

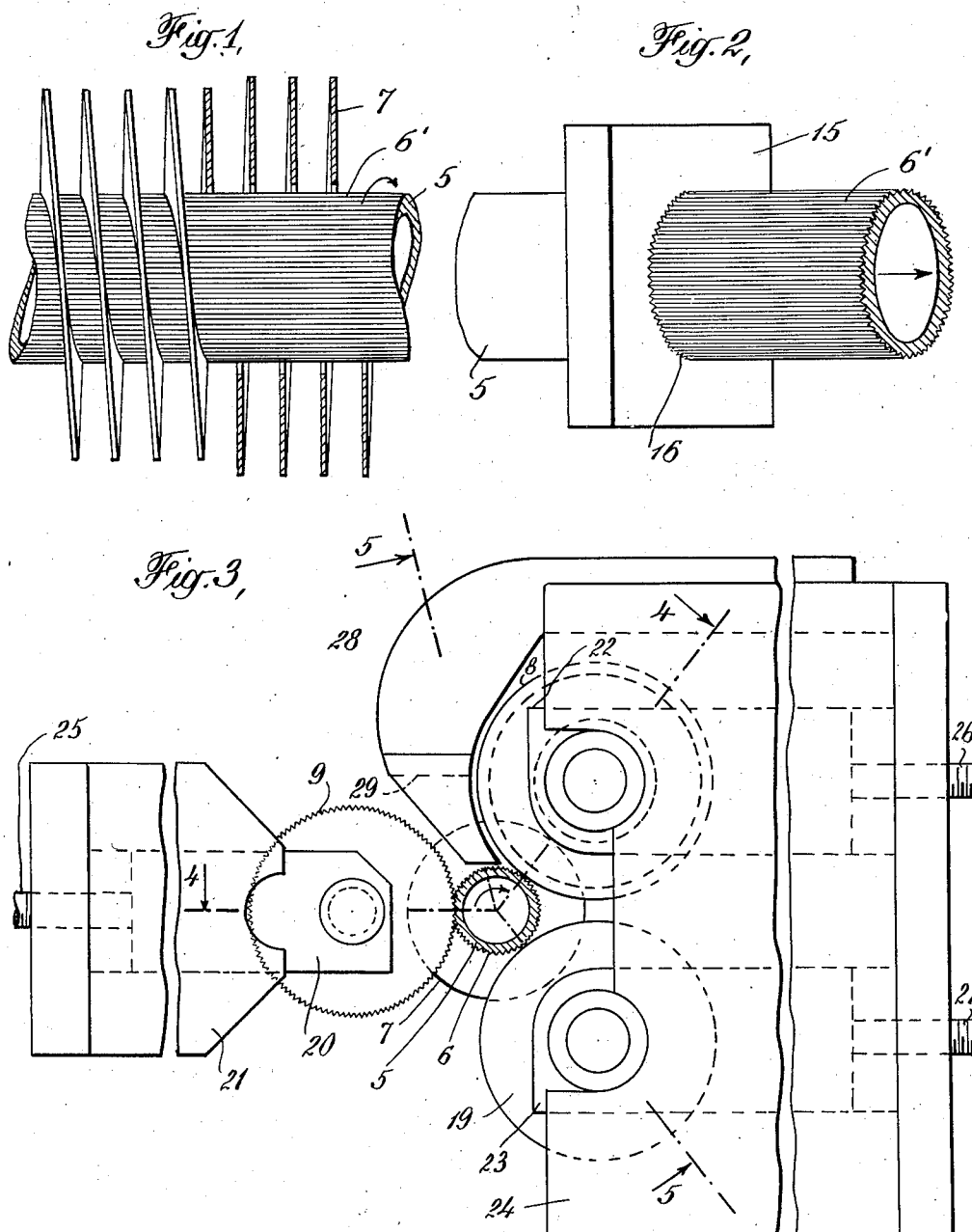
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E. A. DEWALD

1,992,297

METHOD OF MAKING FIN TUBING

Original Filed March 6, 1933 2 Sheets-Sheet 1



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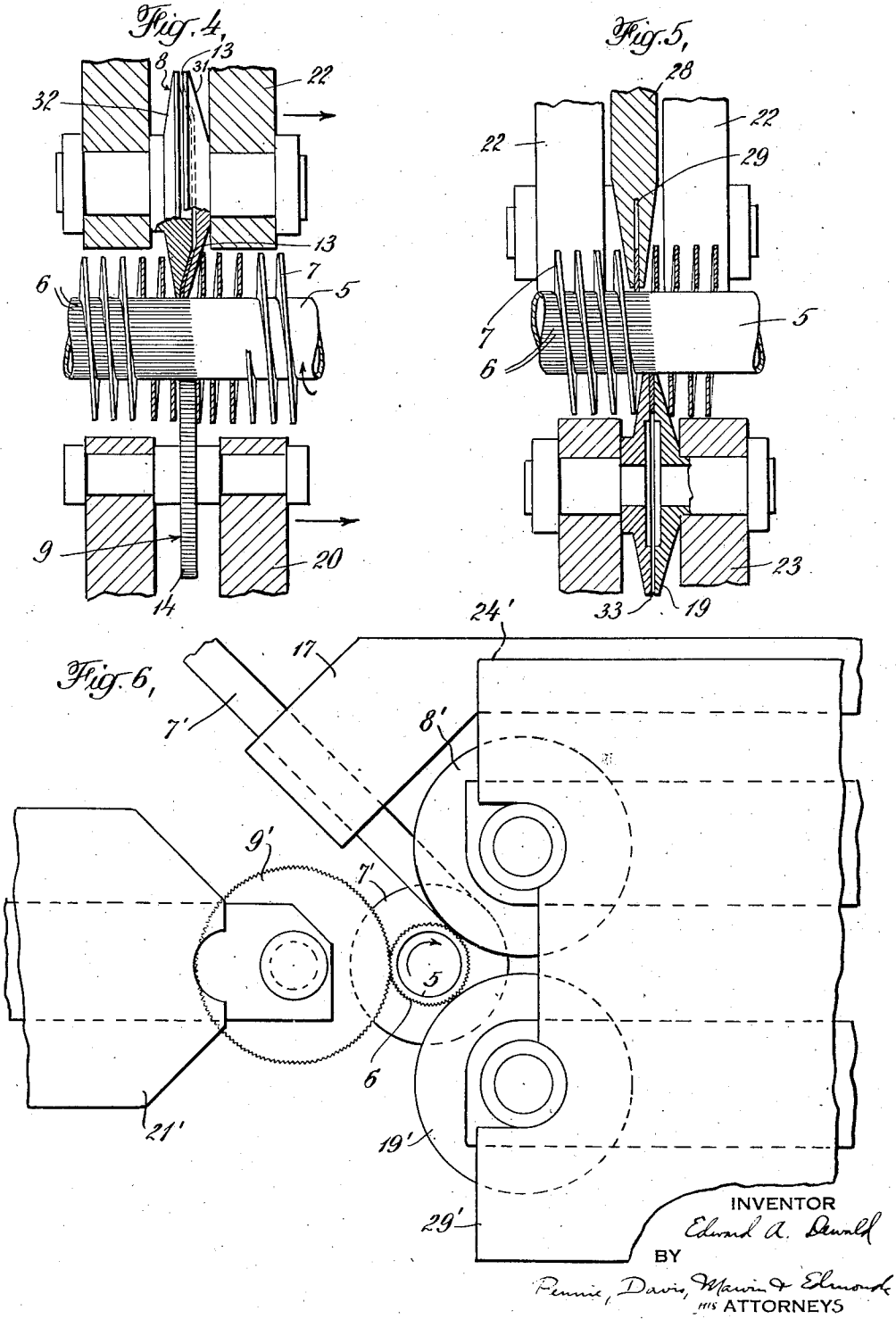
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UNITED STATES PATENT OFFICE

1,992,297

METHOD OF MAKING FIN TUBING

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 means assignments, to Reconstruction Finance
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Original application March 6, 1933, Serial No.
 659,892. Divided and this application Decem-
 ber 19, 1933, Serial No. 703,062

9 Claims. (Cl. 29—157.3)

This invention relates to fin tubing and more particularly concerns a novel method of producing fin tubing of an improved construction.

Fin tubing of the type concerned herein comprises a metallic tube having secured to the external surface thereof a thin ribbon-like metallic fin in the form of a helix. Fin tubing of this nature is extensively used in the manufacture of heat exchangers.

In the past, fin tubing of the character described has been made in either one of two different ways. Thus, the thin ribbon or strip of metallic fin material has been wound helically on a tube and then secured thereto by a molten metal bond of solder or the like. It has also been the practice to cut a helical groove on the outer surface of the tube, insert the inner edge of a helical fin in such groove and press the edges of the groove into clamping relation with the fin edge so inserted whereby the fin is secured to the tube. These known methods of attaching helical fins to tubes are unsatisfactory for various reasons. Thus, the soldered constructions are relatively expensive to manufacture and entail considerable loss of soldering material which adheres to portions of the tube and fin where it is not needed. The grooving method of fin attachment, although satisfactory for certain types of work, cannot be used with success when the tube walls are thin, because the grooving considerably weakens the tube.

The present invention has for its object, the provision of a new and improved method of securing a helical fin to a tube.

The present application is a division of my co-pending application, Serial Number 659,892, filed March 6, 1933, in which the improved tubing produced by the method of the present invention is described and claimed.

According to the present invention, the outer surface of the tube is first roughened to produce a plurality of teeth, knurl marks or other surface extensions or irregularities which preferably form ridge-like protrusions extending in a direction generally longitudinally of the tube. The ribbon or fin is then tightly wound edgewise on the tube and its inner edge is pressed against the tube surface with sufficient force to cause the protrusions or knurl marks on the tube surface to embed themselves into the inner edge surface of the fin. When so wound, it is found that the engagement of the tube surface protrusions or knurl marks with the fin edge is sufficient to effectively prevent the slipping of the fin around

the tube surface and a highly efficient finned tube construction is thereby produced.

It has been discovered that a highly effective heat conductive bond may be secured between a tube and a helical fin if the fin be merely tightly coiled edgewise about the tube. The method of the present invention provides a means for preventing such tightly wrapped fin from unwinding or otherwise loosening after it has been coiled on the tube, and this without the use of solder or similar expedients and without embedding the fin in the tube surface or otherwise weakening the tube structure.

A feature of the present invention comprises winding the metallic fin on the tube in such a manner that the winding operation serves to stretch or extend a portion of the fin metal adjacent the outer edge thereof beyond its elastic limit while the portion of the fin metal adjacent the inner edge thereof, against the tube surface, is compressed, but not beyond its elastic limit. With this procedure, the inner elastically compressed portion of the fin exerts a considerable force on the tube surface and so maintains the fin firmly in place on the tube, this expansive force being exerted between the tube surface and the set outer portion of the fin metal which has been stretched beyond its elastic limit and so maintains the coiled formation of the fin in spite of the expansive force.

The helical fin may be precoiled before attachment to the tube or the coiling and attachment of the fin may be effected in a single continuous operation. Also, the surface protrusions or knurl marks may be formed on the tube before or simultaneously with the winding operation.

The invention will be best understood by reference to the accompanying drawings in which certain embodiments thereof have been illustrated. In the drawings;

Fig. 1 is an elevation of a section of knurled tubing to which a portion of a precoiled helical fin has been attached in accordance with the invention;

Fig. 2 is a perspective view of a tube showing one method of forming surface protrusions or knurl marks thereon;

Fig. 3 is an end elevation of a finned tube in the course of construction in accordance with one embodiment of the invention;

Fig. 4 is a sectional view, taken along the line 4—4 of Fig. 3 and viewed in the direction of the arrows;

Fig. 5 is a sectional view, taken along the line

5—5 of Fig. 3 and viewed in the direction of the arrows; and

Fig. 6 is an end elevation of a finned tube in the course of construction in accordance with another embodiment of the invention.

In a preferred embodiment of the invention, as best shown in Figs. 3 and 4, a metallic tube 5 is simultaneously provided with external longitudinally extending protrusions or knurl marks 6 and a precoiled metallic fin or ribbon 7 is attached thereto. Various means may be provided for effecting these operations. In the disclosed embodiment, the tube 5 is continuously rotated axially on a lathe or other suitable device and a ribbon lead and tension roll 8 and a knurling roll 9 are slowly moved in unison axially along the tube in the direction indicated by the arrows in Figs. 4 and 5.

In order that the tube may be carried in the desired position with regard to the rolls 8 and 9 a tube supported roll 19 is provided and the rolls 8, 9 and 19 are preferably spaced about the tube 5 at angles of substantially 120° C., as shown in Fig. 3. The roll 9 may be journaled in a block 20, slidably supported in a frame 21 and the rolls 9 and 19 may be journaled in similar blocks 22 and 23 slidably supported in the frame 24. The roll-carrying blocks 20, 22 and 23 may be respectively movable by screw means indicated at 25, 26 and 27 to facilitate the insertion of the tube 5 between the rolls. The frames 21 and 24 may be moved in unison along the tube by any suitable means. A fin guide 28 is preferably provided, and as shown, may be fixed to the frame 24. The end of the guide 28 is disposed adjacent the tube 5 between the knurling roll 9 and the lead and tension roll 8, and embraces the fin 7 in a slot 29.

The lead and tension roll 8 is preferably constructed to provide a peripheral groove 13 for the reception of the fin 7, at least a portion of this peripheral groove being disposed at an angle to the normal plane of the fin. As best shown in Fig. 4, this may be accomplished by forming the roll 8 in two parts 31 and 32 having parallel complementary frusto conical end surfaces. These surfaces are sufficiently separated to accommodate the fin 7 therebetween, but the angular disposition of the fin groove results in a firm frictional engagement between the fin 7 and the roll 8 whereby the inner edge of the fin is tightly pressed on the tube surface and the fin is maintained under sufficient tension to ensure tight winding on the tube.

The tube supporting roll 19 may comprise two spaced parts forming a peripheral groove 33 therebetween, as shown in Fig. 5. The groove 33 in this roll merely acts to accommodate the fin 7 so that the peripheral surfaces of the roll may engage and support the tube 5.

The knurling roll 9 is provided on its peripheral surface with a plurality of teeth or serrations 14 which extend substantially at right angles to the plane of rotation of this roll. The roll 9 is firmly pressed against the surface of the tube 5 and thus, as the tube rotates, forms surface protrusions or knurl marks 6 on the tube. The knurl marks or protrusions 6 are generally ridge-like in character and extend in a direction generally longitudinally of the tube. The knurling roll 9 is preferably of sufficient width so that in its movement along the tube 5, it forms knurl marks or protrusions along substantially the entire surface of the tube, although it is sufficient for the pur-

poses of the invention that the knurl marks cover the path of the fin 7.

As shown in Figs. 1, 3, 4 and 5, the fin 7 used may be preformed to a coil having an inner diameter slightly greater than the outer diameter of the tube 5. This precoiling of the fin may be accomplished in any suitable manner, as for example, by the means disclosed in my copending application, Serial No. 403,193, filed October 29, 1929. With the precoiled fin in place on the tube 5, and the fin 7 inserted in the peripheral groove 13 of the lead roll 8, the groove 33 of the tube supporting roll 19 and the slot 29 of the guide 28, the fin attaching operation is initiated by rotating the tube 5 and simultaneously advancing the rolls 8, 9 and 19 along the tube. The knurling roll 9 first engages the tube surface and forms the knurl marks or surface protrusions 6 thereon, and as the rotation of the tube continues, the lead roll 8 tightly winds the fin 7 on the previously knurled tube surface and presses the inner edge of the fin against this surface with sufficient force to cause the protrusions or knurl marks 6 to embed themselves in the inner edge of the fin 7. This penetration of the surface protrusions or knurl marks 6 into the fin edge prevents the slipping of the fin 7 around the tube 5 and so maintains the fin tightly wound on the tube. The tight winding of the fin 7 and the explained penetration of the protrusions into the fin edge prevents movement of the fin longitudinally along the tube.

The bending of the outer edge of the fin 7 as it passes through the angularly disposed groove 13 of the lead and tension roll 8 serves not only to maintain the fin under tension during winding and press the fin edge against the knurl marks 6, but also acts to stretch the portion of the fin metal adjacent its outer edge beyond the elastic limit of this metal thereby setting the fin in its curved or wound position, while the inner portions of the fin are elastically compressed to an extent short of the elastic limit of the fin metal. The wound fin, after being subjected to this treatment, is permanently and tightly fixed to the tube, since the elastically compressed inner portion thereof tends to expand between the set outer portion and the tube surface. This stretching of the outer fin metal beyond its elastic limit and an elastic compression of the inner fin metal during winding may be accomplished in other ways and in some cases, the relation between the fin width and the diameter to which it is bent in coiling it on the tube may be so chosen as to accomplish the desired result. The present invention embraces this method as well as that first described above.

It will be apparent that the improved finned tube of the invention may be formed by methods varying in some respects from that described above. Thus, the longitudinally extending protrusions or knurl marks 6 may be formed on the tube 5 before the fin winding operation is effected. As shown in Fig. 2, the smooth metallic tube 5 may be drawn through the opening in a die having tooth or serration forming grooves 16 on the inner surface thereof. These grooves 16 form longitudinally extending ridge-like protrusions or knurl marks 6' on the tube surface, similar to the protrusions or knurl marks 6 formed by the knurling roll 9 of Figs. 3, 4 and 5.

After the protrusions or knurl marks 6' have been formed by the die 15, the precoiled fin 7 may be attached to the tube 5 by tightly winding the fin about the tube and pressing the inner

edge of the fin against the protrusions 6' so that these protrusions bite into the fin edge. This operation may be effected in the manner described above in connection with Figs. 3, 4 and 5, a lead and tension roll, similar to the roll 8, being employed for this purpose. The application of the fin 7 to a tube 5 having previously formed surface protrusions or knurl marks 6' thereon is shown in Fig. 1.

10 If desired, the fin may be simultaneously coiled and wound on the tube, and apparatus for accomplishing this has been diagrammatically illustrated in Fig. 6. In this embodiment, the tube 5 is rotated in the direction indicated by the 15 arrow between a lead and tension roll 8', a knurling roll 9' and a tube supporting roll 19', carried by frames 21' and 24' which move longitudinally along the tube 5 as the winding operation progresses. The rolls 8', 9' and 19' and the 20 blocks and frames carrying these rolls may be identical with the correspondingly designated parts of the winding apparatus of Figs. 3, 4 and 5 described above, and this construction is clearly shown in Fig. 6. The frame 24' carries a ribbon 23 guide block 17 having an aperture therein for the reception of the fin or ribbon 7'. As shown in the drawings, the ribbon carrying aperture in the block 17 guides the fin ribbon 7' in a tangential direction with respect to the tube 5. The lead 30 and tension roll 8' frictionally engages the ribbon 7' passing through the angularly disposed peripheral groove therein and puts the proper tension on the ribbon so that it will be adequately taut as it approaches the tube 5.

35 In operation, the tube 5 is rotated as indicated, the knurling roll 9' forms a plurality of knurl marks or surface protrusions extending substantially longitudinally of the tube and thereafter the fin ribbon 7' is tightly wound and pressed 40 edgewise against the tube surface whereby the protrusions or knurl marks on the tube penetrate the inner edge of the fin and prevent subsequent movement of the fin on the tube. The outer portion of the fin metal is at the same time 45 stretched beyond its elastic limit in the angular groove of the lead and tension roll 8', and the inner portion of the fin metal is elastically compressed between the set outer fin metal and the tube surface thereby ensuring a permanently 50 tight assembly.

From the description given, it will be apparent that my improved method economically produces a highly efficient finned tube. The intimate contact between the fin edge and the tube surface 55 caused by the tight winding and elastic compression of the fin produces an efficient heat conductive joint without the use of solder and without any weakening of the tube structure. The penetration of the ridge-like protrusions on the tube into the inner edge of the fin permanently 60 maintains the fin in its tightly wound position.

For the reasons given above, it is usually preferred to stretch the outer portion of the fin metal beyond its elastic limit while the inner portion of the fin metal is compressed to a degree short of its elastic limit to obtain the described resilient binding action, but this resilient winding is not essential in certain embodiments of the invention. When the resilient winding method of securing 70 the fin to the tube is employed, the knurling of the tube surface prior to the application of the fin may in certain cases be dispensed with, although it is generally preferred to attach the fin either by the knurling method alone or by a combination of knurling the tube surface and resiliently 75

compressing the inner portion of the tube metal.

In the appended claims, the terms "protrusions" and "knurl marks" are used to denote any form of surface irregularities which produce extensions capable of at least partially embedding themselves into the edge surface of the fin. 5

I claim:

1. The method of securing a metallic helical fin to a metallic tube which comprises roughening the outer surface of the tube to produce surface protrusions thereon and tightly winding a fin helically on the roughened surface of the tube. 10

2. The method of securing a metallic helical fin to a metallic tube which comprises forming a plurality of elongated surface protrusions extending substantially longitudinally of the tube and helically winding a fin on the tube over such protrusions with sufficient force to embed the protrusions into the inner edge of the fin and so 20 prevent the uncoiling of the fin.

3. The method of securing a metallic helical fin to a metallic tube which comprises knurling the outer surface of the tube, tightly winding a fin helically on the tube with the inner edge of the fin in continuous engagement with the knurled tube surface and simultaneously pressing the inner edge of the fin against the tube with sufficient force to cause penetration of the knurl marks on the tube into the inner edge of the fin. 25 30

4. The method of securing a metallic helical fin to a metallic tube which comprises forming on the tube surface a peripherally continuous succession of knurl marks presenting ridge-like protrusions extending substantially longitudinally of the tube, tightly winding a fin edgewise on the tube over such protrusions and simultaneously pressing the inner edge of the fin against the tube surface with sufficient force to cause penetration of the tube surface protrusions into the inner 40 edge of the fin.

5. The method of securing a metallic helical fin to a metallic tube which comprises passing the tube through a precoiled helical fin, progressively knurling the tube surface helically and pressing the inner edge of the fin against such knurled tube surface with sufficient force to cause penetration of the tube surface knurl marks into the inner edge surface of the fin. 45 50

6. The method of securing a metallic helical fin to a metallic tube which comprises forming a plurality of longitudinally extending ridge-like protrusions on a tube, passing the tube through a precoiled helical fin and progressively pressing the inner edge of the fin against the tube surface with sufficient force to cause penetration of the tube surface protrusions into the inner edge of the fin. 55 60

7. The method of securing a helical fin to a tube which comprises roughening the surface of the tube to produce protrusions thereon, tightly winding a metallic fin edgewise on the roughened surface of the tube and stretching the fin metal adjacent the outer edge of the fin beyond its elastic limit and compressing the fin metal adjacent the inner edge of the fin, against the tube surface, to a degree short of its elastic limit, whereby the elastically compressed portion of the fin, acting between the stretched and set outer portion of the fin and the tube surface, maintains a firm grip on the tube and tightly secures the fin thereto, the fin being wound on the tube with sufficient force to cause penetration of the tube surface protrusions into the inner edge of the fin. 70 75

8. The method of securing a metallic helical

fin to a metallic tube which comprises roughen-
ing the outer surface of the tube to produce sur-
face protrusions thereon, winding a fin helically
on the roughened tube surface and maintaining
5 the fin under sufficient tension during the wind-
ing operation to embed the tube protrusions into
the inner edge of the fin.

9. The method of securing a metallic helical
fin to a metallic tube which comprises forming on
10 the tube surface a peripherally continuous suc-

cession of knurl marks presenting ridge-like pro-
trusions extending substantially longitudinally of
the tube, winding a fin edgewise on the tube over
such protrusions and simultaneously maintain-
ing the fin under tension and impressing the
inner edge of the fin against the tube surface
to cause penetration of the tube surface pro-
trusions into the inner edge of the fin. 5

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