arm, if necessary, is made using knob 20 through shaft 18. Yoke 24 is pivoted forwardly upon the overarm extension 22 and suitable downward pressure to the rollers is supplied by fluid pressure means connected with piston arm 29. Fin stock 13 is supplied beneath the tubing to that space between the forming roll 90 and spindle roll 92. The bare tubing is rotated and moved axially, as shown by the arrows in FIG. 1, for a short distance until the initial fin stock is retained in place. Any adjustments as to the depth of the groove may be made by adjustment bolt 52. Any other minor adjustments in the helix angle may also be made utilizing adjustment bolts 49. Movement of the frame about bolt 50 is permitted within slots 47 and 51 upon loosening bolts 48. Adjustments as needed may be made of finning finger 70 which is adapted to ride against the emerging fin from the rolls 90 and 92 as a stabilizing means until it has been positioned and locked within the preformed groove of the tubing. Further guidance of the fin is given as it passes between rollers 40 and 42 which act to groove the tubing by a rolling action and backfill the inserted fin in such a manner as to interlock the fin with the tubing as illustrated in FIG. 4.

Referring to FIG. 4, bare tubing 10 enters the finning apparatus of this invention, roller 40 includes portion 100 which is adapted to form groove 101 by a pressure rolling action, that is, not by gouging, plowing, or cutting action. Below the tubing, at a location of one-half the pitch of the desired fin helix downstream, fin stock 13 is preformed into a cross-section tapered outwardly-inwardly. This occurs by the application of pressure between primary forming roll 90 and power driven spindle roll 92 at which point the base of the pin stock enters previously formed groove 101. Upon traversing a full revolution or one pitch, the backfilling of the groove and locking of the fin takes place utilizing backfill protrusion 102 of roller 40 and 104 of roller 42 substantially at the same time. The backfilling operation tends to move the wall of the tubing 10 so as to partially deform the base of the fin and interlock the fin with the tubing. Although exaggerated in this view, a substantially dovetail lock of the fin with the tubing is achieved.

Referring now to FIG. 5, another embodiment of this invention is provided in those instances using heavy walled tubing for attachment of aluminum fin. As such, rollers 40A and 42A are modified to the extent that the backfilling operation takes place by applying rolling pressure to that space between the fins which acts to force the steel into the fin.

1 claim:

1. A method of forming integral finned tubing comprising, rotating and axially advancing bare tubing, helically grooving the exterior of said tubing by pressure rolling without deformation of said tubing interior, and within at least one full pitch from the start of said grooving:

   (1) forming a substantially continuous fin, of outwardly-inwardly tapered cross-section, adjacent said grooves,

   (2) inserting the base of said fin into said groove, and

   (3) pressure rolling said tubing adjacent said groove on each side of said fin to backfill said groove and substantially simultaneously deform and fill said fin to interlock same with said tubing.

2. A method of claim 1 wherein, said inserting of said base of said fin occurs subsequently at a position about 1/2 pitch of said grooving, and said pressure rolling to backfill begins subsequently at a position about the next 1/2 pitch.

3. Apparatus for forming finned tubing comprising, a support frame, means on said frame to rotate and axially advance said tubing from upstream to downstream, overarm means pivotally supported above said tubing, said arm supporting grooving and backfilling rollers which are on the same rotatable axis, said rollers including, in advancing order, a first roller having a groove forming peripheral protrusion, and a backfilling peripheral protrusion positionable adjacent the upstream side of said formed groove, a second roller having a backfilling peripheral protrusion positionable adjacent the downstream side of said groove, means to apply force to said rollers, and means to form an outwardly-inwardly tapered fin and position the base of said fin within said groove at a position price to said backfilling peripheral protrusion of said first and second rollers.

4. Apparatus of claim 3 wherein said means to apply pressure to said rollers includes a yoke arm pivotal and engageable with said overarm, and variable pressure fluid force means interconnected with said yoke arm to apply desired force to said rollers.

5. Apparatus of claim 3 including means to adjust said overarm relative to said tubing to obtain desired helix angle of said rollers to said tubing.

6. Apparatus of claim 3 wherein said means to apply said rollers includes, a yoke arm releasably attachable to said overarm, and means including mechanical advantage linkage and a
pressure fluid cylinder and piston connected to said arm to extend or retract said piston and said yoke arm.

7. Apparatus of claim 6 including, a control to automatically actuate said yoke arm at desired intervals, said control comprising first and second switches operable relative to the passage of the end of a bore tubing section to respectively extend said piston or release force on said overarm, and subsequently retract said piston or apply force to said overarm, and manual control means to override said switches if necessary.

8. Apparatus of claim 3 wherein said second roller includes another downstream peripheral protrusion positionable adjacent the upstream side of the advancing groove.

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