Nov. 28, 1950 J. S. NEWLIN 2,532,239

FINNED TUBE WINDING MACHINE

Filed July 23, 1948 5 Sheets-Sheet 1

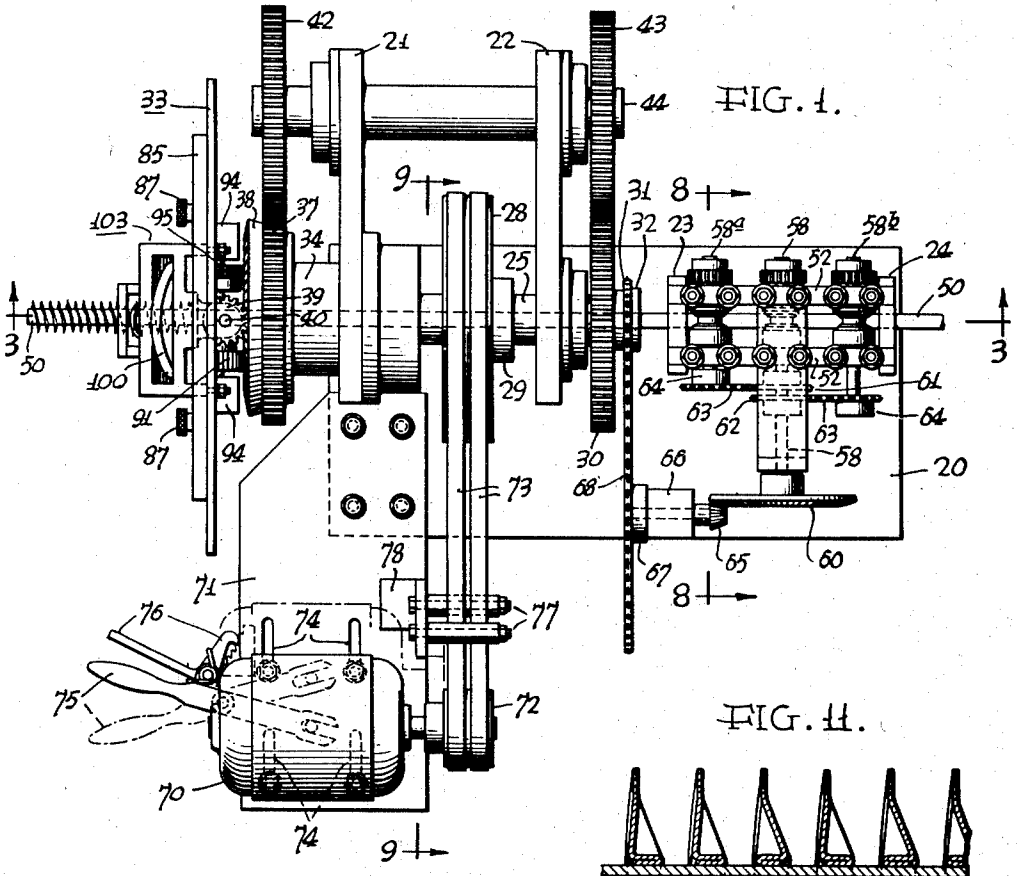


FIG. 1.

FIG. 11.

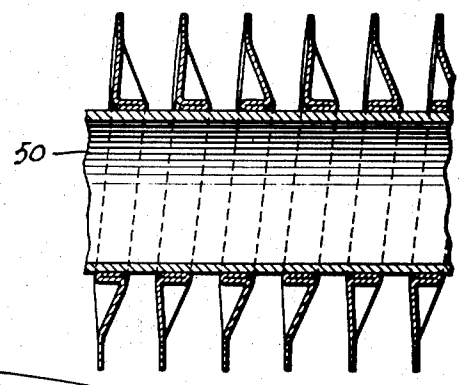


FIG. 13.



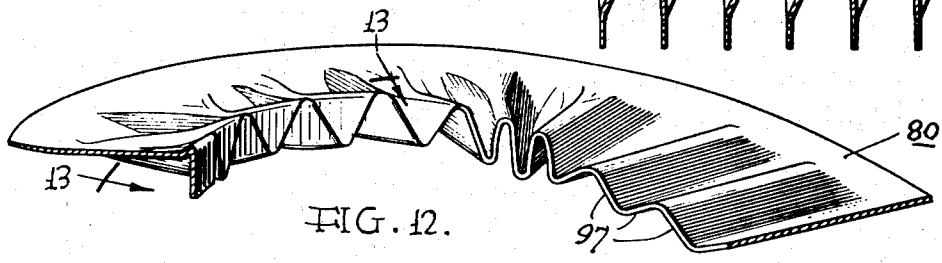


FIG. 12.

Inventor:
J. Shipley Newlin
by his Attorneys
Howson & Howson

Nov. 28, 1950 J. S. NEWLIN 2,532,239

FINNED TUBE WINDING MACHINE

Filed July 23, 1948 5 Sheets-Sheet 2

FIG. 2.

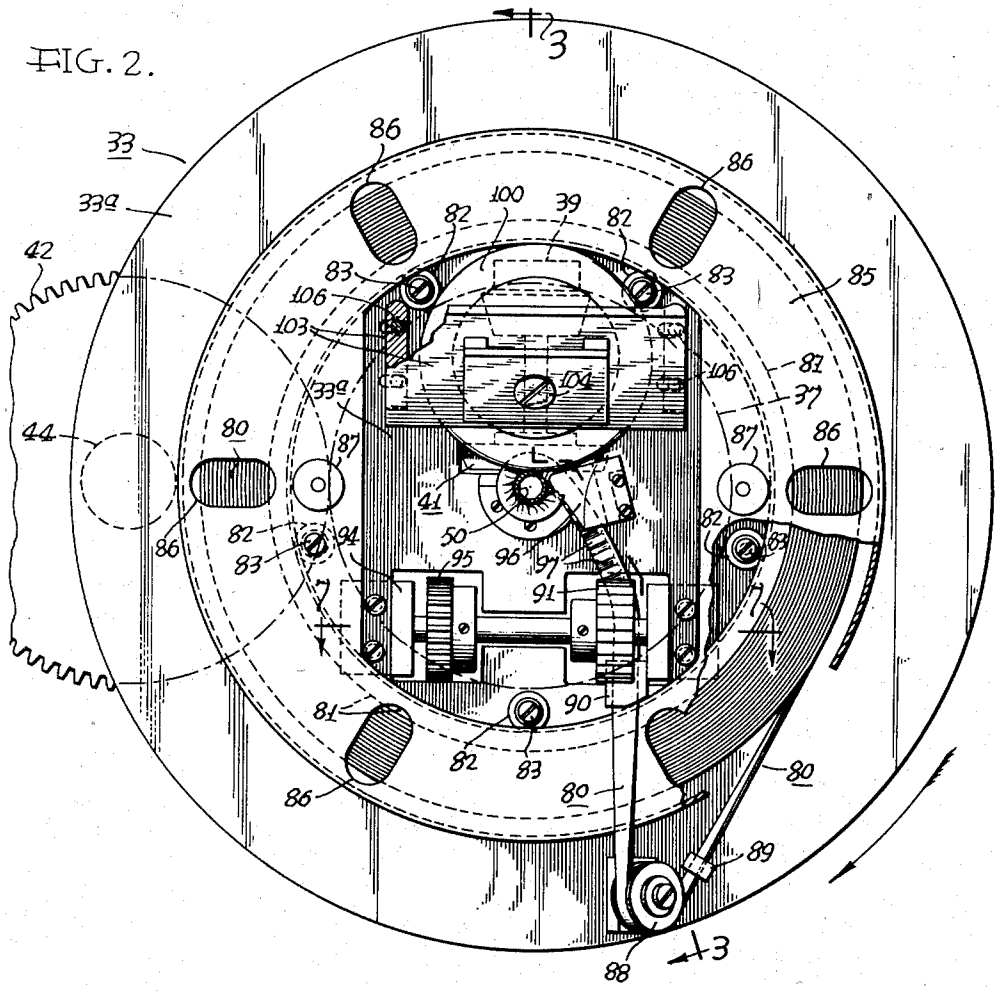
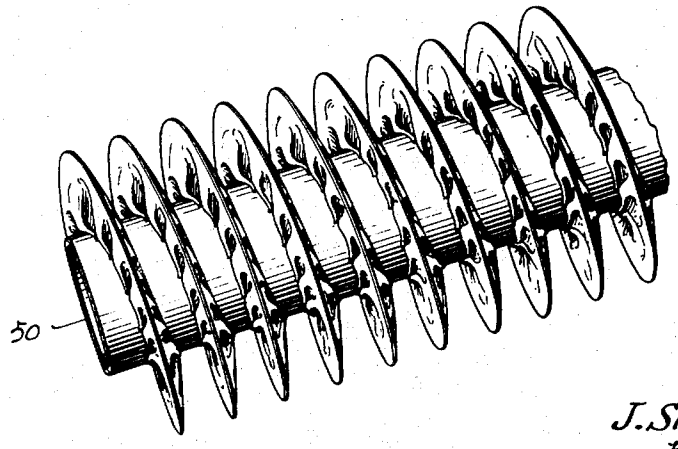


FIG. 10.



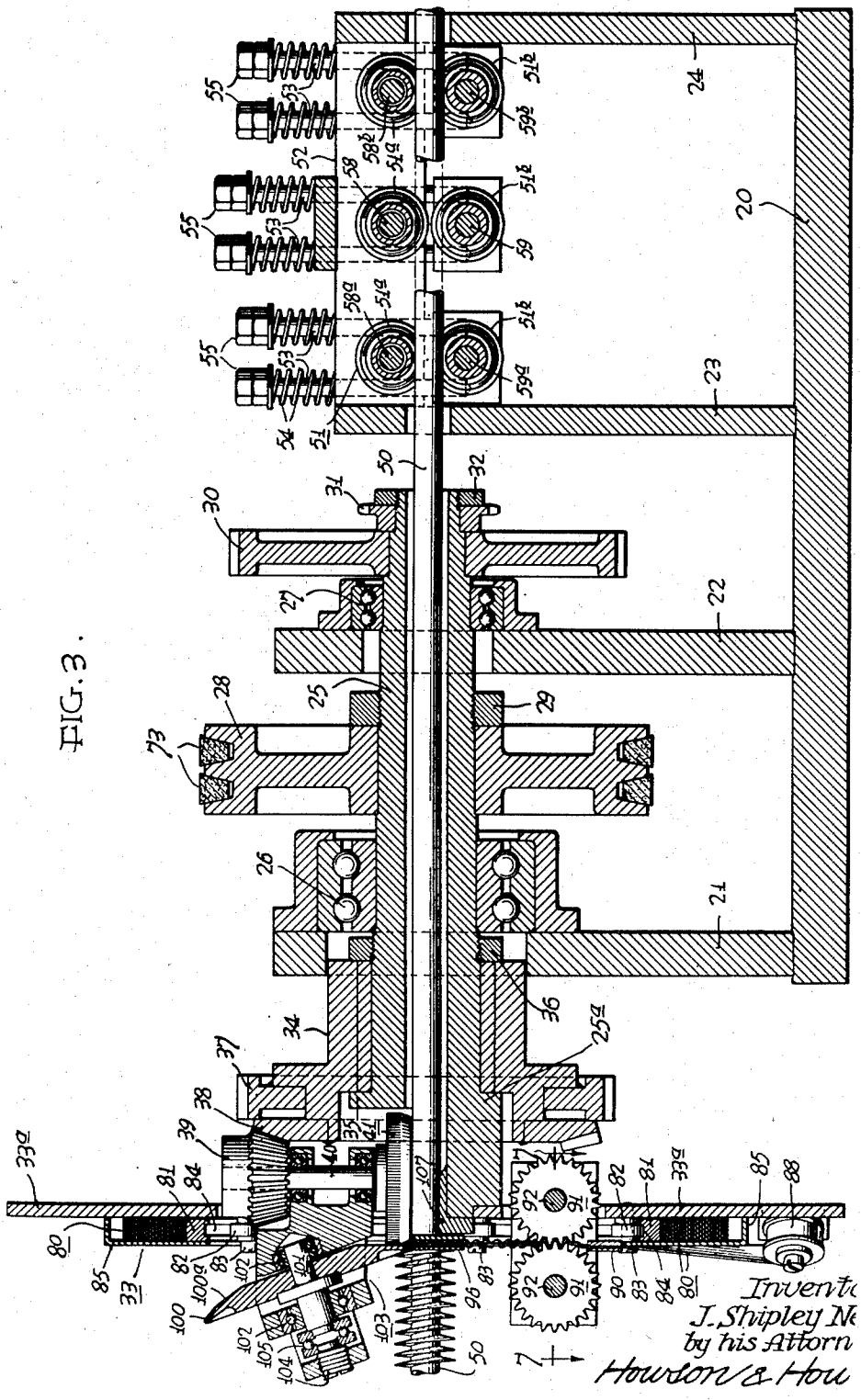
Inventor:
J. Shipley Newlin
by his Attorneys
Howson & Howson

Nov. 28, 1950 J. S. NEWLIN 2,532,239

FINNED TUBE WINDING MACHINE

Filed July 23, 1948 5 Sheets-Sheet 3

FIG. 3.



Nov. 28, 1950 J. S. NEWLIN 2,532,239

FINNED TUBE WINDING MACHINE

Filed July 23, 1948 5 Sheets-Sheet 4

FIG. 4.

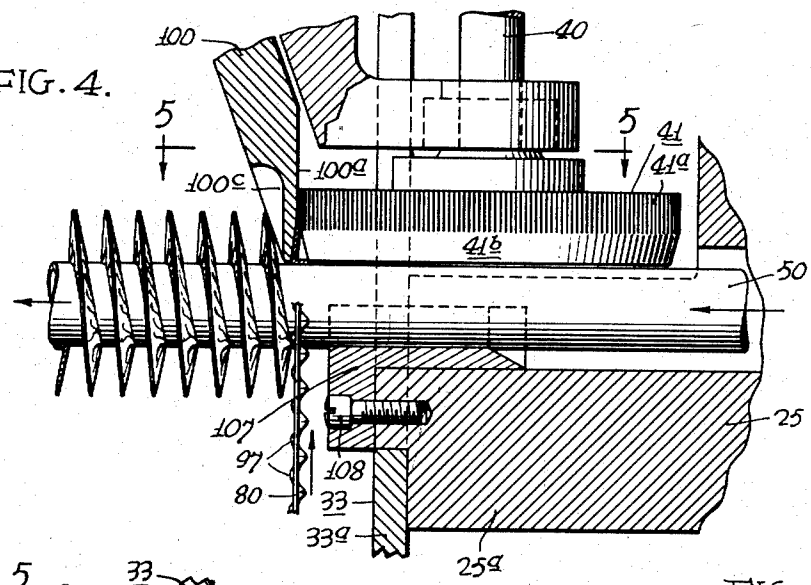


FIG. 5

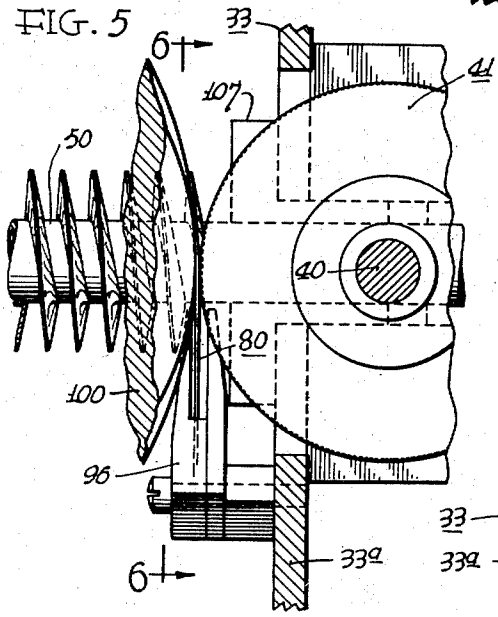


FIG. 6.

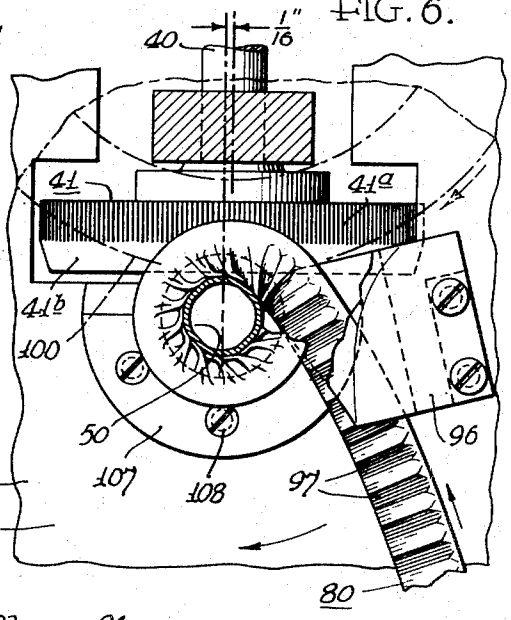
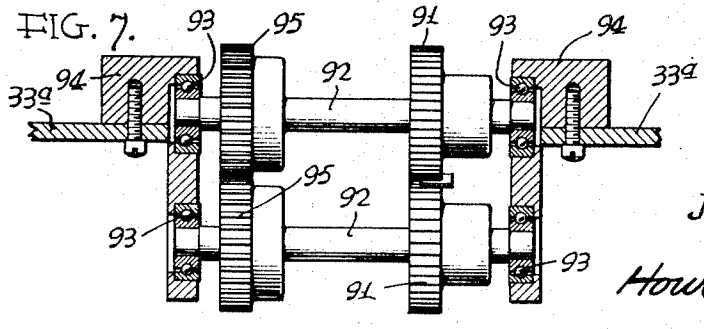


FIG. 7.



Inventor:
J. Shipley Newlin
by his Attorneys
Howson & Howson

Nov. 28, 1950 J. S. NEWLIN 2,532,239

FINNED TUBE WINDING MACHINE

Filed July 23, 1948 5 Sheets-Sheet 5

FIG. 8.

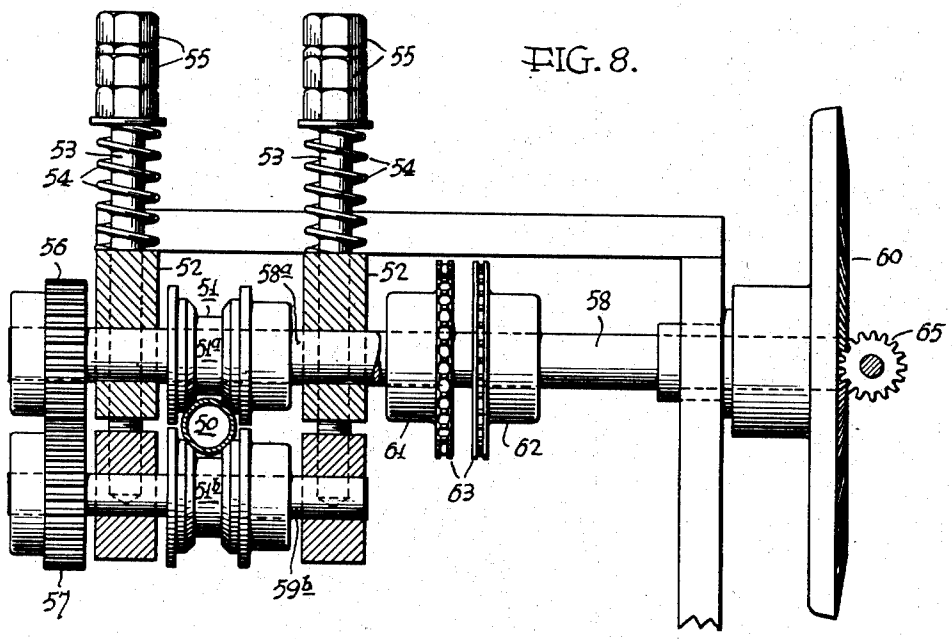
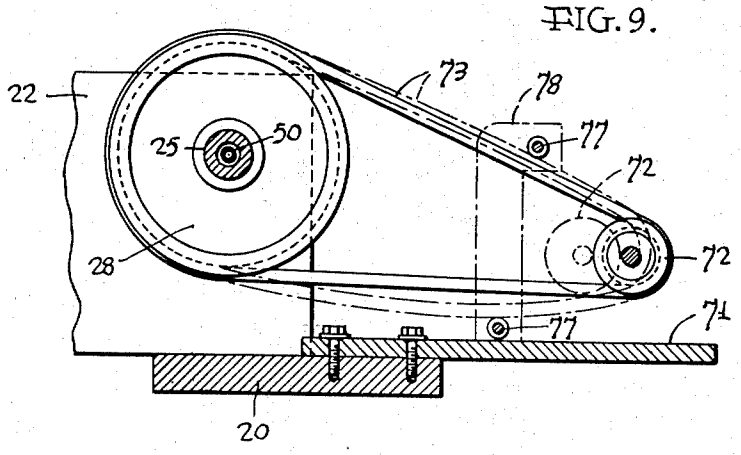


FIG. 9.



Inventor:
J. Shipley Newlin
by his Attorney.
Howson & Howson

Patented Nov. 28, 1950

2,532,239

UNITED STATES PATENT OFFICE

2,532,239

FINNED TUBE WINDING MACHINE

John Shipley Newlin, Paoli, Pa., assignor to Merchant & Evans Company, Philadelphia, Pa., a corporation of Pennsylvania

Application July 23, 1948, Serial No. 40,389

3 Claims. (Cl. 153—64.5)

1

This invention relates to a machine for fabricating finned tubing of the type commonly used for heat exchangers. The invention includes an improved finned tube construction as well as the machine for fabricating same.

Although the prior art contains many forms of finned tubing in which a length of tubing is helically wound with a strip of heat-radiating material, many of these devices have contained inherent objections. In the first place, the conventional winding machine is complicated and expensive; the rate at which the machine could wind tubing has been relatively slow; the heat transfer, which in turn depends upon the surface of the fin, has been inefficient; and the product has been unable to withstand hard usage.

A primary object therefore of the invention, is to provide a simple, inexpensive winding machine for finned tubing which is extremely easy to operate and adjust.

Another object of the invention is to provide an article of manufacture characterized by a fluted fin, the fin being smooth around its outer periphery and having feet at the base of the formed leg pressing the flutes into tight overlapping relationship to extend from either side of the fin, thereby providing maximum heat transfer surface, extreme fin rigidity, and excellent conductivity between the tube and the fin.

Further objects will be apparent from the specification and drawings in which:

Fig. 1 is a plan of the entire fin winding machine;

Fig. 2 is an enlarged front elevation of the winding head;

Fig. 3 is an enlarged longitudinal sectional view as seen at 3—3 of Figs. 1 and 2;

Fig. 4 is an enlarged sectional detail showing the pressure rolls and a portion of the winding head;

Fig. 5 is a sectional detail as seen at 5—5 of Fig. 4;

Fig. 6 is a sectional detail as seen at 6—6 of Fig. 5;

Fig. 7 is an enlarged sectional detail of the crimping rolls as seen at 7—7 of Fig. 3;

Fig. 8 is an enlarged sectional detail as seen at 8—8 of Fig. 1;

Fig. 9 is an enlarged sectional detail of the belt-drive as seen at 9—9 of Fig. 1;

Fig. 10 is a perspective of a length of finned tubing as wound on the machine;

Fig. 11 is a longitudinal section of the finished product of Fig. 10;

Fig. 12 is an enlarged perspective of the fin as it is being wound on the tubing; and

2

Fig. 13 is a section as seen along the line 13—13 of Fig. 12.

The winding machine is of the rotating head type having a central sleeve which acts as a guide for the tubing and also journals the gears for driving one of the pressure rolls. The tubing is fed axially through the sleeve by means of a series of feed rolls geared to the sleeve. The feed rolls not only control the rate at which the tubing is fed through the sleeve, but also serve to form a series of axial flats or grooves in the tubing, the function of which is of importance in the finished product. A supply of strip material is carried on the winding head by means of an annular support mounted on rollers, and is fed through a pair of crimping wheels also on the head. A beveled pressure roll or disc is mounted on the head and is adapted to cooperate with a backing pressure roll also journaled on the head but independently driven. The first roll is axially adjustable and driven only by friction. Both of the rollers may be tangentially adjusted in the head with respect to the periphery of the tube. For purposes of clarity, the floating pressure roll will be referred to as the pressure disc and the driven roll as the backing roll; nevertheless it will be understood that both rolls exert pressure adjacent each other through the fin.

The axis of the pressure disc is set at the angle of about 20° to the axis of the tube; whereas the axis of the backing roll is perpendicular but slightly offset to the axis of the tube. The disc and pressure rolls may be adjusted with respect to each other and they are both mounted in a bracket which is adjustable with respect to the head. This range of adjustability enables any desired effect to be produced in the fin and also permits the machine to wind fins of different materials.

The drive for the winding machine is from an electric motor through a pair of V-belts, and the engaging device permits gradual starting to avoid rupture of the strip. The winding head is driven through back gears from the main shaft and the feed rolls are also driven from the main shaft through a pair of sprockets and suitable bevel gears.

The machine is especially designed to apply a relatively soft, ductile material such as copper or copper alloy, although other materials may be employed equally well by making suitable adjustments. The crimpers form a wavy edge on the strip, the waves being of relatively low amplitude. The outer edge of the strip is securely gripped between the pressure disc and the backing roll and wiped around the periphery of the tubing as it

advances through the head. This wiping action not only flattens the waves radially against each other but also serves to bend the base of the waves around the periphery of the tubing to form a thickened foot portion for the fin on either side of the fin. The axial flats in the tubing formed by the feed rollers act as keys to prevent unwinding of the fin and it has been found unnecessary to attach the fin to the tubing in any way other than the pressure produced by the winding head.

Referring now more particularly to the drawings, the winding machine is supported on a bench or table 20 by means of upright brackets 21, 22, 23 and 24. Brackets 23 and 24 support the feed roll assembly, whereas brackets 21 and 22 journal the winding head and driving mechanism. A hollow shaft or spindle 25 is journaled in annular ball bearings 26 and 27, mounted in posts 21 and 22 respectively (Fig. 3). A driven pulley 28 is keyed to spindle 25 and positioned thereon between posts 21 and 22. Lock nut 29 retains pulley 28 on spindle 25. One end of the spindle carries a spur gear 30 and a small sprocket 31, both of which are retained on the spindle by means of lock nut 32. The opposite end of spindle 25 carries integrally therewith the winding head assembly 33 which comprises a plate 33*a* mounted on the enlarged hub portion 25*a* of spindle 25. A hub member 34 is independently journaled on spindle 25 between head 33 and post 21. This hub is free to rotate on the spindle but is axially retained thereon by means of flange 35 and lock nut 36. Hub 34 carries a spur gear 37, and a bevel gear 38 which engages bevel gear 39 on the backing roll shaft 40 so that the drive for backing roll 41 can be varied independently of spindle 25 through back gears 42 and 43 (Fig. 1) mounted on countershaft 44 which is in turn journaled in posts 21 and 22. Gear 43 meshes with gear 30 on the spindle so that the revolutions of hub 34 and shaft 40 are controlled by the ratios of gears 30, 43 and 37, 42.

The tubing 50 moves axially and non-rotatably through the bore of spindle 25 in controlled relation to the rotational speed of winding head 33 and backing roll 41. A series of pressurized feed rolls 51 in alignment with the bore of spindle 25 are mounted on longitudinally extending brackets 52, 52 supported on posts 23 and 24. The feed roll assembly in the preferred form comprises three sets of rolls, each set having an upper grooved roll 51*a* and a lower complementary feed roll 51*b*. The lower rolls 51*b* are resiliently suspended from brackets 52 by means of studs 53 loosely fitting in brackets 52 and supported on the top of brackets 52 by helical springs 54 and lock nuts 55. Suitable adjustment of nuts 55 enables the desired pressure to be provided on the tubing as it passes between the rolls. In practice however, it has been found that the movement of the upper and lower rolls with respect to each other is extremely limited for any given size of tubing, so that each lower roll 51*b* may be driven by means of spur gears 56 and 57 mounted respectively on upper roll shafts 58, 58*a*, 58*b*, and lower roll shafts 59, 59*a*, 59*b* (Fig. 3). The shape of the rolls themselves is such that the contact area with the tubing is limited to four diametrically opposite areas on the rolls, so that four continuous axial flats or grooves on the tubing are formed as it feeds through the rolls. The middle roll shaft 58 is extended to carry a bevel gear 60 and a pair of sprockets 61 and 62. Roll shafts 58*a* and 58*b* are driven by chains 63, 63 connecting driven sprockets 64, 64 on roll shafts 58*a*, 58*b* and sprockets 61, 62 on shaft 58. Bevel gear 60 is driven in timed relation with spindle 25 through pinion gear 65 journaled in posts 66 and carrying at its opposite end a sprocket 67 connected to spindle sprocket 31 by means of chain 68. It will thus be apparent that various lengths of tubing 50 are fed into the first pair of feed rolls whereupon the tube is axially moved through the succeeding pairs of rolls into the bore of spindle 25 until the tube projects through the winding head 33.

Driving means both for the spindle and the feed rolls is from an electric motor 70 slidably mounted on plate 71 and having a pulley 72 in alignment with pulley 28, both pulleys carrying belts 73, 73. Since it is important that the winding head and spindle be brought up to speed slowly, motor 70 is slidably mounted on plate 71 by means of slots 74, 74. A lever 75 pivoted to plate 71 and having a spring loaded pawl 76 serves to move motor 70 in slots 74, thereby loosening and tightening belts 73. The advantage of this construction lies in the fact that the motor switch may be closed without starting the winding head or spindle when motor 70 is in the loosened position as shown in broken lines in Figs. 1 and 9. In this position, belts 73, 73 are held completely out of contact with pulley 72 by means of spaced arms 77, 77 horizontally mounted on bracket 78. As lever 75 is moved upwardly in Fig. 1, pulley 72 gradually engages belt 73 to start the winding machine smoothly. When the winding head and feed rolls have been brought up to speed so that no slippage occurs in the belts, motor 70 is locked in a tightened position by means of pawl and ratchet 76. It will be understood that the slipping belt mechanism is merely illustrative of any device for gradually bringing the winding head up to speed. Other well known means of accomplishing this effect may be incorporated, such as a slipping clutch or a fluid coupling.

Referring now to Figs. 2–7, the winding head assembly is adapted to receive a coil of flat ductile strip material 80 which is stored on an annular carrier 81 rotatably mounted on head plate 33*a* by means of rollers 82 supported on the head by cap screws 83 and adapted to fit in an internal groove 84 in the carrier 81. The coil of strip material 80 is retained axially on carrier 81 by means of a retaining cover plate 85 having inspection holes 86, 86 and secured to head plate 33*a* by means of thumb nuts 87, 87. A flanged pulley 88 is mounted near the periphery of plate 33*a*, the axis of the pulley being mounted at approximately 45° to the plate so that the strip feeds from the supply coil through a fixed guide 89 over pulley 88 and into a second fixed guide 90 which changes the position of strip 80 so that instead of the flat portion of the strip being parallel to the axis of the machine, it is now at right angles thereto. From guide 90, the strip feeds between a pair of crimpers 91, 91 which are keyed to shafts 92, 92 mounted in bearings 93, 93 and brackets 94, 94 on plate 33*a* (Fig. 7). The opposite ends of shafts 92 carry a pair of spur gears 95, 95 so that the teeth of the crimpers are constantly in meshed relation. Guide 90 feeds the strip 80 through the crimpers so that from ½ to ¾ of the surface of the strip is crimped as shown clearly in Figs. 2 and 7. From the crimpers the strip passes through a bifurcated guide block 96, the forks of which are spaced sufficiently far apart to accommodate the partially formed crimps 97 in strip 80. Guide block 96 terminates

near the periphery of tube 50 at a point in radial alignment with the edge of backing roll 41.

The pressure disc 100 is keyed to shaft 101 and journaled in annular ball bearings 102, 102 which in turn are supported in a housing 103.

The shape of pressure disc 100 is of especial importance in forming the desired properties of the fin. Referring to Figs. 3 and 4, it will be seen that the disc is mounted in bracket 103 at an angle to the horizontal center line of the tubing. The cross section of the disc is of generally frusto-conical shape but the conical surface is of dual nature in that a substantially long portion 100a is positioned at right angles to the center of the tube and is adapted to be maintained in spaced relation to the serrated upper portion 41a of backing roll 41. The peripheral surface of disc 100 is beveled at a slightly increased angle to provide relief and a forming surface for the crimps and this surface is adapted to register with a similarly beveled periphery 41b of backing roll 41 (Fig. 4). The opposite peripheral edge of disc 100 is provided with an annular recess 100c to provide clearance for the formed fins and to enable the pressure disc to be positioned between the fins as they are formed. Suitable axial adjustment for pressure disc 100 is provided by means of adjusting screw 104 which acts through thrust bearing 105 at housing 103. Adjustment of the housing 103 may be made by loosening cap screws 106 which mount the bracket on plate 33a.

The backing roll 41 has a serrated vertical face 41a and a tapered face 41b which cooperate with the conical edges of disc 100 as described above. It has been found that the location of the center line of shaft 40 with respect to the center of the tube is of extreme importance in the proper application of the fin. A lead of approximately $\frac{1}{16}$" has been found to give desirable results with soft copper strip material. Fig. 6 illustrates this lead and shows the center line of shaft 40 displaced horizontally in the direction from which the fin is being wound on to the tube.

The axial position of shaft 101 and pressure disc 100 may likewise be adjusted with respect to the axis of shaft 40 in order to vary the gap between the disc and the pressure roll as seen in Fig. 5. However, it will be understood that in some cases it may be desired to offset the axis of the shaft 40 and disc 100 while retaining substantially the same gap between the roll and the disc. The above axial adjustment of the disc in bracket 103 as well as the lateral adjustment of the entire bracket and disc in a line at right angles to a radius of the winding head 33, is an important element in obtaining improved adhesion and forming of the fin. When shaft 40 is positioned as shown in Fig. 6 to provide a lead, the partially formed crimps 97 will be wiped onto the periphery of the tube and pressed radially inward to provide the tangential feet shown clearly in Figs. 11–13. If the shaft 40 is moved to the left in Fig. 6, this wiping action may be eliminated so that the crimps 97 will be radially unbent. In this event, of course, it may be desirable to utilize some bonding material such as solder or brass for the fin and the tube. A semicircular collar 107 (Fig. 4) is mounted in the bore of spindle 25a by means of cap screws 108, in order to provide suitable guiding and backing for the tube at the point opposite to the application of the fin.

The fin, when applied in accordance with the mechanism heretofore described, is characterized by a corrugated radially tapering web shown clearly in Figs. 10–13. In effect, the fin is wiped on to the periphery of the tube and the base of the fin is folded and pressed to form a foot, as shown in Fig. 11. The webs do not extend along a diameter of the tube but vary from an inner tangential position at the periphery of the tube to a somewhat radial position at the point where the webs blend into the smooth periphery of the fin. In operation, the cylindrical member or tube 50 is fed axially through spindle 25 and collar 107 by means of the power-driven rolls 51, 51a from right to left (as seen in Fig. 3). Spindle 25 is rotated at a predetermined speed by motor 70 through belt 73 and pulleys 28 and 72. Spindle 25 drives the back gears 43 and 42 by means of spur gear 30 (as shown in Fig. 1) and the winding head 33 which is journaled on spindle 25 is in turn rotated at a differential speed with respect to spindle 25 by means of bevel gears 38 and 39. This action not only causes the backing roll 41 to rotate on its own axis but also to revolve as a unit with a head around the cylindrical member 50. The flat strip material 80 which is fed through the crimpers 91, 91 is tightly engaged between the pressure disc 100 and the periphery of backing roll 41 so that as the winding head, together with the pressure disc 100 and roll 41, revolve around the periphery of cylindrical member 50, the crimped fin material is wiped around the periphery of the cylindrical member under substantial tension.

The action of the disc and backing roll is such that the inner edge of the strip is foldably compressed around the periphery of the tube and at the same time the outer edge of the strip is radially controlled and thinned. This action doubly forces strip material into the area adjacent the periphery of the tube since the distance from the periphery to the edge of the fin is less than the width of the strip which is applied and since the thickness of the outer edge of the fin is also less than the thickness of the strip as it is applied. The result of this feature is that ample stiffening at the base of the fin is obtained and this concentration of fin material around the tube periphery accounts for the unexpected result that it is unnecessary to solder or attach the fin to the tube in any other way. The supporting area and rigidity are sufficiently great that in many cases it is even unnecessary to anchor the termini of the fins to the sleeve, there being no apparent tendency for the fin to become loose or to unwind. Furthermore, the heat transfer properties of the fin are likewise enhanced. The concentration of fin material and relatively greater contact area at the base of the fin enable greater conductivity of heat from the tube to the fin. As the heat progresses radially outward, the material in the fin decreases, whereas the surface area increases and it has been found that a remarkably efficient heat transfer is thereby obtained.

I claim:

1. In apparatus for winding strip material around the periphery of a cylindrical member, a hollow sleeve through which the cylindrical member is axially fed, a support in which said sleeve is journaled, a plate mounted at one end of said sleeve, an annular carrier journaled on said plate for rotatably positioning a supply of strip material, a pressure disc mounted on said plate and adapted to rotate independently thereof, a shaft for said pressure disc, the axis of said shaft being biased with respect to the axis of the hollow sleeve, means for axially adjusting said pressure disc shaft, a backing roll journaled on said plate,

the axis of said backing roll being substantially perpendicular to the axis of the cylindrical member, means for adjusting the position of the backing roll with respect to the periphery of the cylindrical member, means for rotating the hollow sleeve, and back gears for independently rotating the backing roll.

2. Apparatus for winding finned tubing comprising a supporting member, a hollow sleeve horizontally journaled in said supporting member, a hub journaled near one end of said hollow sleeve, a bracket adjustably mounted on said hub, a backing roll shaft journaled in said bracket, a backing roll mounted on said shaft and adapted to rotate in a plane parallel to the axis of the hollow sleeve, a bevel gear mounted at the opposite end of said shaft, a bevel gear mounted on said hub and adapted to mesh with said first-named bevel gear, a gear train connecting the bevel gear on the hub with the hollow sleeve, and means for rotating the hollow sleeve in its journals.

3. In apparatus for winding strip material around the periphery of a cylindrical member, a hollow sleeve through which the cylindrical member is axially fed, means for feeding said cylindrical member through the hollow sleeve, a support in which said sleeve is journaled, a plate mounted at one end of said sleeve, an annular carrier journaled on said plate for rotatably positioning a supply of strip material, a bracket on said plate, a pressure disc journaled in said bracket and adapted to rotate independently thereof, a shaft for said pressure disc, the axis of said shaft being biased with respect to the axis of the hollow sleeve, means for axially adjusting said pressure disc shaft, a backing roll journaled

on said bracket, the axis of said backing roll being substantially perpendicular to the axis of the cylindrical member, means for adjusting the bracket in a line substantially perpendicular to a radius of the plate whereby the pressure disc and the backing roll are moved simultaneously with respect to the periphery of the cylindrical member, means for rotating the hollow sleeve, and back gears for independently rotating the backing roll.

J. SHIPLEY NEWLIN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,151,721	Sahlin	Aug. 31, 1915
1,472,719	Horvath	Oct. 30, 1923
1,629,918	Kastler	May 24, 1927
1,840,317	Horvath	Jan. 12, 1932
1,868,438	Thomas	July 19, 1932
1,950,623	Owston	Mar. 13, 1934
1,972,230	Lehman	Sept. 4, 1934
1,992,297	Dewald	Feb. 26, 1935
1,997,197	Nigro	Apr. 9, 1935
2,002,793	Park	May 28, 1935
2,082,600	Squires	June 1, 1937
2,087,723	McCord	July 20, 1937
2,089,381	Kassing	Aug. 10, 1937
2,152,437	Lear	Mar. 28, 1939
2,273,157	Tenney	Feb. 17, 1942

FOREIGN PATENTS

Number	Country	Date
29,458	France	May 5, 1925