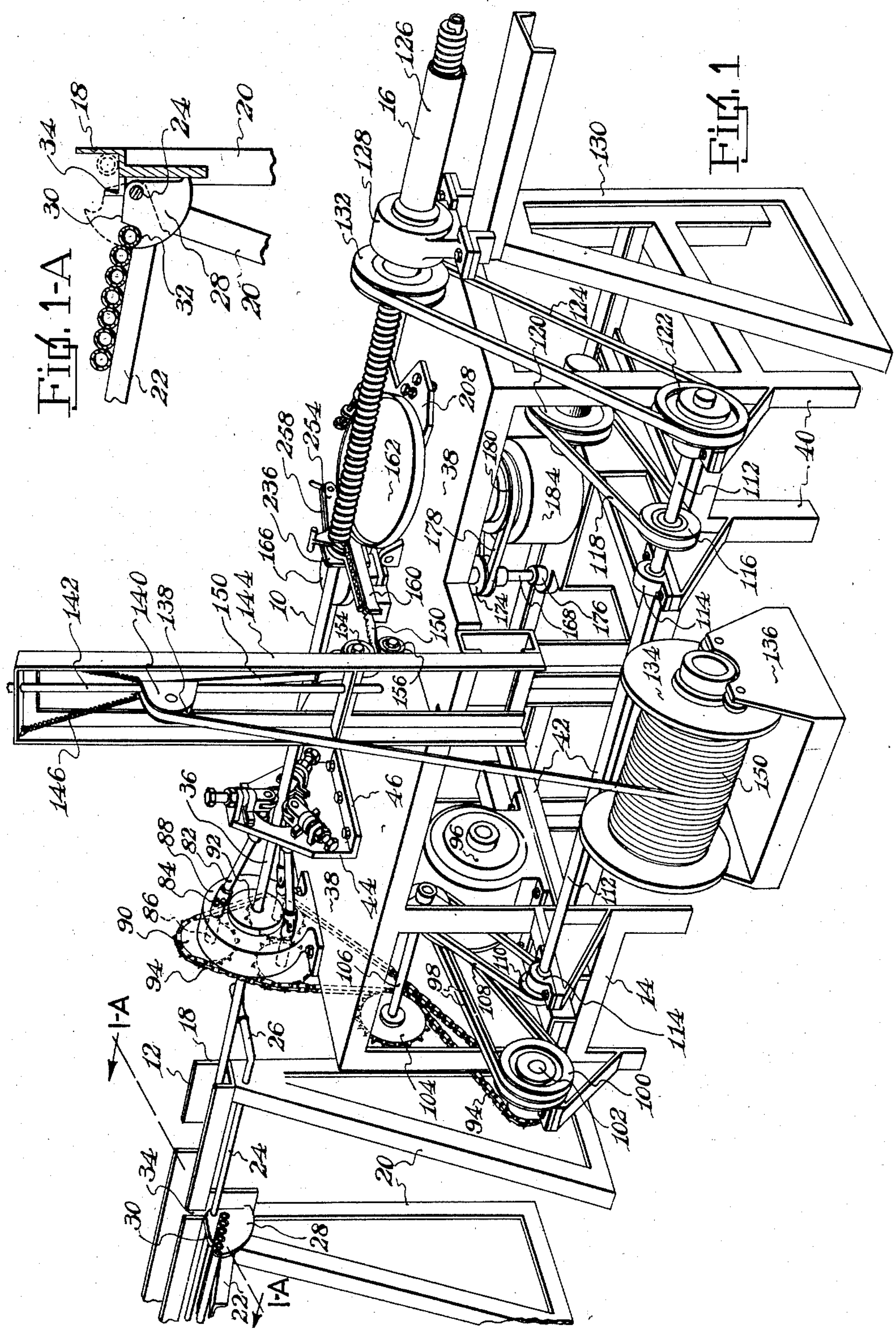
Dec. 23, 1958 A. H. McELROY 2,865,424

MACHINE FOR FORMING FINNED HEAT TRANSFER TUBES

Filed Jan. 27, 1955 7 Sheets-Sheet 1



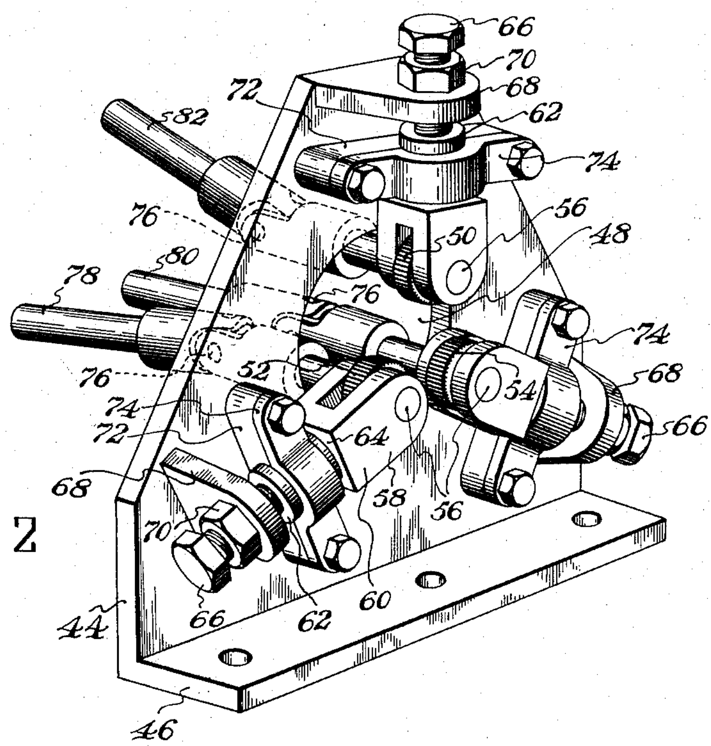

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Fig. 2

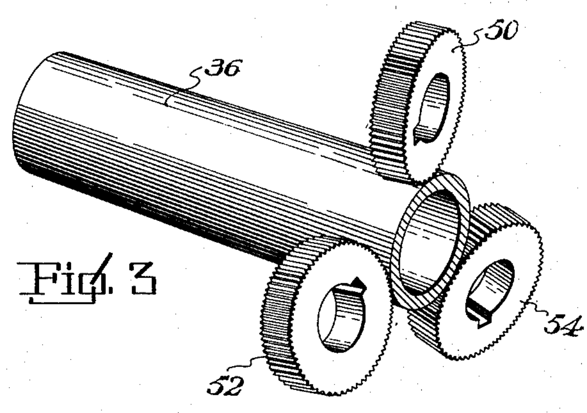
50
36
54
52

Fig. 3

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MACHINE FOR FORMING FINNED HEAT TRANSFER TUBES

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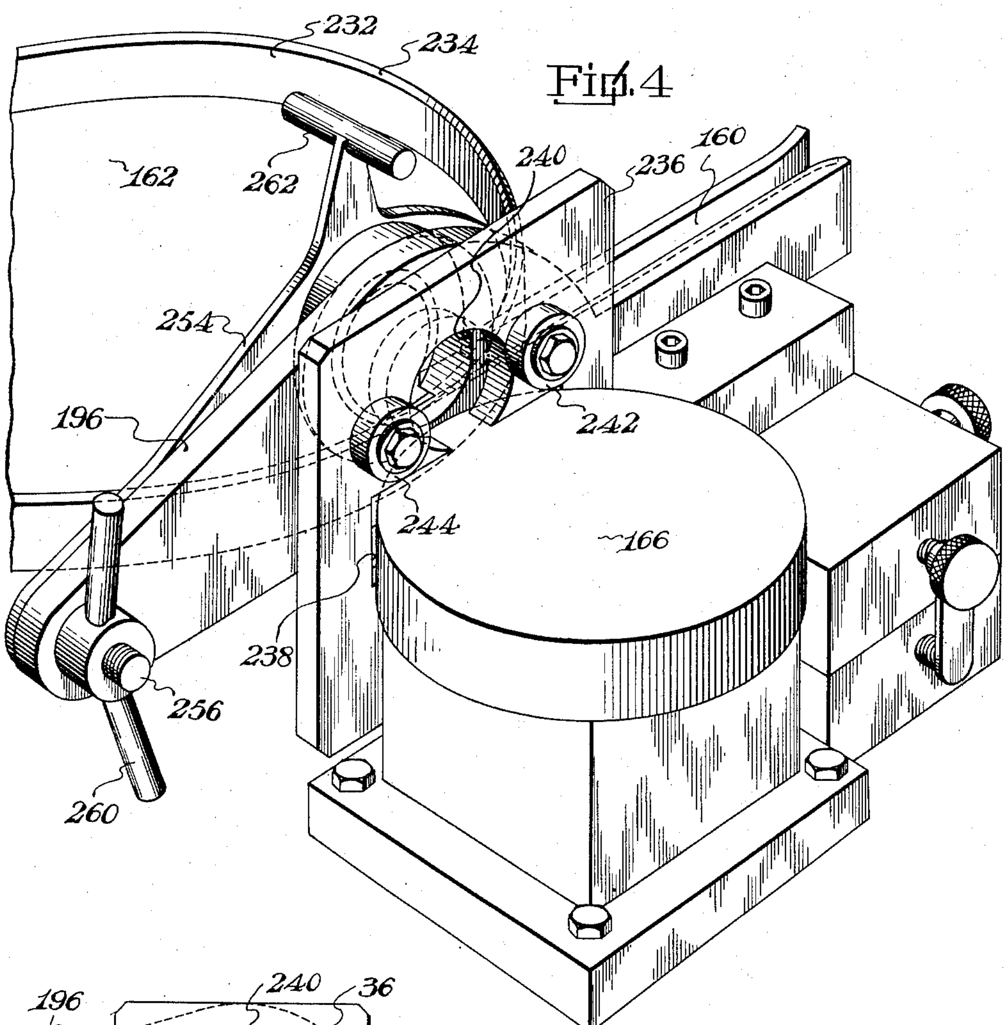
Fig. 4



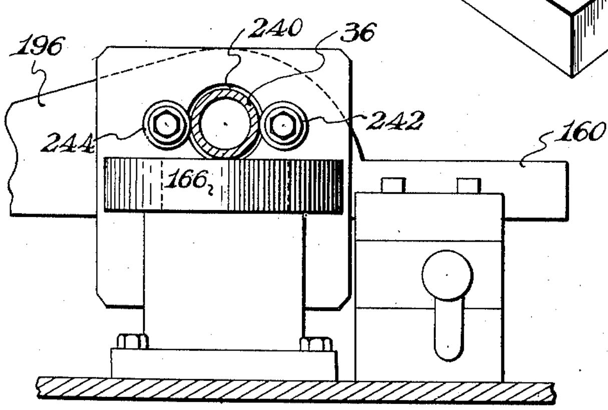
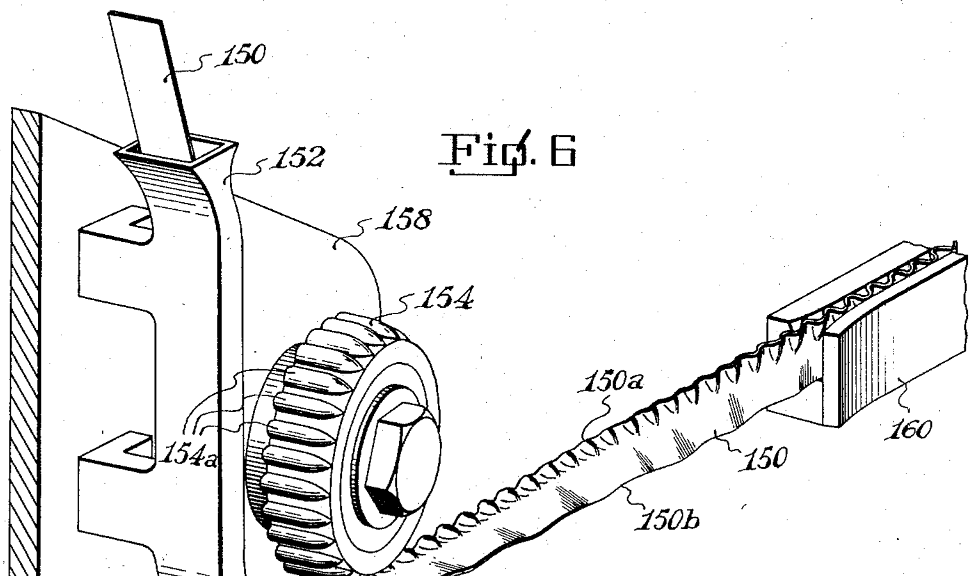


Fig. 5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150b
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156a
156

Fig. 6

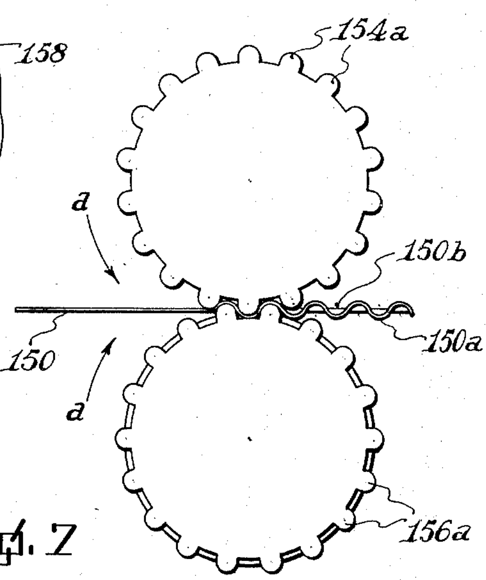
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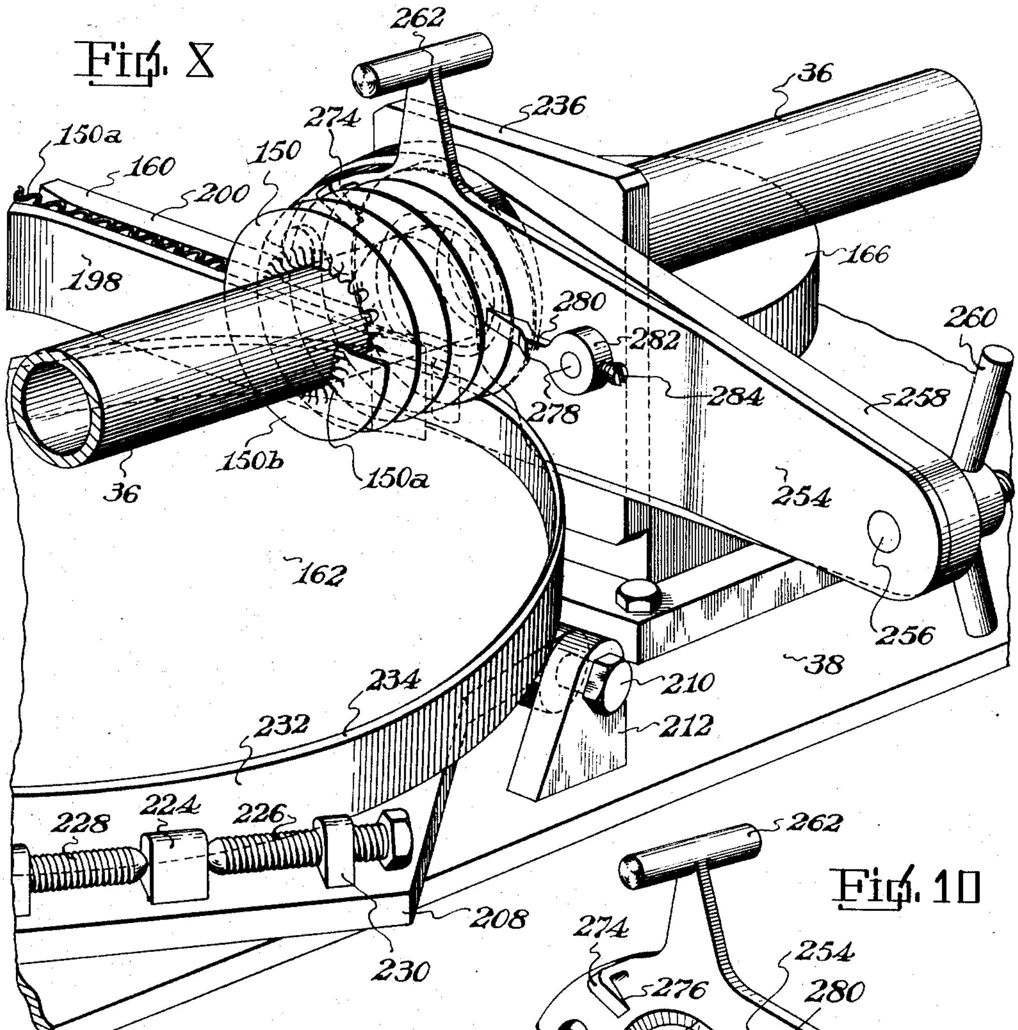
Fig. 7

Fig. 8



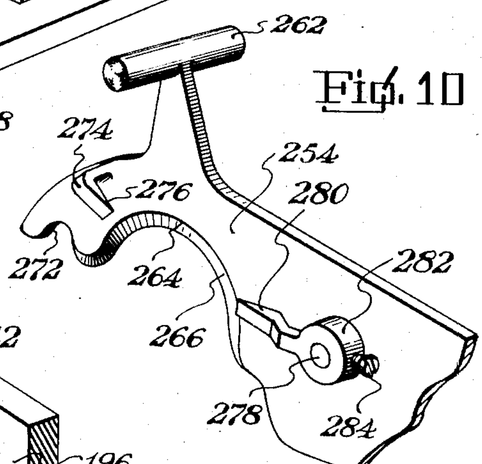


Fig. 10

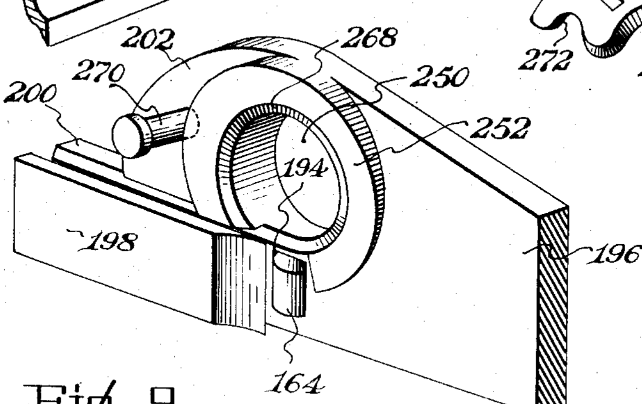


Fig. 9

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MACHINE FOR FORMING FINNED HEAT TRANSFER TUBES

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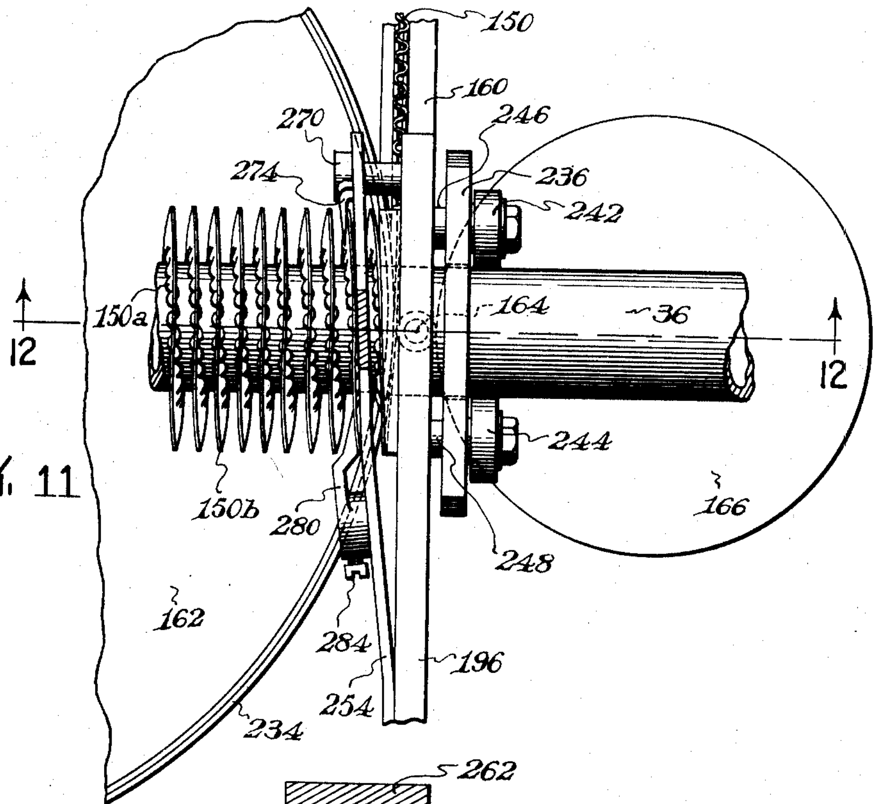


Fig. 11

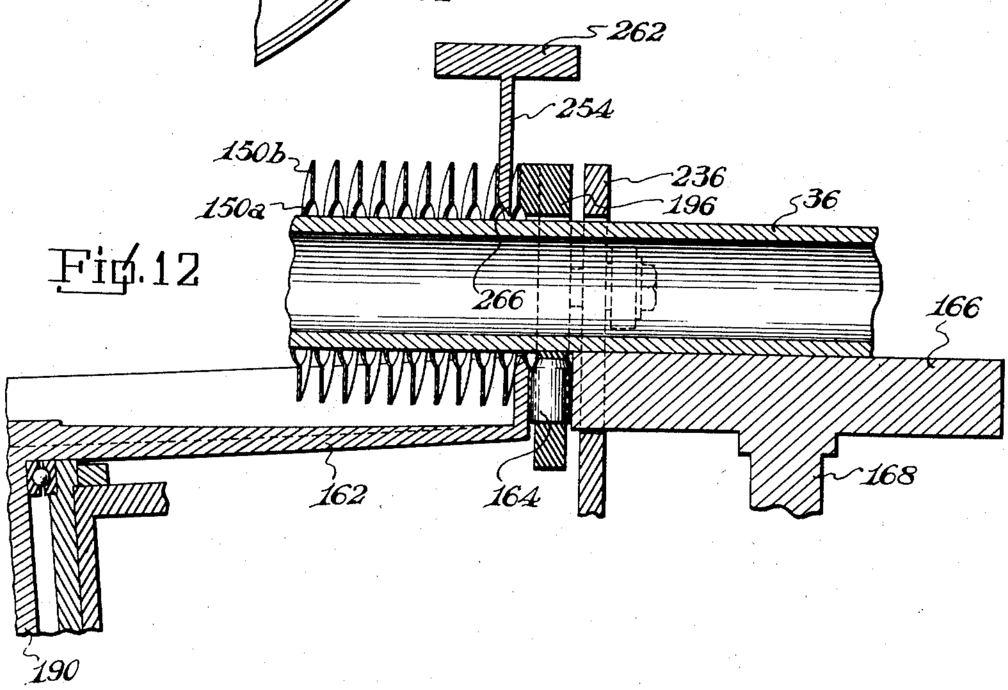
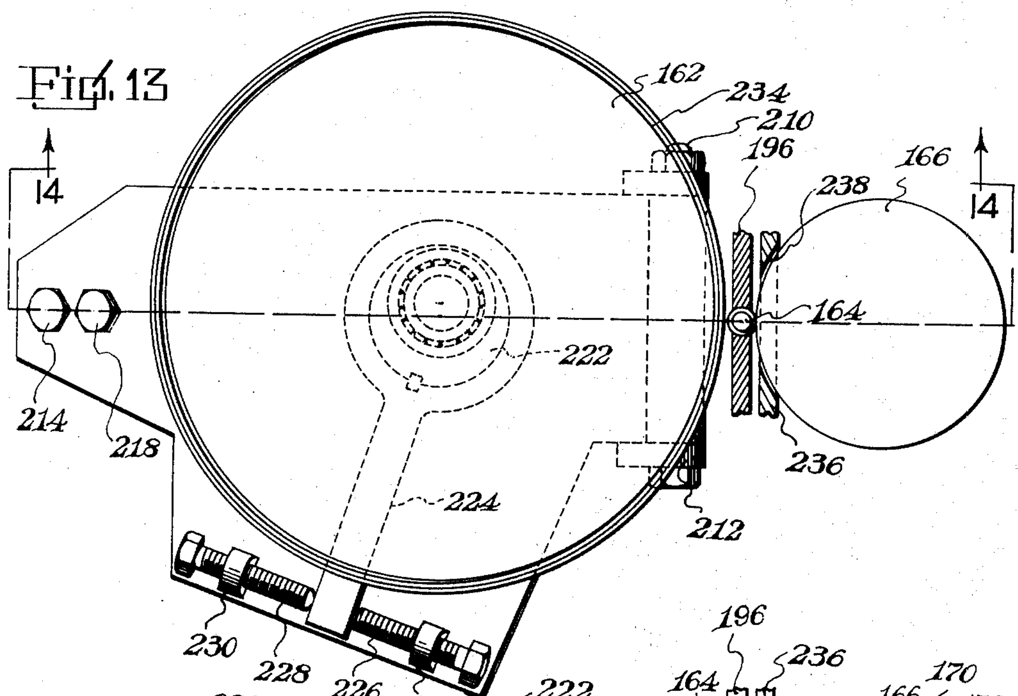


Fig. 12

Fig. 13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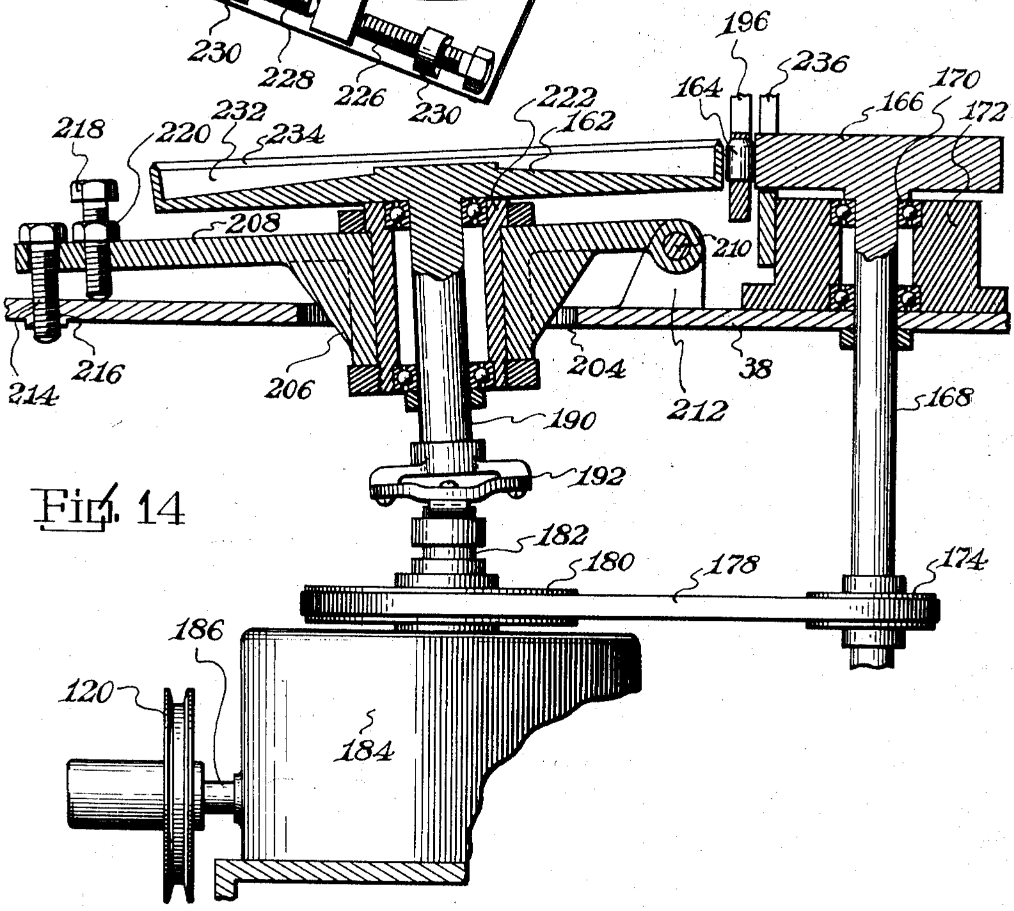
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178
174
186
120
184

Fig. 14

2,865,424
Patented Dec. 23, 1958

2,865,424

MACHINE FOR FORMING FINNED HEAT TRANSFER TUBES

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Application January 27, 1955, Serial No. 484,391

11 Claims. (Cl. 153—64.5)

This invention appertains to improvements in machines for forming finned heat transfer tubes and particularly relates to an improved machine for wrapping a strip of material spirally on a tube to form individual spiral fins on the exterior of the tube.

A primary object of this invention is to provide cooperating means for simultaneously moving a tube axially while rotating it about its axis; the rotation of the tube effecting the wrapping of the fin strip stock on the tube, and for deforming the strip, as it is coiled on edge about the tube, to ensure the creation of a smooth spiral fin which has its inner peripheral edge in proper heat transfer association with the exterior surface of the tube.

Another object of this invention is to provide means for rotating a tube while moving it longitudinally, as the strip is wrapped on edge concentrically about the exterior thereof, and to provide means driven in an exact synchronous speed with the tube for deforming the strip as it is being wound on the tube, the strip being deformed in an exact ratio of the finned tube external diameter to the external diameter of the tube itself.

A further object of this invention is to provide guide means over which the strip passes, as it leaves a holder, the guide means being formed and mounted to hold the strip taut and protect the strip against accidental deformation due to shock.

A still further object of this invention is to provide a drive means for rotating and longitudinally moving a tube, which drive means is adjustable to accommodate tubes of various diameters and to advance the tube longitudinally at ranging speeds, the latter function being important in providing control of the pitch of the fins wound on the tube from the strip.

A still further object of this invention is to form a smooth fin with a very low corrugated base or inner peripheral edge and, in this respect, to provide means for partially corrugating the strip while maintaining the rest of the strip free from strain and in a smooth condition, the corrugated portion forming the base or inner peripheral edges of the fins or tube side edge of the strip.

A further important object of this invention is to provide a novel means for rolling or extruding the smooth portion of the strip up to the corrugated portion, that is, the outer peripheral edges of the fins, as they are wound on the tube, such means embodying cooperating forming rolls between which such portion of the strip passes. The forming rolls are rotatable about parallel axes perpendicular to the path of movement of the tube and receive the strip therebetween as it is starting to wind on the tube.

A still further important object of this invention is to

provide means for relatively adjusting the rolls bodily towards and away from each other so as to adjust the pressure of the rolls on the strip and to provide means for relatively adjusting the rolls about an axis transverse to the axes of rotation of the rolls to change the angle of attack thereof on the strip.

Another important object of this invention is to provide fin guiding means through which the tube transversely passes in its axial movement, the guiding means being formed and correlated with the forming rolls so as to lead the strip, after it leaves the rolls, around the tube, while maintaining the fin in its formed position and under the stress imparted by the rolls.

A further important object of this invention resides in the provision of a rotatable support at the delivery or outlet end of the machine, which support guides and supports the finned portion of the tube to eliminate wear on the fins.

Generally considered, this invention contemplates the provision of an automatic machine wherein a tube to be finned is moved axially while being rotated about its axis and, after one end of the strip is fixed on edge to the exterior thereof, the strip is wound by the tube spirally on its outer surface. The strip is drawn from a rotatable holder over a resiliently mounted guide, which serves as a shock absorber and then through partial corrugating rollers to the fin forming unit or rolls which are driven at an exact synchronized speed to the speed of the tube and deform the fin strip in an exact ratio of the external diameter of the finned tube to the outside diameter of the plain tube. When the strip leaves the rolls, it immediately passes over the guiding means and around the tube with the corrugated portion in heat transfer contact with the exterior of the tube. The finned portion of the tube leaving the machine is conveyed from the machine in a rotating barrel which rotates at approximately the same speed as the tube and prevents the imposition of wear on the finned surface of the tube.

These and ancillary objects, including the provision of a compact, automatic and easily operated and controlled machine, are attained by this invention, the preferred embodiment of which is set forth in the following description and illustrated in the accompanying drawings, wherein:

Figure 1 is a perspective view of the machine, with the tube shown moving from left to right as it is finned;

Figure 1A is a cross-sectional view taken on line 1A—1A and illustrating the means for supplying additional tubes to the machine, the tubes being axially aligned and secured in end to end relationship to form a large tubing;

Figure 2 is a perspective view of the drive means for axially feeding the tubes through the machine, while rotating the tubes;

Figure 3 is a diagrammatic illustration of the action of the feed wheels which comprise the drive means for the tubes;

Figure 4 is an enlarged perspective view of the forming head unit and guide means from the inlet end thereof;

Figure 5 is an end elevational view of the forming head unit from the inlet end thereof;

Figure 6 is an enlarged perspective view of the corrugating means which corrugates one longitudinal edge of the strip as it passes to the forming head unit, a guide element of which is shown in Figure 5;

Figure 7 is a diagrammatic illustration of the corrugating wheels, showing that the corrugations are formed accurately from the plane of the strip while the other portion of the strip is maintained planar;

Figure 8 is an enlarged perspective view of the forming head rolls and guide means showing such guide means in operation as the fin is wrapped on the tube immediately after passage from the finning head rolls;

Figure 9 is an enlarged perspective view of the fin guide showing the spiral lead of the guide face thereof;

Figure 10 is an enlarged perspective view of the fin following guide;

Figure 11 is an enlarged fragmentary top plan view of the forming head unit and guide means;

Figure 12 is an enlarged longitudinal vertical sectional view taken on line **12—12** of Figure 11;

Figure 13 is an enlarged top plan view of the forming head rolls; and

Figure 14 is an enlarged longitudinal vertical sectional view taken on line **14—14** of Figure 13.

Referring now more particularly to the accompanying drawings and initially to Figure 1, the machine **10** includes a feeding section **12**, a working section **14** and a delivery or outlet conveying section **16**.

The feeding section **12** includes a stationary supporting trough **18** which is horizontally supported by legs **20** and is disposed axially at one end of the working section **14**. Alongside the trough and inclined upwardly therefrom, a table **22** is provided and is mounted on the legs. The table supports a supply of tubes in side by side fashion and means is provided for ejecting the tubes in single fashion from the table and carrying the selected tube onto the trough. As shown in Figures 1 and 1A, a rod **24** is rotatably journalled in the upper ends of the legs and has a laterally offset handle **26**, which, when manually pulled, rotates the rod. Substantially triangular plates **28** are fixed at their apices on the rod and have rounded bases which are provided to cam over the tubes and hold them back, as the first tube is picked up thereby for deposit in the trough. To effect the pick-up of the tubes, the sides **30** of the plates are notched, as at **32**, adjacent the bases and the wall of the notch is configured in the form of a hook that will accommodate a tube. Thus, when the plates are in the position, shown in full lines in Figure 1A, the first tube will gravitate down and nest in the hooks.

When the rod is rotated clockwise, the plates will swing curvilinearly and pass through the slots **34** in the adjacent sdie wall of the trough to permit the tube to roll off the sides **30** onto the base of the trough and against the opposite side wall of the trough. In such position in the trough, the tube will be in axial alignment with the preceding tube **36**, whose rear end has cleared the last slot **34** in the wall (Figure 1) and which is being processed through the working section of the machine.

The working section **14** includes a horizontal table top **38** which is supported by legs **40** and beneath which a horizontal frame **42** is provided. A plate **44** upstands from the top **38** and is positioned transversely thereon with a lateral mounting flange **46** on its lower end bolted onto the top. The plate **44** has a large opening **48** to receive the tube **36**, the opening being large enough in diameter for the passage through the plate of tubes of varying diameters. A drive means for moving the tube **36**, for example, axially over the top **38**, while rotating it about its axis, is provided and is shown more particularly in Figures 2 and 3. As shown in such figures, the drive means includes three knurled drive wheels **50**, **52** and **54**, which are grouped in a circular arrangement, 120° apart, around the opening **48**. Each wheel is keyed on a shaft **56**, which is rotatably journalled in the legs **58** of a U-shaped carrier **60** for the wheels. An internally threaded sleeve **62** projects axially from the web **64** of each carrier and the threaded shank of a bolt **66** is threaded in the sleeve. The bolts extend through apertures in the lateral lugs **68** which are formed on the inner

face of the plate **44**. Lock nuts **70** are provided for each bolt and hold the bolts in axially adjusted positions in the lugs. By this mounting construction of the carriers **60**, the wheels are adjustable radially of the opening **48** to drive tubes of varying diameters.

Means is provided to adjust the pitch of the wheels in relation to the tube, which adjustment controls the speed of the longitudinal or axial movement of the tube and, therefore, the pitch of the fins as the strip is wrapped around the tube. Such adjustment means includes a saddle block **72** in which each sleeve is slidable and which is mounted on the face of the plate **44**. A clamping plate **74** is releasably bolted over the sleeves to the blocks **72** and holds the sleeves **62** against axial rotation. To adjust the pitch of the wheels the clamping plates **74** are loosened and the sleeves **62** are rotated until the wheels are in the desired angular relationship to the tube (for example, as shown in Figure 3) and then the plates **74** are tightened to hold the sleeves in place.

Each of the shafts **56** is secured by a universal joint **76**, provided to accommodate the adjustment of the wheels, to one of the three drive shafts **78**, **80** and **82**. The drive shafts are connected by universal joints **84** to the shafts **86**, which are rotatably journalled in the support **88** and which carry the sprockets **90**. The support **88** is bolted onto the top **38** and has a center opening **92** for the passage of the tube. The sprockets **90** are driven by a chain **94** which is powered by a motor **96**.

As shown in Figure 1, the motor **96** is mounted on the frame **42** and drives a double belt **98** which is connected to a double sheave **100**. The shaft **102**, which carries the sheave **100**, has a sprocket fixed thereon over which the chain **94** is passed. A chain tightener sprocket **104** is engaged with the chain and is carried by a shaft **106**, which projects from the frame **42**. The shaft **106** powers a drive belt **108** which is connected by a pulley **110** to a jack shaft **112**. The jack shaft is mounted by bearing blocks **114** on the frame and extends axially of the frame. A pulley **116** is fixed on the jack shaft and drives a belt **118** which through a larger pulley **120** drives the forming rolls, as will be described. A pulley **122** is also fixed on the jack shaft **112** and has a belt **124** entrained thereon. The belt **124** powers the outlet conveying section **16**.

In the latter respect, the outlet conveying section **16** includes a rotating cylindrical conveyor or barrel **126**, which is rotatably mounted in bearing collars **128**. The bearing collars are vertically supported by a frame **130** (a portion of which is shown in Figure 1 along with one of the collars) and the barrel **126** is rotatable within the collars in axial alignment with the tubes moving axially through the working section. A pulley **132** is secured to the inner end of the barrel and is driven by the belt **124**. The barrel rotates in the same direction as the tubes and receives the finned portions of the tubes, as the tubes leave the machine, for the purpose of supporting the tubes. Because the barrel rotates with the tube, there is little wear imposed on the finned surface of the tube. In this regard, the barrel is rotated by the motor through the jack shaft and belt **124** at approximately the same speed as the tube is rotated by the motor through the drive wheels **50**, **52**, **54**, shaftings and chain drive. Thus, the barrel has the same R. P. M. as the tube.

A holder for a supply of fin stock is provided and, as shown in Figure 1, includes a drum **134** which is rotatably supported by a supporting block **136** so that the drum is free to rotate as the stock fin in strip form is unwound from the drum.

The frame **144** upstands from the top **38** and carries the slide member **142** between its sides, the slide member being fixed to the top of the frame and a transverse bar between the sides thereof. The holder **140** is urged upwardly by springs **146** which are connected to the top of the frame **144** and to the holder **140**. The holder **140**, which carries the guide pulley **138** for the strip **150** is thus mounted on the slide member **142** to tension the strip, By means of the resiliently mounted holder the pulley floats on the slide member and absorbs any shock coincident with the holder and strip **150** thus avoiding accidental deformation or damage to the strip. As shown generally in Figure 1 and more specifically in Figure 6 the strip **150** is passed through a funnel type guide **152** which is mounted vertically on the frame **144**. The guide **152** is rectangular in cross section and is of a width to freely receive the strip which moves in flattened form therethrough. The lower end of the guide **152** is turned inwardly to turn the strip from a vertical to a horizontal plane. As the strip exits from the guide **152**, it is passed through a means for corrugating one longitudinal edge thereof.

As shown in Figures 6 and 7, the edge **150***a* of the strip is transversely corrugated, while the remaining portion and opposite edge **150***b* is left smooth. The corrugated edge **150***a* of the strip constitutes the tube edge thereof or the inner peripheral edges or bases of the fins formed by the spiral winding of the strip on the tube **36**. Only the edge **150***a* is corrugated by means of a pair of cooperating corrugating rollers **154** and **156**. The rollers are rotatably journalled on shafts which project laterally from a support **158** that is carried by the frame **144** and which also carries the guide **152**. The corrugating rollers are disposed in vertical alignment with the teeth **154***a* and **156***a* in meshing engagement. The roller **156** is provided with a smooth cylindrical extension **158** which lies alongside the teeth **156***a* and projects beyond the end of the roller **154**. The extension **158** is provided to support the edge **150***b* of the strip, and thus, the uncorrugated portion of the strip.

As shown in the diagrammatic illustration in Figure 7, the teeth of the corrugated rollers form the corrugations in the edge **150***a* by accurately displacing the material from the plane of the strip proper. From the corrugating rollers, the strip passes through a channel guide **160**, the channel passage of which is vertically disposed and thus, turns the strip 90° from a horizontal plane to a vertical plane. The channel **160** positions the corrugated edge **150***a* adjacent the exterior of the tube so as to form the tube side edge of the strip or inner peripheral edges of the fins.

As shown in Figures 8 and 11, the strip **150** is guided by the channel **160** toward the underside of the rotating tube **36**, and positioned beneath the tube **36** to act on the strip **150** as it advances under the tube **36** in the forming head unit. Such unit includes a pan roll **162** and a small cooperating roller **164**, with a backup roll **166** being provided for the small roller **164**. The pressure between the pan roll **162** and the roller **164** causes the strip **150** to be unreeled from the drum **134**.

The backup roll **166** is horizontally disposed above the surface **38** and is provided with an integral depending shaft **168** as shown in Figure 14. The shaft is rotatably supported by bearings **170** in a block **172** which upstands from the surface **38**. A pulley **174** is fixed on the shaft above the lower end thereof which is rotatably journalled in a collar **176** on the frame **42**. The pulley **174** is connected by a belt **178** to a pulley **180** which is horizontally carried by a shafting **182** below the top or surface **38**. The shafting **182** projects from a gear reduction unit **184** from which an input shaft **186** laterally projects and is provided with the pulley **120**. The shaft **168** and the shafting **182** are driven by the motor **96** through the jack shaft **112** and attendant belt transmission systems in an exact synchronized speed with the speed of the rotating tube **36** so that the forming roll unit rotates in the linear movement therebetween of the strip in a synchronized speed with the rotational speed of the tube **36** as the strip is wrapped or wound thereon.

A shaft **190** is connected by a constant speed universal joint **192** to the shafting **182** and projects upwardly therefrom. The shaft **190** carries the pan roll **162** which is integral therewith.

The roller **164** is rotatably mounted in a suitable manner in a transverse cutout **194** formed vertically in a guide plate **196** which is interposed between the backup roll **166** and the pan roll **162** in a manner and for a purpose to be described. As shown in Figure 9, the channel guide **160** is integral with the plate **196** and one side **198** of the channel guide extends beyond the opposite side **200** in a manner to confront in spaced relation the face **202** of the plate **196**. The side **198** of the channel guide is not attached to the face **202** which is spaced therefrom so that the strip moves between the side **198** and the lower portion of the face **202**. The side **198** terminates at the roller **164** so that the strip is lead directly by the channel guide, particularly the side **198** in cooperation with the portion of the face **202**, over the protruding peripheral portion of the roller **164**. In this respect as shown in Figure 14, the diameter of the roller **164** is slightly greater than the width of the plate **196** so that the roller protrudes or extends beyond the opposite faces of the plate **196** and is in contact with the periphery of the backup roll **166** and the pan roll **162**. The strip passes between the contacting peripheries of the pan roll **162** and the roller **164** and the outer peripheral edges of the fins or uncorrugated outer edge of the strip is rolled or extruded by the pressing coaction of the pan roll and the roller **164**. At the time that the strip is subjected to the rolling or extruding action of the pan roll and the roller **164** the corrugated edge **150***a* is in contact with the underside of the rotating tube **36** and the strip is in the commencement of the fin forming process. Thus, the strip is rolled or extruded so as to force the inner corrugated edge **150***a* into contact with the tube and to relieve the outer periphery of the fin proper of any strain and thereby create a smooth spiral fin as the strip is being wound on the tube **36**.

The pan roll **162** is mounted for bodily adjustment relative to the roller **164** so that the amount of pressure exerted by the pan roll and roller **164** on the strip can be adjusted. In other words the pan roll and the roller are relatively adjustable both towards and away from each unit. The pan roll is also mounted for adjustment about an axis transversely to the axes of rotation of the rolls and roller so as to adjust the angle of deformation of the strip.

Such adjustable mounting structure is shown in Figures 13 and 14 wherein it will be noted that an opening **204** is formed in the surface **38** and receives the depending hub portion **206** of a plate **208**. The plate is hingedly mounted at one end on a pivot rod **210** which is supported by lugs **212** that upstand from the surface **38**. The plate is locked in a tilted position of adjustment about the pivot rod by a bolt **214** which is threaded vertically through the opposite end thereof and extends through a threaded opening **216** in the surface **38**. A bolt **218** is threaded vertically through the plate adjacent the bolt **214** and is held in adjusted positions by a locknut **220**. The bolt **218** rests on the surface **38**. Thus, to adjust the angle of tilt of the plate **208** and thereby the angular relationship between the pan roll **162** and the roller **164**, that is the angle of deformation of the strip, the bolt **214** is unscrewed from the surface **38** and the bolt **218** is axially adjusted to set the plate **208** in the desired angle. The bolt **214** is then threaded into the opening **216** to lock the plate in such set position.

The shaft **190** of the pan roll **162** is rotatably mounted by ball bearing assemblies in an eccentric hub **222**, which is mounted within the hub **206** of the plate **208** by an arm **224**, which radially projects therefrom and extends beyond the periphery of the roll **162**. The outer end of the arm **224** is disposed between a pair of axially aligned set screws **226** and **228**. The set screws are carried by ears **230**, which upstand from the plate and receive the set screws. It can be seen from a consideration of Figure 13 that the relative axial movement of the set screws controls the rotation of the eccentric hub which will advance the periphery of the pan roll towards and away from the periphery of the roller **164**.

It will be particularly noted that the upstanding annular periphery **232** of the pan roll is slightly inclined outwardly from the bottom of the roll so as to engage the roller **164** at a slight angle and thereby roll and extrude the interposed strip, without flattening the corrugated edge **150***a*. In this respect, the upper edge **234** of the peripheral portion of the pan roll is V-shaped or at least the outer portion of the upper end is provided with a relief angle and, similarly, the upper edge portion of the small roller **164** is converged at an angle. Therefore, the upper outer edge of the peripheral portion of the pan roll and the upper edge of the roller **164** are cut back at an angle so as to permit the corrugated edge **150***a* to pass therebetween without being subjected to the rolling or extruding action.

As shown in Figures 4 and 5, a plate **236** is vertically mounted on the block **172** on the table top surface **38** and is provided with a suitable cutout portion **238** to accommodate a portion of the periphery of the backup roll **166** which bears against the small steel roller **164** and provides the necessary pressure to withstand the pressure imposed on the roller by the pan roll. The plate **236** is also formed with a circular opening **240** through which the tube passes. Guide rollers **242** and **244** are mounted on the front face of the plate **236** and project inwardly of the opening **240** to engage the rotating tube and stabilize the tube as it passes over the table top **38**, and particularly over the forming roll unit as the strip is being wound.

The rollers **242** and **244** are rotatably journalled on suitable shafts **246** and **248** which extend through the plate **236** and are attached to the guide plate **196**. The guide plate **196** is formed with a circular opening **250** to accommodate the axial passage of the tube **36** therethrough. The face **202** of the plate **196** is formed with a spiral cam **252** which is concentric to the opening **250** in the plate. The cam surface **252** starts at the roller **164** as shown in Figure 9, and spirals around the opening back to its terminating low point at the channel passage. The purpose of the spiral cam surface is to guide the fins, as shown in Figure 11, around the tube, after the strip has been rolled or extruded by the forming roll unit.

Cooperating with the guide plate **196** is a fin following guide member **254**, which is hinged by a pin **256** to the projecting end **258** of the plate **196**. The pin **256** is threaded and the following guide member **254** is locked in place by a nut **260**, which is threaded on the threaded shank of the pin **256**. The fin following guide member **254** has a handle **262** which extends above the plate **196** so that when the nut **260** is loosened the fin following guide member can be swung about the pin **256**. The fin following guide member has a concave recess **264** formed in its lower edge to provide clearance for the tube **36**. The edge **266** of the recess is beveled.

As shown in Figure 9, the inner end of the side **198** is concaved, as at **199**, to provide clearance for the periphery of the pan roll and enable the periphery of such roll to contact the roller **164**, with the bite of the roll and roller immediately disposed at the exit end of the channel guide passage. The purpose of the beveled edge **266**, as shown in Figure 12, is to avoid mashing the corrugated inner edges or bases **150***a* of the fins. The outer portions of the fins, as shown in Figure 12, pass over the spiral cam surface **252** and also over the inner face of the fin following guide member **254**. Therefore both the beveled edge **266** of the concave recess **264** and the beveled inner peripheral edge **268** of the cam **252** are necessary to permit the outer peripheral portions of the fins to slide over the cam and the face of the fin following guide member, without the corrugated inner peripheral edges or bases of the fins contacting such members.

The plate **196** has a laterally projecting pin **270** and the fin following guide member has a notch **272** which seats on the pin to locate the fin following guide member in the proper horizontal position. To assist in the guiding of the strip in its fin forming windings around the tube, the inner face of the fin following guide member is provided with an integral hook **274**, the portion **276** of which has a flattened inner surface which parallels the face of the member. A pin **278** projects laterally from the inner face across the concave recess from the hook **274** and carries a finger **280**. The finger **280** has a hub portion **282** which is rotatably positioned on the pin and held in adjusted positions by a radial set screw **24**. Thus, the hook **274** is adjustable to various positions on the face. The purpose of the hook and finger which cooperate together is best shown in Figure 11 wherein it will be noted that such members cooperate to hold the outer peripheral portions of the fins in guided contact with the flat inner face of the fin following guide member.

While the operation of the machine is believed clear from the drawings, a brief description of the operation will be given. Thus, considering Figure 1, it will be understood that the tube **36** is fed from trough **18** through the working section, where it is finned, to the rotating outlet conveying barrel **126**. Before the tube is passed to the drive means for movement through the working section the exterior surface of the tube is coated with a suitable substance, such as solder or the like. This is not necessary for the purpose of causing an adherence between the corrugated inner peripheral edges or bases of the fins with the extruded surface of the tube but is more for the purpose of ensuring an intimate heat exchange contact between the fins and the tube, avoiding air gaps. The tube is, of course, moved axially while being rotated about its axis by the adjustable drive means and the pan roll and backup roll are rotated, thus rotating the interposed small steel roller, at exact synchronized speed with the speed of rotation of the tube. The end of the strip **150** is manually fixed or attached to the exterior surface of the tube preparatory to the automatic operation of the machine.

The rotation of the tube will, of course, wind the strip in fin formations on the exterior surface of the tube after the strip has been partially corrugated and passed through the forming head rolls. The forming head rolls deform the fin strip in an exact ratio of the fin tube outside diameter to the tube outside diameter. Thus, the fins will have a very low corrugated base and the outer peripheral portions of the fins will be extremely smooth. The relationship between the speed of the axial movement of the tube and the cam surface **252** will control the pitch of the fins on the tube, each fin being identically pitched and evenly spaced from its companion fins. The portion of the tube that has been finned and passed beyond the forming roll unit enters the rotating barrel **126** which supports the tube and ensures against the imposition of wear on the finned surface.

While this machine has been designed to form a smooth fin with a very low corrugated base or inner peripheral edge, the same machine can form a perfectly and entirely smooth fin by removing the relief angle of the top edge of the peripheral portion of the pan roll and the top edge of the small roller and omitting the companion corrugating rollers.

Thus, while the preferred form of the invention has been described herein and illustrated in the accompanying drawings, other forms may be realized as come within the scope of the appended claims.

I claim:

1. A device for wrapping a strip on edge spirally around the exterior of a longitudinally moving and rotating tube to provide spiral, spaced heat exchange fins exteriorly on the tube comprising drive means for longitudinally feeding and rotating a tube having one end of a strip affixed on edge to its exterior surface, means for rolling the strip as it initiates the formation of fins on the tube, guide means around the tube and through which the tube passes receiving the strip from said rolling means

and guiding it around the tube, while maintaining it in its roller condition, a rotatable guide cylinder axially aligned with the tube following the fin formation and guidingly receiving and supporting the finned tube, motor means, and a drive transmission means connected between the motor means, the drive means for the tube, the strip rolling means and the guide cylinder, said drive transmission means commonly actuating the drive means and the rolling means so that the rolling means rotates in the linear movement therethrough of the strip in synchronized speed with the rotational speed of the tube as the strip is being wound on the tube and the drive transmission means rotating the guide cylinder in the same direction and at approximately the same speed as the tube is rotated to prevent wear being imposed on the fins of the tube.

2. A device for wrapping a strip on edge spirally around a tube to provide heat exchange fins exteriorly on the tube comprising, a drive means for axially rotating and longitudinally feeding a tube having an end of a strip affixed on edge to the exterior thereof and adapted to wind the strip spirally on edge around its exterior surface as it rotates, resiliently tensioned guide means for the strip, means for transversely corrugating one longitudinal edge of the strip as it passes from the guide means to the tube with such corrugated edge forming the inner peripheral edges of the fins, means disposed adjacent the tube for rolling the uncorrugated portion of the strip as it initiates the fin windings on the tube, guide means through which the tube passes disposed adjacent said last means and receiving the strip therefrom to guide the strip around the tube in forming the fins while maintaining the strip in its stressed condition, a rotatable guide cylinder axially aligned with the tube and receiving the tube following the formation of fins thereon, motor means and a drive transmission means connected between the motor means, the tube drive means and the cylinder for rotating the tube and the cylinder at approximately the same rate of speed and in the same direction.

3. In a device for forming spiral heat exchange fins on a longitudinally moving and axially rotating tube; means for guiding and forming a strip as it is wound around the tube responsive to the rotational movement of the tube, said means comprising a small roller rotatably positioned vertically below the tube, a pan roll positioned adjacent said roller and having a peripheral flange disposed alongside the roller and cooperating therewith to roll the outer edge of the strip and force the inner edge into contact with the tube as the strip is being wound on the tube, a backup roller engaging the small roller and positioned on the opposite side from the pan roll, said roller and backup roller being rotatable about parallel axes perpendicular to the tube, and means mounting the pan roll for bodily curvilinear adjustment toward and away from the small roller about an axis at right angles to the axis of rotation of the small roller and for rotation about an axis, substantially parallel with the axis of the small roller and adjustable relative to and away from the small roller whereby the amount of pressure exerted by the pan roll and the roller on the strip can be adjusted and whereby the angle of deformation of the strip can be selectively adjusted.

4. A device as claimed in claim 3, wherein said peripheral flange is slightly inclined outwardly toward the small roller so as to engage the roller at a slight angle and said flange has a V-shaped outer edge and said roller has an upper end cut back at an angle so that there is a space between the upper end of the roller and the outer edge of the flange for free passage of the inner edge of the strip between the pan roll and the roller.

5. A device as claimed in claim 3, wherein a support is provided transverse to the tube and through which the tube passes, said support carrying the small roller and having a face formed with a spiral guide surface for the strip as it is initially wound on the tube and channel guide means carried by the support and positioned so as to guide the strip right up to the bite of the pan roll and the small roller below the tube at the initial point of contact between the strip and the tube.

6. A device as claimed in claim 5, wherein an arm is mounted above and transversely of the tube and is movable toward and away from the tube into a position confronting the face of the support, said arm having a guide surface on its side confronting said face which cooperates with the guide surface on the support and having an opposite side provided with a guide means for engaging and guiding the outer edge of the strip after it has been wound on the tube.

7. A device as claimed in claim 3, wherein a table top is provided below the tube and said last means includes a plate hingedly mounted at one end on the table top and movable vertically about a horizontal axis, means carried by the other end of the plate in cooperation with the table top for setting the plate in selected positions, said plate having a vertical opening coinciding with a vertical opening in the table top, an eccentric hub rotatably mounted in the plate opening, a shaft for the pan roll mounted in the hub, an arm radially extending from the hub parallel with the top of the plate and beyond the pan roll and adjustment means on said plate in engagement with the arm to rotate the arm and hub and lock the arm and hub in selected positions.

8. In a device for forming spiral heat exchange fins on a longitudinally moving and axially rotating tube; means for guiding and forming a strip being wound on the tube responsive to the rotational movement of the tube, said means comprising a vertical support arranged transversely of the tube and having an opening through which the tube passes, said support having a face formed with a spiral cam concentric to the opening over which the strip passes as it is being wound on the tube, a channel guide means carried by the support tangently to the cam and leading almost directly up to the starting low point of the cam so as to guide the strip immediately up to the cam, a guide arm coperating with the cam and disposed in confronting relation at one side therewith, said guide arm having an opposite side provided with guide means for engaging the outer edge of the strip and guiding the fins after they have been formed on the tube, and means disposed below the opening at the end of the channel guide means for rolling the outer edge of the strip at the moment the inner edge of the strip contacts the tube.

9. A device as claimed in claim 8, wherein said channel guide means includes a first vertically disposed arm extending laterally from the plate flush with the face thereof, a second vertically disposed arm spaced slightly from and arranged parallel with the first arm and extending inwardly beyond the first arm and arranged in confronting relation with said face of the support.

10. A device as claimed in claim 8, wherein said guide arm is movable vertically above the tube toward and away from the tube and said guide means on the opposite side thereof includes a fixed finger and an adjustable finger disposed in spaced confronting relation with said side.

11. A device as claimed in claim 8, wherein said last-named means includes a small roller, said support having a cut-out formed below the opening and in which said roller is vertically positioned for rotation, said roller being disposed intermediate the end of the channel guide means and the starting point of the cam and being of a diameter slightly greater than the thickness of the support, a cooperating pan roll engaging the small roller on the cam side of the support and a backup roller engaging the small roller on the other side of the support, the bite between the small roller and the pan roll being disposed right at the end of the channel guide means.

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