

Nov. 9, 1954

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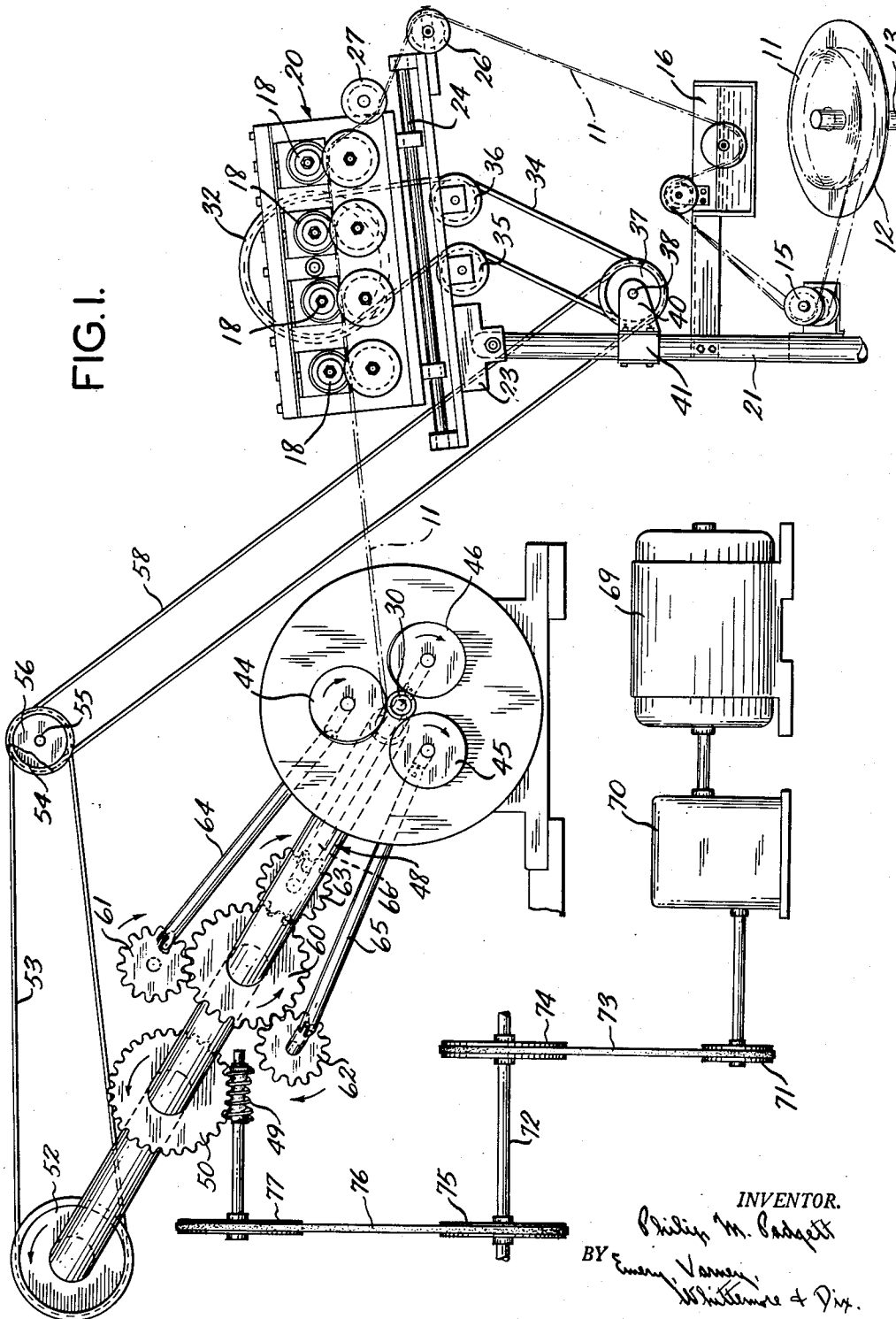
2,693,779

MACHINE FOR MAKING ROUND FLEXIBLE METAL TUBES

Filed April 28, 1951

4 Sheets-Sheet 1

FIG. 1.



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4 Sheets-Sheet 2

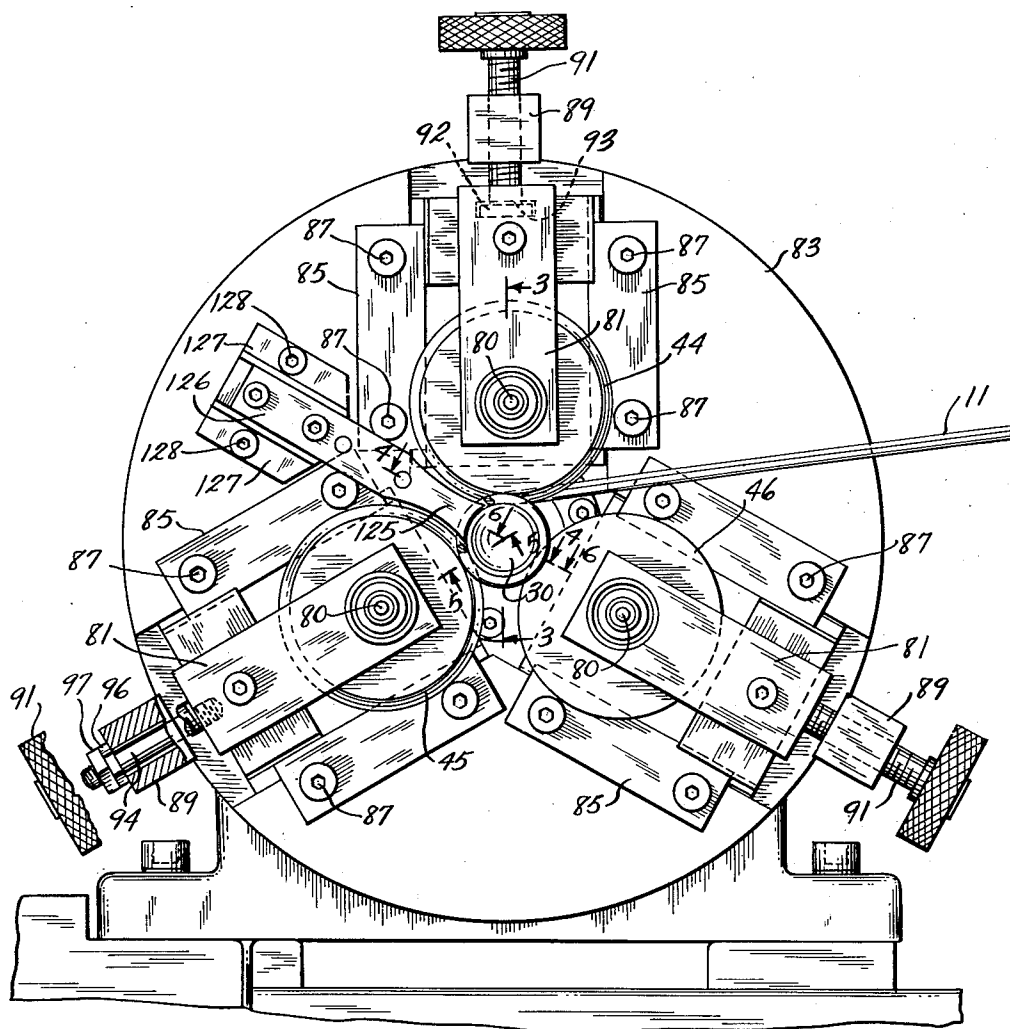


FIG. 2.

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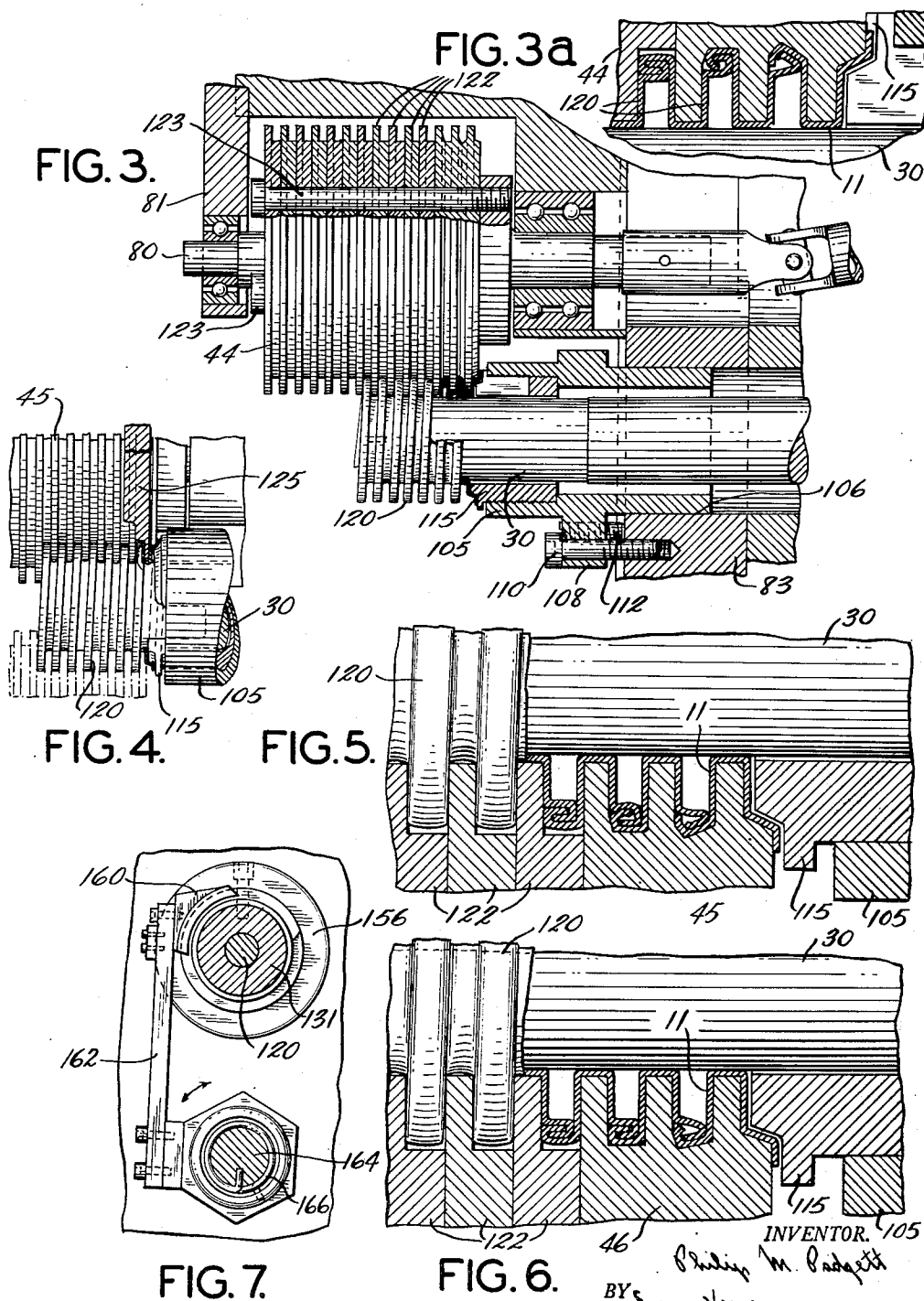
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MACHINE FOR MAKING ROUND FLEXIBLE METAL TUBES

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4 Sheets-Sheet 3



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MACHINE FOR MAKING ROUND FLEXIBLE METAL TUBES

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4 Sheets-Sheet 4

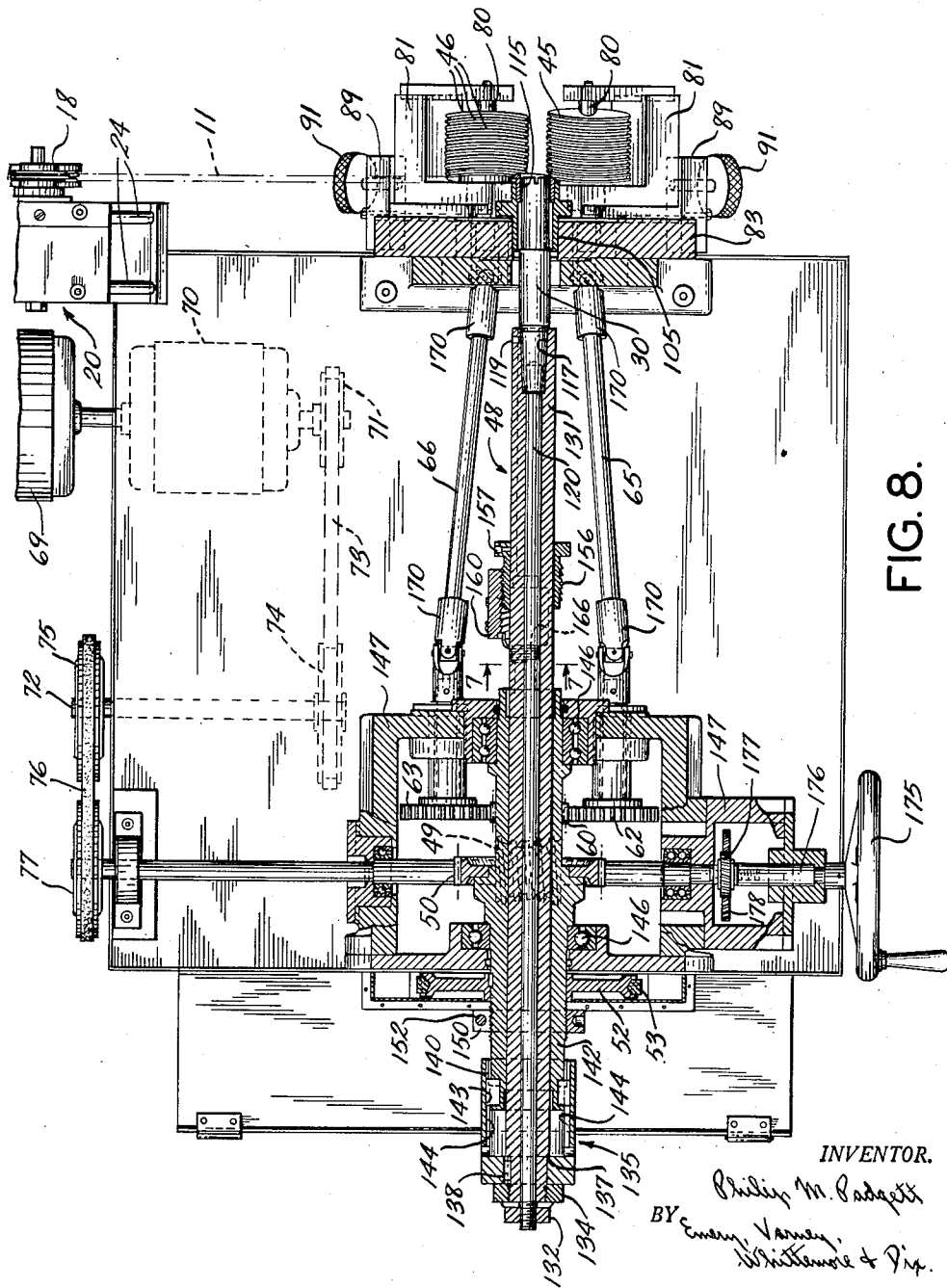


FIG. 8.

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2,693,779

MACHINE FOR MAKING ROUND FLEXIBLE METAL TUBES

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Application April 28, 1951, Serial No. 223,476

6 Claims. (Cl. 113—35)

This invention relates to machines for making helically seamed flexible tubing from strip stock. The strip is preferably formed with a longitudinal corrugation; with one edge folded over; and with an upturned flange along the other edge for engagement with the folded edge of the next adjacent convolution when the strip is wound into a helically seamed tube.

It is an object of this invention to provide improved apparatus for winding a formed strip into a helically seamed tube or metal hose, and to make such a tube at higher speed than has been possible with conventional tube making equipment.

More particularly, this invention relates to machines in which the strip is wrapped on a power driven mandrel and progressively stripped from the mandrel as a continuous operation with the forming of the tube. The mandrel is preferably provided with a slight taper that increases the arbor diameter toward its discharge end and the forming is done with power driven rollers having corrugations that fit the corrugations of the tube along a substantial length of the mandrel, and in the preferred embodiment of the invention to the discharge end of the mandrel, for stripping the tube over an enlarged end of the mandrel.

Other features of the invention relate to apparatus by which power is supplied to rolls that are adjustable toward and from the axis of the mandrel without disconnecting them from their power supply; to a power advancement of the mandrel during the starting of each new strip; to the roll construction and roll position adjusting mechanism; and to means for insuring a uniform curvature to the walls of the tube.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views,

Fig. 1 is a diagrammatic view of a tube-making machine embodying this invention,

Fig. 2 is an enlarged, front elevation of the actual construction of the mandrel and tube wrapping mechanism that is shown diagrammatically in Fig. 1,

Figs. 3-6 are greatly enlarged, sectional views taken on the lines 3—3 to 6—6, respectively, of Fig. 2,

Fig. 7 is an enlarged detail view of the mandrel feed mechanism shown in Fig. 8,

Fig. 8 is a horizontal, sectional view through the machine on a plane through the axis of the mandrel.

Fig. 1 shows a reel of metal strip 11 on a supporting plate 12 that rotates with its axle 13 as the reel is unwound by pulling the strip around a guide roll 15, then through a flux bath 16, and to forming and wrapping mechanism. The flux bath covers the metal strip with lubricant necessary to protect it in the subsequent forming roll passes, and during the wrapping and seaming of the tube.

Strip-forming means comprising a plurality of forming roll stands 18, in a roll assembly frame 20, are supported from a post 21. The post 21 has a bracket 23 at its upper end and there are bars 24 connected to the bracket 23 and providing the immediate support for the roll assembly frame 20. These bars 24 slope and provide an inclined track along which the frame 20 is movable.

The strip 11 passes around a guide roller 26 supported from the bracket 23; and then passes around an

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arc of another guide roller 27 which is supported by the roll assembly frame 20. From this guide roller 27, the strip 11 passes successively through four forming passes of the roll stand 18 where the strip is formed progressively to a predetermined transverse contour with one edge flanged and the other edge folded over to engage the flanged edge of an adjacent convolution when the strip is wrapped in a helix around a mandrel 30.

The forming rolls of the stands 18 are driven through gearing, or other motion transmitting connections, from a pulley 32. Such driving connections are well known and commonly used with tube making equipment of this kind, and no further description of it is necessary for a complete understanding of this invention.

The pulley 32 is driven by a belt 34 which passes over guide pulleys 35 and 36, and around a driving pulley 37 on a jack shaft 38. This jack shaft 38 turns in bearings 40 on a bracket 41 that clamps to the post 21 and that is adjustable up and down along the post to control the tension of the belt. The guide pulleys 35 and 36 deflect the run of the belt 34 so that the tension of the belt urges the assembly frame 20 to slide upward along the inclined bars 24. As the frame moves upward along these bars, the tension of the belt slackens until it is insufficient to move the assembly frame 20 any further along the bars 24, and the belt has insufficient friction on the pulley 32 to drive the pulley when the full load of forming the strip must be overcome by the power supplied to the pulley 32.

Tension on the strip 11, resulting from the pull of the mandrel 30, as it wraps the strip in a helix, supplies some of the power required to advance the strip through the forming roll stands 18, and this pull on the strip moves the assembly frame 20 to increase the tension on the belt 34. In this way an automatic control of the strip feed is obtained. Whenever the strip feed is sufficient to relax the tension caused by the wrapping of the strip on the mandrel, the belt 34 pulls the forming roll assembly frame 20 along the track or bars 24 in a direction away from the mandrel and thereby reduces the tension of the belt 34 until the strip feed is cut down by slipping of the belt. This prevents the strip from being fed to the mandrel too rapidly. The speed of the forming rolls 18, when there is no slippage of the belt 34, is slightly more than necessary to supply strip to the mandrel; and the speeds of the forming rolls and mandrel are coordinated by driving them from the same motor or other power source.

The strip 11 comes from the forming roll stands 18 to the mandrel 30 along a substantially straight line. There are three rolls 44, 45 and 46 located at angularly spaced regions around the mandrel 30. There can be more than three rolls around the mandrel, but others are unnecessary and less than three makes even stripping of the tube difficult.

The mandrel 30 is connected with a mandrel drive assembly 48 driven by a worm 49 through a worm wheel 50 of the drive assembly 48. A pulley 52, operatively connected to the drive assembly 48, is connected by a belt 53 with another pulley 54 on a shaft 55. This shaft 55 has a pulley 56 that drives the jack shaft 38 through a belt 58.

The mandrel drive assembly 48 also supplies power to the rolls 44, 45 and 46 so that they turn with the mandrel and in the opposite direction. This makes the peripheral surfaces of the rolls 44, 45 and 46, which are closest to the mandrel, always move in the same direction as the mandrel surface immediately adjacent to them. The driving power is supplied from a gear 60, of the mandrel drive assembly 48, to other gears 61, 62, and 63 meshing with the gear 60 at angularly spaced regions around this gear 60. The gear 61 is connected with the first roll 44 by a drive shaft 64. The gears 62 and 63 are connected with the rolls 45 and 46, respectively, by drive shafts 65 and 66.

The machine is driven by an electric motor 69 through reduction gearing 70. The output end of the reduction gearing 70 has a pulley 71 that drives a countershaft 72 through a belt 73 and pulley 74. Another pulley 75 on the countershaft 72 transmits motion through a belt 76 to a pulley 77 on the shaft with the worm 49.

Fig. 2 shows the actual construction of the rolls 44, 45 and 46. Each of these rolls is carried on an axle 80 which is supported on opposite sides of the roll by a roll carrier or yoke 81. The rearward side of the yoke bears against a face plate 83 which constitutes a part of the fixed frame of the machine. Longitudinal edges of the rearward side of each yoke 81 extend into undercuts behind side blocks 85 that provide a guideway in which the yoke 81 is movable toward and from the axis of the mandrel 30 to adjust the machine for strips of different gauge from that of the strip 11.

Each of the side blocks 85 is secured to the face plate 83 by screws 87, and when these screws are tight, the yoke is rigidly clamped against the face plate 83 to hold the yoke and its roll in adjusted position. A frame element 89 is located radially outward from each of the roll carriers or yokes 81. Each frame element 89 is rigidly secured to the face plate 83; and there is a screw 91 threaded through the frame element 89. The radially inner end of each screw 91 has a collar 92 on it contained in an undercut socket 93 which serves as a thrust bearing for raising or lowering the yoke and its associated roll 44 accurately when the screws 87 are released. This collar and the undercut socket serve as abutments that hold the roll carrier or yoke against displacement both from and toward the mandrel in a position determined by the adjustment of the screw 91. Thus a roll may be held in adjusted position until its yoke is clamped against further adjustment, with the screw 91, by tightening the screws 87 of the side blocks 85.

In order to make it unnecessary to adjust the positions of each yoke 81 every time that the yoke is pulled back away from the mandrel, an adjustable limit is provided. In Fig. 2, the screw 91 is broken away to show the limit stop for the yoke 81 of the roll 45. This limit stop comprises a stud bolt 94 extending freely through the frame 89 and threaded into the end of the yoke 81. There is a nut 96 on the stud 94, and a lock nut 97 immediately adjacent to the nut 96.

After the roll 45 has been adjusted for the particular gauge of the strip being used on the mandrel 30, the nut 96 is screwed down into contact with the outer face of the frame 89, and the nut 96 is then locked in this position by the lock nut 97. Whenever the roll 45 is to be pulled back from the mandrel 30, the screws 87 are released, and the adjusting screw 91 is turned to pull the yoke 81 as far back as necessary to provide access to the mandrel or strip on the mandrel. The stud bolt 94 slides lengthwise in the frame 89 as the yoke 81 is pulled away from the mandrel. Whenever the roll 45 is to be returned to its working position, it is not necessary for the operator to again adjust its clearance from the mandrel. It is sufficient to merely turn the screw 91 until the nut 96 comes into contact with the outer face of the frame 89.

Fig. 3 shows the roll 44 in section and on a greatly enlarged scale. A cam support 105 surrounds the mandrel 30 and fits snugly in the face plate opening 106. The cam support 105 has a flange 108 extending radially outward across the front of the face plate 83. Screws 110, of which there are preferably three at 120 degree angular spacing around the mandrel, attach the flange 108 to the face plate 83. There is a limit screw 112 threaded through the flange 108 near each of the attaching screws 110.

The inner end of the limit screw 112 abuts against the front of the face plate 83 and maintains a clearance between the face plate and the flange, if any clearance is necessary for proper longitudinal adjustment of the cam support 105. A cam 115 threads into the end of the cam support 105 and is screwed into the support 105 until the end of the cam abuts against a shoulder in the cam support. This threaded connection secures the cam rigidly to the cam support.

The rearward portion of the mandrel 30 is tapered and fits snugly in a socket 117 (Fig. 8), of complementary taper, in the end of the mandrel drive assembly 48. A set screw 119 prevents rotation of the mandrel and a draw bolt 120 holds the mandrel in the socket. The intermediate portion of the mandrel is cylindrical and at least a part of the length of this intermediate portion extends into the rearward end of the cam support 105 when the mandrel is in operating position.

The forward or working end of the mandrel 30, the

part on which the strip is wound to make the tube, is of reduced diameter at its juncture with the intermediate cylindrical portion of the mandrel and then increases gradually in diameter toward the front or discharge end of the mandrel. This slight taper to an increased diameter insures a tight wrapping of the strip on the mandrel because the helically wound material is advanced progressively toward the discharge end of the mandrel by the stripping action of the rolls.

The cam 115 surrounds the mandrel 30 beyond the cylindrical portion of the mandrel and has some clearance from the surface of the reduced diameter, slightly tapered, forward end of the mandrel. The forward face of the cam 115 is the displacement face of the cam and this displacement face is helical with a pitch substantially equal to the pitch of the helix in which the strip is wrapped on the mandrel.

Referring again to Fig. 3, the roll 44 has parallel corrugations along the entire length of its peripheral face, and the ridges of these corrugations extend into a longitudinal corrugation of the formed strip. The spacing of the roll corrugations correspond with the pitch of the helix in which the strip is wound so that each successive ridge of the roll extends into the corrugation of the strip at each successive convolution of the helix. The roll 44 has its axis canted with respect to the axis of the mandrel so that the ridges of the roll 44 engage the helical corrugation of the tube along the line of the helix pitch.

The other rolls around the mandrel are similarly canted to line up their corrugations with the pitch of the helix. Each roll is also located further from the face plate 83 than the preceding roll by an amount equal to one third of the pitch of the helix.

The cam 115 is adjusted longitudinally to locate it in position to support the flanged edge of the strip 11 around the first convolution of the strip on the mandrel, as shown in Figs. 3 and 3a. The face of the cam 115 advances with the same pitch as the helix and thus supplies a positive displacement of the flange. At the beginning of the second convolution, the flanged edge of the strip engages the folded over edge of the run of strip that is starting to wrap in the first convolution. After having wrapped beyond the first convolution, the strip is controlled by the corrugations of the rolls.

The first two or three corrugations and intervening grooves of the roll 44, and of the other rolls around the mandrel, are shaped so as to bring the edges of adjacent convolutions into engagement and then to bend the engaged edges over and to roll them into a tight helical seam. This requires that at least some of the first two or three corrugations and grooves of the rolls be of slightly different contour; but all of the remaining corrugations are the same since their only function is to assist in the progressive stripping of the tube from the mandrel. The tube is designated in the enlarged views of the drawing, by the reference character 121.

As the mandrel rotates, the helical corrugation of the tube, running in the corrugations of the rolls, screws the tube off the mandrel. It is a feature of the illustrated embodiment of the invention that the corrugated faces of the rolls extend substantially to the discharge end of the mandrel so that each convolution of the tube is subjected to local stripping pressure for advancing it along the tightly fitting portion of the mandrel.

In order to reduce the cost of the roll 44, this roll and the other similar rolls that are located around the mandrel are of composite construction. The body of the roll having the first two or three corrugations is made in one piece. The remaining length of the roll is made of a number of aligned rings 122 which are clamped together and connected to the body of the roll by screws 123. The rings 122 have center openings that fit the roll side and each ring has a shoulder that divides its peripheral surface into cylindrical areas of different diameter. When the rings are assembled together the alternating cylindrical areas of different diameter form a corrugated roll face.

In addition to the fact that this composite roll construction is more economical to make, it has the further advantage that the body portion of the roll can be replaced when it becomes worn. The rings 122 which are not subject to the seaming stresses, have very little wear compared to that of the initial grooves of the rolls. Considerable economy results from the replacement of only

the body portion of the roll instead of having to replace the entire length of a roll merely because the first two or three grooves are worn.

Immediately beyond the first roll 44, there is a shoe 125 (Figs. 2 and 4) extending into the longitudinal corrugation of the preformed strip 11. This shoe has an end face that is curved to substantially the same curvature as the mandrel, that is, the axis of curvature of the end face of the shoe 125 is substantially coincident with the longitudinal axis of the mandrel. The shoe 125 has an upper end or shank portion 126 that slides in a guideway between two blocks 127. These blocks are connected with the face plate 83 by screws 128. The shank portion extends into undercut clearances along the confronting edges of the blocks 127; and these blocks clamp the shank portion 126 against the face plate 83 and in any adjusted position when the screws 128 are tightened.

Fig. 4 shows the longitudinal position of the shoe 125 with respect to the mandrel and the tube that is wrapping on the mandrel. The circumferential position of the shoe 125 is shown in Fig. 2. The sides of the shoe are cut away to provide clearance for the rolls 44 and 45, and the end face of the shoe confronts a substantial arc of the mandrel between these rolls 44 and 45. The roll 44 is adjusted to clear the mandrel surface by a few thousandths of an inch in excess of the thickness of the material of the strip 11. The shoe 125 is adjusted to have a similar clearance from the surface of the mandrel.

The purpose of the shoe 125 is to obtain a smoother curvature of the strip as it winds around the mandrel. Without the shoe, the strip winds in a series of short, more or less straight lengths joined by small arcs having sharper curves than the surface of the mandrel. With the shoe 125 extending along an arc of the mandrel near the region of initial bending of the strip, and spaced from the mandrel by a distance only slightly greater than the thickness of the strip material, the strip wraps with a smooth curvature.

Fig. 5 shows the roll 45 and illustrates the way in which the second groove of this roll bends the engaged edges of the seam partway over as a step in the seaming of the tube. The roll 45 is adjusted to leave a clearance between the mandrel and the roll ridges slightly greater than the thickness of the strip material, as in the case of the other rolls.

Fig. 6 shows the roll 46 which completes the bending over of the engaged edges that form the seam. This roll may be adjusted to apply the final seaming pressure; or the rolling of the seam to its final tightness may be done in the next convolution by the rolls 44 and 45.

When starting the winding of a new strip upon the mandrel, provision is made for advancing the mandrel longitudinally, at the rate of the helix pitch, so that no stripping force need be applied to the first few convolutions of the new tube at a time when there are only a few convolutions among which the stripping force can be distributed.

The draw bolt 120, which extends lengthwise through a hollow shaft 131 of the mandrel drive assembly 48, has a nut 132 at its rearward end. This nut is screwed against the end face of the hollow shaft 131. Another nut 134 screws on the end of the drive shaft 131 and secures a cap 135 to the drive shaft. This cap 135 has an end flange that fits the drive shaft and that is clamped against a shoulder 137 of the shaft. The flange of the cap 135 is also connected to the shaft 48 by a key 138.

The cap 135 has a shell portion 140 extending forwardly over one end of a bearing sleeve 142. Keys 143 project from the bearing sleeve 142 into longitudinal grooves 144 in the inner surface of the shell portion 140. The sleeve 142 provides a bearing in which the mandrel drive shaft 48 has both rotary and longitudinal movement. The sleeve 142 is itself rotatable in ball bearings 146 mounted in the fixed frame 147 of the machine. There are shoulders on the sleeve 142 in contact with the ball bearings 146 so that these bearings serve as thrust bearings as well as radial load bearings.

The movement of the drive shaft 131 and the mandrel 30, toward the right in Fig. 8, is limited by a split nut 150 on the bearing sleeve 142. The end of the shell portion 140 abuts against the nut 150. There are threads on the bearing sleeve 142 along a substantial length of the bearing sleeve to provide adjustment of the nut 150.

This nut 150 is, therefore, an adjustable limit stop for determining how far forward (to the right in Fig. 8) the mandrel 30 moves when it is advanced into final working position when starting the winding of a new strip. Being of split construction, the nut 150 can be locked in any adjusted position by tightening up a screw 152 that spans the split of the nut 150.

The pulley 52 is connected to the sleeve 142 by a key. The rotation of this pulley is thus transmitted to the sleeve 142 which in turn transmits its rotation to the hollow drive shaft 131 through the keys 143 in the splines or grooves 144 of the cap 135. This driving connection permits longitudinal movement of the drive shaft 131 and mandrel 30, within the limits imposed by the length of the grooves 144, without interfering with the rotary movement of the parts.

The mandrel driving assembly 48 has a threaded section or thrust element 156. This thrust element fits over the hollow sleeve 131 and is slidable along the sleeve for adjustment, but is held securely in adjusted position by a set screw 157. The threads on the thrust element 156 have the same pitch as the helix of the strip that is wound on the mandrel. A nut section 160 has threads that are brought into engagement with the threads of the thrust element 156 when it is desirable to advance the mandrel longitudinally at the rate at which the tube forms on the mandrel. There is a frame 162 (Fig. 7) by which the nut section 160 is carried. This frame prevents longitudinal movement of the nut section 160; but the frame can swing about a tie rod 164 by which it is supported; and this swinging movement permits the nut section to be disengaged from the threads of the thrust element 156. A spring 166 urges the frame 162 to swing in a direction to hold the nut section 160 in contact with the thrust element 156 or the surface of the sleeve 131 when that sleeve has been advanced longitudinally (toward the right in Fig. 8) far enough to carry the thrust element 156 beyond the nut section 160.

When the hollow sleeve 131 and the mandrel 30 are in retracted position, the end of the mandrel is substantially even with the region where the preformed strip 11 comes into its initial contact with the first roll 44. The thrust element is in engagement with the threads of the nut section 160. There is a slot in the end of the mandrel 30, and the end of a new strip is anchored in the slot before starting the rotation of the mandrel.

As the mandrel turns, the thrust element 156 screws itself forward along the nut section 160 and advances the mandrel at the same rate that the strip winds in a helix around the mandrel. The thrust element 156 continues to advance the mandrel until the threads of the thrust element reach the end of the threads of the nut section 160. The mandrel assembly continues to rotate but no longer moves forward. The thrust element 156 is preferably located in such a position on the sleeve 131 that the end of the mandrel reaches the ends of the rolls 45 and 46 at the same time that the threads on the thrust element 156 reach the end of the threads on the nut section 160. Thus, the thrust element 156 provides a driving mechanism for the mandrel assembly adjustable to automatically stop longitudinal movement of the mandrel at the selected normal working position of the mandrel.

The mandrel assembly is pulled back manually by gripping the cap 135. When retracting the manual assembly, the nut section 160 must be lifted out of the path of the thrust element 156. The retracted mandrel assembly can be pushed forward, without waiting for the thrust element 156 to advance it. The threads on the thrust element 156 and on the nut section 160 are preferably made with cross sections similar to ratchet teeth so that the thrust element 156 can be pushed forward without disengaging it from the nut section 160.

The drive shafts 65 and 66 are provided with universal joints 170 at their opposite ends and the connection of at least one end of each shaft to its universal joint is splined so that the rolls 45 and 46 can be adjusted to operate on mandrels of larger size, and so that the rolls can be pulled back away from the mandrel, when necessary, without disconnecting the rolls from their power driving mechanism. The provision of power for rotating the rolls 45 and 46 reduces the wear on the rolls and facilitates the forming of the tube on the mandrel. It will be understood that the third roll, corresponding

to the rolls 45 and 46, which is above the plane of section of Fig. 8, is provided with similar universal joints for its drive shaft.

In order to turn the mandrel slowly by hand when initially threading a new strip on the machine, a handwheel 175 is provided on a shaft 176 extending from the frame or housing 147. This shaft carries a small spiral gear 177 which meshes with a larger spiral gear 178 on the same shaft with the worm 149.

The shaft 176 preferably has a limited longitudinal movement for bringing the gears 77 and 78 into and out of engagement with one another.

When the handwheel 175 is turned in the direction to rotate the worm 149 in the same direction as the worm is rotated by the motor of the machine, the operator pushes the shaft inward until the gears touch, the spiral gear 177 screws into engagement with the spiral gear 178 and the hub of the handwheel 175 strikes against the housing 147 to prevent further inward movement of the shaft 176. When the motor begins to operate the machine, the rotation of the spiral gear 178 provides a thrust that pushes the smaller spiral gear 177 out of mesh and thrusts the shaft 176 and the handwheel 175 outward. This feature automatically disengages the hand drive whenever the power drive is brought into operation.

The preferred embodiment of the invention has been illustrated and described but changes and modifications can be made, and some features of the invention can be used in different combinations without departing from the invention as defined in the claims.

I claim as my invention:

1. A machine for making spirally seamed tubing from a formed strip, including a mandrel which is longitudinally movable and rotatable and on which the strip is wound in a helix, mechanism that rotates the mandrel including a splined connection that maintains a driving connection during longitudinal movement of the mandrel with respect to the mechanism that rotates the mandrel, rollers at angularly spaced locations around and adjacent the mandrel in position to control the forming of the tube and to strip the tube progressively from the mandrel as the tubing is formed, bearing means on which the mandrel has longitudinal movement with respect to the rollers, a threaded section on the mandrel having a pitch equal to the pitch of the helix, a nut segment movable in a plane normal to the axis of the mandrel into and out of engagement with the threads, and a bearing on which the nut segment is supported and held against displacement parallel to the axis of the mandrel, the nut segment and the threaded section of the mandrel being correlated with the normal working position of the mandrel with respect to the rolls so that the end of the threaded section passes the end of the nut segment when the mandrel reaches its normal working position thereby stopping further longitudinal movement of the mandrel.

2. A machine for making helically corrugated flexible tubes including a frame, a mandrel, bearing means on which the mandrel is rotatable and axially movable, a guide that supplies a longitudinally corrugated strip to the mandrel in a direction to wrap around the mandrel in a helix, a thrust element connected with the mandrel and movable longitudinally with the mandrel, a nut element connected to the frame by a bracket that prevents axial movement of said nut element, the bracket to which the nut element is connected being movable radially into and out of engagement with the thrust element on the mandrel, threads on both the nut element and the thrust element, the thread on at least one of the elements being of ratchet-tooth section and facing in a direction that screws the mandrel along the nut section when the mandrel rotates but that leaves the mandrel free to be advanced by ratcheting of the threads over one another.

3. A machine for making spirally seamed flexible metal tubing including a mandrel, means that supply a formed strip to the mandrel in a direction to wrap as a helix about the mandrel with the adjacent edges of the helix overlapping to form the spiral seam, means for guiding the strip and seaming the edges as the tube is formed on the mandrel, said means including a plurality of rolls at angularly spaced locations around and adjacent the mandrel, bearings along which the mandrel is movable axially with respect to the guiding and seaming means, a mechanical feed that advances the mandrel axially, in-

cluding screw threads and a nut segment, one of which has a connection to a fixed portion of the machine and the other of which is connected with the mandrel beyond the portion of the mandrel on which the tube is formed, power driving mechanism that rotates the mandrel, a driving gear secured to the mandrel and rotatable as a unit with the mandrel, a plurality of other gears angularly spaced around the mandrel in position to mesh with a driving gear located on the mandrel, and motion transmitting connections between each roll and one of said other gears.

4. A machine for making helically wound, flexible tubes including a mandrel assembly having a mandrel of gradually increasing diameter toward its discharge end, means that supply a preformed, longitudinally corrugated strip to the mandrel with a flange along one side of this strip and a folded over edge along the other side, a cam plate extending angularly around at least a portion of the circumference of the mandrel, said cam plate being located in position to contact with the strip as it initially winds about the mandrel and said cam being shaped to guide and longitudinally advance the strip, a plurality of rolls at angularly spaced locations around and adjacent the mandrel in positions to guide the strip in conjunction with the cam plate and bring the flange into engagement with the fold of the other edge of the next convolution and to bend the engaged edges to form an interlocked seam, as the strip winds upon the mandrel, corrugations on the rollers that engage corrugations on the tube to strip the tube from the mandrel, bearing means on which the mandrel is movable longitudinally, the mandrel assembly including a threaded section that serves as a thrust element for advancing the mandrel longitudinally, and power driving mechanism that applies force to said thrust element to move the mandrel longitudinally in the direction of advance of the tube during initial forming of the tube, a part of the power driving mechanism being adjustable to provide an automatic stop that prevents longitudinal movement of the mandrel beyond a predetermined location.

5. A machine for making spirally wound and corrugated flexible metal tubes including a cylindrical mandrel about which a longitudinally corrugated strip is wound, power driven rolls at angular spaced locations around and adjacent the mandrel, said rolls having peripheral faces that fit the transverse contour of the strip, a face plate through which the mandrel extends, a separate carrier by which each roll is supported, bearing means on the face plate along which the carriers are movable to shift the rolls toward and from the mandrel, power driving mechanism for the rolls including a drive shaft connected with each roll and extending through a slot in the face plate, said slot providing clearance for the shaft during adjustment of the roll toward and from the mandrel, universal joints at spaced locations along each drive shaft, screw-downs carried by the face plate in position to regulate the positions of the roll carriers along their bearing means, said screw downs including lead screws for advancing and retracting the carriers, a support for the mandrel including bearing means in which the mandrel is movable longitudinally to retract most of the length of the mandrel rearwardly into and behind the face plate, a driving element operatively connected with the mandrel and driven elements actuated by the driving element and connected with the respective drive shafts for the rolls.

6. A machine for making helically seamed and corrugated, flexible metal tubes including a cylindrical mandrel, means that supply a longitudinally corrugated strip to the mandrel at an angle for winding in a helix, corrugated rolls located at angularly spaced regions around and adjacent the mandrel in position to strip and seam the tube as it forms on the mandrel, the corrugated faces of the rolls being of sufficient width to extend at least to the end of the mandrel and the end portions of said rolls comprising rings connected in axial alignment with the body portion of the rolls, portions of the rings being of reduced diameter to provide corrugations for the rolls, a separate carrier by which each of the rolls is supported, a face plate through which the mandrel extends, bearing means on the face plate along which the carriers are movable to shift the rolls radially with respect to the mandrel, screws connected with the face plate and located in position to provide positive abutments that hold the frames against movement either toward or from the mandrel, a bearing along which the

mandrel is movable longitudinally to withdraw most of its length through the face plate prior to starting the winding of a strip, driving mechanism that rotates the mandrel, motion transmitting connections between the mandrel and each of the power driven rolls for turning the rolls in timed relation with the mandrel, a threaded section connected with the mandrel and serving as a thrust element for advancing the mandrel longitudinally through the face plate at the rate of the helix, a connection through which the driving mechanism applies force to said thrust element to advance the mandrel longitudinally, said connection and threaded section being adjustable with respect to one another to provide an automatic stop that limits further longitudinal movement of the mandrel when it reaches a predetermined position.

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