Sept. 19, 1961 R. J. GARLAND 3,000,084

APPARATUS AND METHOD FOR FABRICATING FINNED TUBING

Filed March 27, 1957 2 Sheets-Sheet 1

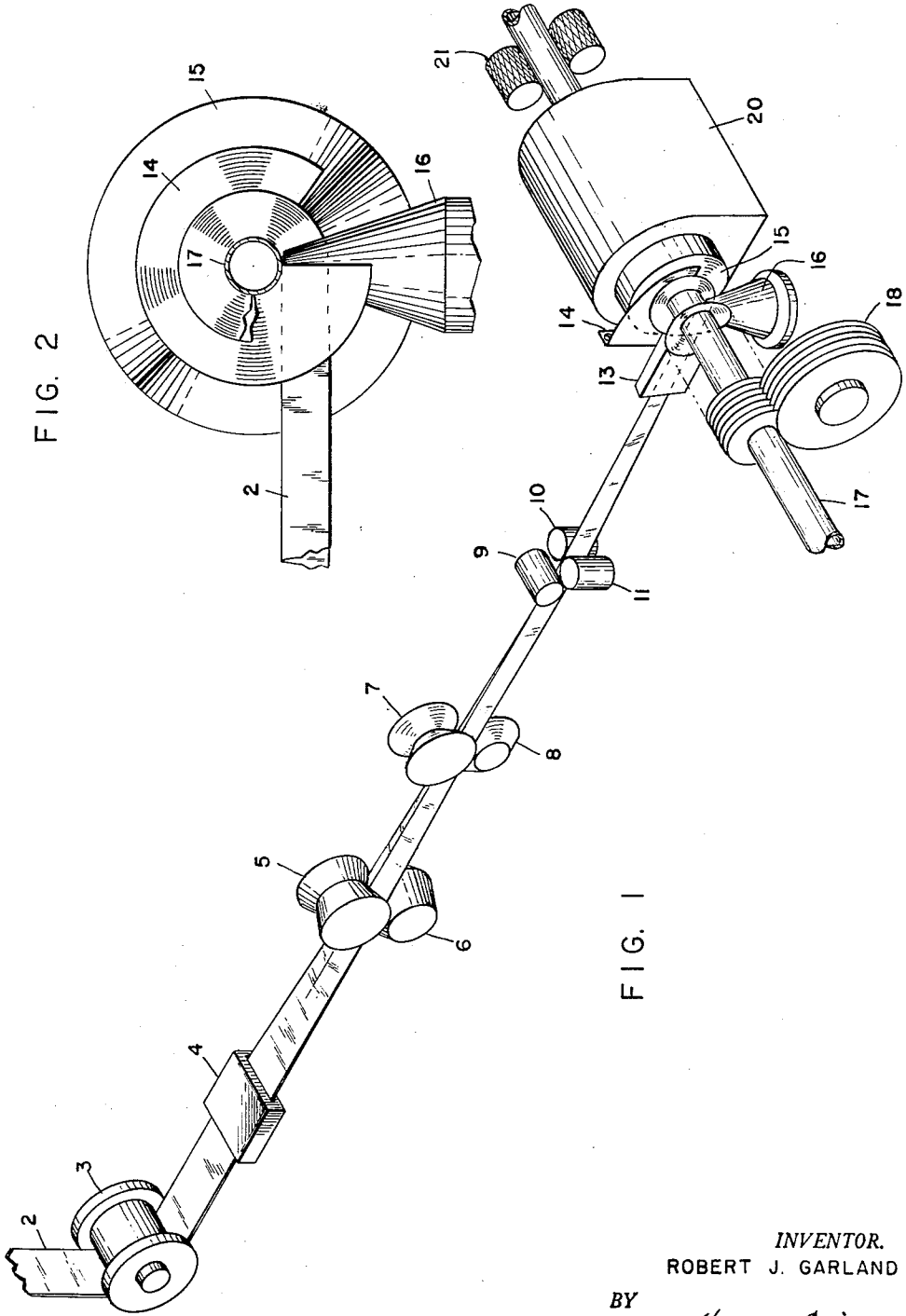


FIG. 2

FIG. 1

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FIG. 3

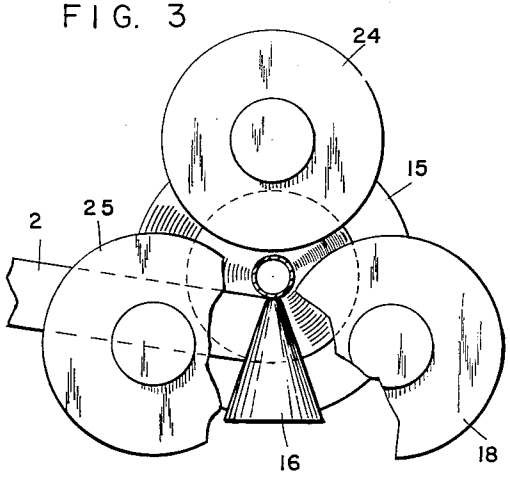


FIG. 4

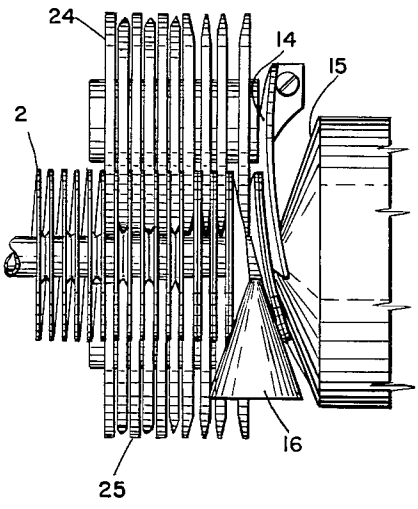
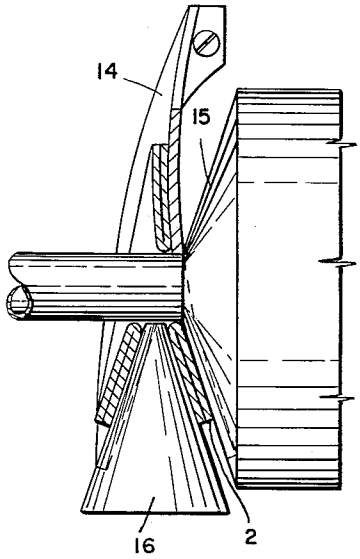


FIG. 5



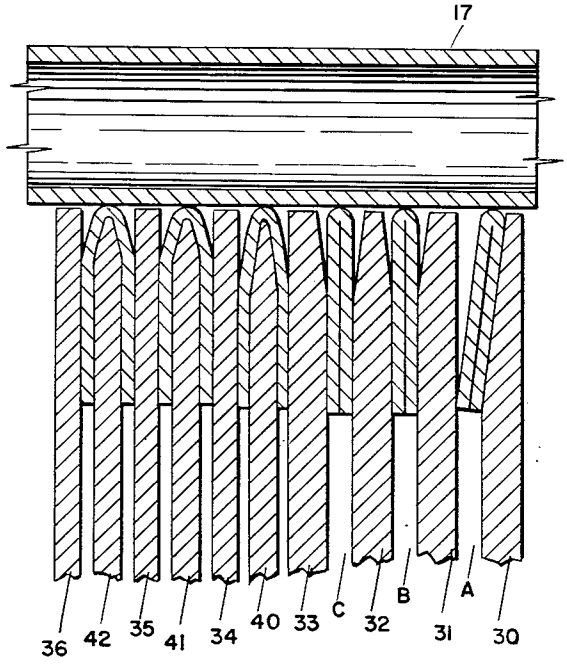


FIG. 6

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United States Patent Office 3,000,084 Patented Sept. 19, 1961

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APPARATUS AND METHOD FOR FABRICATING FINNED TUBING

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Filed Mar. 27, 1957, Ser. No. 648,940
5 Claims. (Cl. 29—157.3)

This invention relates to a finning machine and a method of forming a plurality of helically extending fins about a tube, and more particularly, to a method and machine by which a plurality of fins may be helically wound around a tube and secured thereon in a single operation.

Finned tubing is perhaps the most popular type of heat exchange surface presently being used. Although this type of tubing is relatively inexpensive, a major factor in its low price resides in its production in large quantities. The machines that manufacture finned tubing comprise a substantial investment and yet because of the tremendous amount of this surface that is used, they can easily be rendered obsolete by machines capable of producing similar surfaces at an insignificant fraction of a cent less per length than existing machines.

The present invention is concerned with a method and apparatus for applying a dual fin to a tube without exceeding the complexities of a normal single fin machine. In this manner production of finned tubing may be substantially increased with the capital investment of a single fin machine thereby materially reducing the cost of this type heat exchange surface.

The chief object of the present invention is to provide an apparatus and method for making a more inexpensive finned tube.

An object of the present invention is to provide an apparatus and method for forming a single ribbon dual fin on a tube.

Another object is to provide an apparatus and method for placing a plurality of fins on a tube of a thickness substantially less than presently commercially used.

A further object is to provide an apparatus and method for applying a single ribbon dual fin to a tube by folding a single ribbon of metal to a double thickness, winding the strip so formed on the tube as a single fin and then separating and spacing the portions of the strip into a double fin. Other objects of the invention will be readily perceived from the following description.

This invention relates to a method of winding a dual fin about a rotating and advancing tube in which the steps consist in creasing the center of a ribbon and folding the equal sections of the ribbon on both sides of the crease into face-to-face engagement. The folded ribbon is passed through forming rolls to wind the strip in a helix about the tube with the fold adjacent the tube. The folded ribbon is directed through a series of spacing discs which separate the sections of the ribbon and widen the fold adjacent the tube.

This invention further relates to an apparatus for winding a plurality of fins about a rotating and advancing tube comprising in combination, means for creasing the center of a ribbon, means for folding the equal sections of the ribbon on both sides of the crease into face-to-face engagement. Forming rolls wind the folded ribbon into a helix about the tube with the fold adjacent the tube, and spacing discs separate the sections of the ribbon and widen the fold adjacent the tube.

The attached drawings illustrate a preferred embodiment of the invention, in which—

FIGURE 1 is a diagrammatic view illustrating the finning machine of the present invention;

FIGURE 2 is a view in elevation, taken in a plane normal to the center line of the head of the machine illustrating the winding of the ribbon onto the tube;

FIGURE 3 is a view in elevation similar to FIGURE 2, however, indicating the position of the spacing disc with respect to the tube and ribbon;

FIGURE 4 is a view in elevation illustrating the operation of the guide and spacing rolls;

FIGURE 5 is a view similar to FIGURE 4, however, indicating the guide and ribbon in section thereby illustrating the action of the forming rolls; and

FIGURE 6 is an enlarged sectional view illustrating the action of the spacing discs.

Referring to the drawings, there is shown in FIGURE 1 a ribbon **2**, which originates from a spool of material not shown. The ribbon is fed over the pulley **3** through a slot type guide **4**, which directs the ribbon between the folding rolls **5** and **6**, these folding rolls place a crease longitudinally and substantially in the center of the ribbon **2**. The ribbon is passed from these first folding rolls **5** and **6**, to the second folding rolls **7** and **8**, in which the angle of the initial fold is accentuated. The ribbon is fed from the folding rolls **7** and **8** to the roller guide **9**, which is in engagement with the folded end of the ribbon and is adjacent the rolls **10** and **11**. The rolls **10** and **11** urge the folded sections of the ribbon **2** into face-to-face relationship through the slot guide **13** which passes the folded ribbon to the finning machine proper.

The finning machine proper includes a head **20** which includes a conventional mechanism to rotate the tube **17** while simultaneously advancing the tube. This head may also include suitable rolls such as **21**. These rolls are knurled to roughen the surface of the tube prior to the application of the ribbon thereon. In some heads this roughening function may be performed by the knurled rolls which grip the tube as part of the advancing and rotating mechanism.

This particular head, it will be noted, should be of the type wherein the horizontal forming roll **15**, the vertical forming roll **16** and the rotating and advancing tube mechanism are mechanically connected with suitable slip-clutch means between the advancing mechanism and the rotating mechanism for allowing desirable lost motion therebetween during the finning operation.

Referring to FIGURE 2, the forming rolls **15** and **16** are shown with the folded ribbon **2** being passed under a portion of the guide **14**. This guide **14** defines a surface having a general helical convolution. The forming rolls **15** and **16** grasp the fin and wind it about the tube **17**. After the fin leaves this winding section, it is urged away from the surface of the roll **15** by the guide **14**, which guides the fin in a helical path to the rear of the vertical forming roll **16**, and then to the spacing rolls or discs **18** shown in FIGURE 1.

FIGURE 3 illustrates an end view of the machine looking toward the head. This view shows the location of three sets of spacing discs **18**, **24** and **25**. It will be noted that these discs are located on 120° intervals for the purpose of adequately spacing and supporting the fin during the forming operation which will be more fully described hereinafter.

Referring to FIGURE 4 there is shown a side view of the finning apparatus shown in FIGURE 3. In this view, the ribbon in its folded face-to-face orientation is shown being rolled through the forming rolls **15** and **16**, and then being guided by the contour of the guide **14** to the rear of the forming roll **16**. The fin then enters into the zone wherein are located the various spacing discs. Generally these discs first straighten the double fins, separate the fins and then increase the contact between the fins and the tube.

FIGURE 5 is a view similar to FIGURE 4, however, the fin and guide **14** are shown in section and the view is enlarged. In this particular view, the shape of the fin is clearly indicated, the manner in which it passes through the forming rolls **15** and **16** is shown. The contour of the guide **14** may be better understood from this view and its function more easily appreciated.

FIGURE 6 illustrates an enlarged section of the tube, fins and spacing discs, and further illustrates the progressive forming of the fins by the discs. Discs **30—36** are support discs and discs **40, 41** and **42** are separating discs. The function of the supporting discs is merely to space and maintain the position of the fins whereas the function of the separating discs is to space the two funs comprising the ribbon and to increase the contact between the fold of the ribbon and the tube.

Considering the operation of the present invention, the ribbon **2** is passed over the pulley **3** through the slot guide **4** and through the folding rolls **5** and **6** and **7** and **8**. These rolls form a longitudinal crease in the center of the ribbon and the rolls **10** and **11** urge the leg portions **2'** and **2''** of the ribbon into face-to-face engagement.

The ribbon **2** is then passed into the slot guide **13** which directs the ribbon through the forming rolls **15** and **16**. These forming rolls wind the ribbon **2** onto the tube **17** and the guide **14** directs the ribbon so applied in a general helical path about the tube **17**. The ribbon, at this point, is in substantial mechanical engagement with the tube. Referring to FIGURE 4, the general path of the ribbon is illustrated from the point where it emerges from the forming rolls until it passes from the spacing discs.

Referring to FIGURE 5, this sectional view illustrates the angular disposition of the ribbon after it has been wound on the tube and it is noted that the fin on the rear side of the forming roll **16** is angularly disposed with respect to the tube **17**. In some cases where a high fin is desired, it may be found desirable to have the fin as straight as possible on the pass of the ribbon at the rear of the vertical forming roll **16**. To facilitate this condition the forming roll surfaces and axes orientations may be such that the angle between the axes of the forming rolls is less than 90°. With such a situation the ribbon will be passed to the forming rolls at a considerable angle, however on the rear side of the roll **16** just prior to entrance into the spacing discs, the ribbon may be almost perpendicular to the tube.

Referring to FIGURE 3, it will be noted that the ribbon is passed through three sets of spacing discs. These discs may be motor driven if desired. The number of sets of discs and their configurations may be varied. The number of sets of discs is determined by the amount of support the ribbon and tube require. This is further affected by the size of the separating discs which spread the folded portions of the ribbon. Should the separating step be abrupt, the ribbon will require greater support and more sets of spacing discs are necessary.

FIGURE 6 shows a sectional view of the finning operation ilustrating fully the progressive forming of the fin terminating with the final step wherein the dual fin is urged against the tube in such a manner as to increase the surface contact between the fin and the tube.

The fin passes from the guide **14** into the space A which lies between the support rolls **30** and **31**. In this particular space the fin is at an angle to the surface of the tube **17**. The fin passes through adjoining complimentary discs until it is straightened with respect to the surface of tube **17** and is substantially perpendicular thereto, as shown in the space B between the discs **31** and **32**. This function is continued in space C between discs **32** and **33**. The essential function of these support discs is to confine the movement of the fin.

As the fin passes around the tube **17** the separating disc **40** separates the legs **2'** and **2''** of the ribbon **2**. It will be noted that this action is a progressive one. The sides of the ribbon are constrained by the support discs **33** and **34**. It will be noted that by this action the height of the fin is slightly decreased over the height of the fin in the space C. The separating disc **40** at its periphery has two surfaces at an angle with respect to the side walls of the disc. The peripheral portion of the disc has a slight land. The function of this particular disc is to separate the folded fin into the ultimate double fin construction.

It will be appreciated that in the original forming operation the folded fin was placed in substantial mechanical engagement with the tube **17**. As the fin passes through the various discs, this mechanical engagement and the amount of surface contact between the fin and the tube tends to reach a maximum condition. The fin continues to rotate and advance in accordance to the action of the aforementioned head and enters in the space between the support discs **34** and **35**.

Between these discs there is located the separating disc **41**. This disc is similar to the disc **40**. However, at the periphery of the disc the angle of the tapered surfaces is increased as compared to the angle used on disc **40**. This angle is more abrupt for the purpose of bringing more of the folded area of the fin into surface contact with the tube **17**.

In bringing more surface into contact with the tube **17**, it will be appreciated that this contacting surface area of fin is obtained at the expense of the legs **2'** and **2''**. Therefore, the height of the fin between the support discs **34** and **35** is less than the height of the two previous passes of the fin through the spacing discs. The tube continues to rotate and advance and is finally passed between the spacing discs **35** and **36** which have located therebetween the separating disc **42**. This disc is physically similar to the separating disc **41** of the previous pass. It will be noted that this last separating disc merely emphasizes the fin contour created by the separating disc **41**.

It will be noted that the initial separating disc **40** keeps the legs of the fin in substantial parallelism. However, the fold in the ribbon is given a pronounced V-shape. The subsequent pass of the separating discs modified this V-configuration to a general U-shape. This U-shaped fold increases the amount of surface contact between the tube and the fin which will greatly enhance the heat transfer between the tube and the fin.

In considering FIGURE 1 it will be noted that the knurling rolls **21** are utilized to score or roughen the surface of the tube **17** prior to the finning operation. It will be appreciated that this is an optional step which will greatly increase the surface contact between the fin and the tube. The roughened surface permits the fin to come into more intimate contact with the tube which results in a tighter fin with a better mechanical bond to the tube and with consequent improved heat transfer properties.

In the present invention, due to the fact that the ribbon is applied to the tube in a manner similar to a single fin machine, the total thickness of the folded fin may be of a thickness comparable to that of a normal single fin. Therefore, the ribbon initially supplied may be considerably thinner than the stock used on single fin machines. In this manner a fin is applied much thinner than was physically possible previously which results in a cheaper and lighter heat exchanger.

While I have described a preferred embodiment of the invention it will be understood that the invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. In a method for winding a ribbon about a rotating and advancing tube, the steps which consist in placing a longitudinal crease in a ribbon, folding the legs of the ribbon into face-to-face engagement, winding the folded

ribbon about the tube with the fold adjacent the tube and separating the legs of the folded ribbon from face-to-face contact.

2. In a method for winding a ribbon about a rotating and advancing tube, the steps which consist in placing a longitudinal crease in a ribbon so as to define substantially equal legs, placing the folded legs of the ribbon into face-to-face engagement, winding the folded ribbon about the tube with the fold adjacent the tube, guiding the ribbon on the tube in a substantially helical path, straightening and spacing the ribbon on the tube and separating the legs of the ribbon from face-to-face engagement.

3. The method according to claim 2 further including the step wherein the fold in the ribbon is widened to increase the surface contact between the ribbon and the tube.

4. In a method for winding a ribbon about a tube, the steps which consist in rotating and advancing the tube, roughening the surface of the tube, placing a longitudinal crease in a ribbon substantially defining two equal legs, placing the folded legs of the ribbon into face-to-face engagement, winding the folded ribbon about the tube with the fold adjacent the tube, guiding the ribbon on the tube in a substantially helical path, straightening and spacing the ribbon on the tube, separating the legs of the ribbon from face-to-face engagement and progressively widening the fold in the ribbon to increase the surface contact between the ribbon and the tube while simultaneously decreasing the height of fin so formed on the tube.

5. The method of assembling a continuous helical ribbon about the surface of a tube to form a finned heat transfer element which consists in the steps of folding a ribbon substantially about its longitudinal axis with the folded sections in engagement with one another, feeding the folded ribbon between forming rolls to curl the ribbon about the periphery of a tube with the folded edge engaging the tube, guiding the ribbon about the tube in a helical path, straightening the folded ribbon as it progresses along the tube and separating the folded sections while enlarging the amount of ribbon surface, at the folded edge, in engagement with the tube to strengthen the bond between the tube and the ribbon.

References Cited in the file of this patent

UNITED STATES PATENTS

505,071	Sterling	Sept. 12, 1893
1,689,568	Wade	Oct. 30, 1928
1,992,296	Dewald	Feb. 26, 1935
1,992,297	Dewald	Feb. 26, 1935
2,380,111	Kasten	July 10, 1945
2,416,865	Bronander	Mar. 4, 1947
2,472,245	Busse	June 7, 1949
2,532,239	Newlin	Nov. 28, 1950
2,669,012	Bruegger	Feb. 16, 1954
2,779,383	Johnson	Jan. 29, 1957
2,800,944	Schmeling	July 30, 1957

FOREIGN PATENTS

302,605	Germany	Sept. 17, 1916
52,466	Sweden	Feb. 17, 1919
226,175	Great Britain	July 2, 1925