United States Patent [19]

Meserole

[11] **3,863,480**

[45] **Feb. 4, 1975**

[54] **APPARATUS FOR FORMING CORRUGATED STRIP MATERIAL INTO HELICALLY WOUND TUBING**

[75] Inventor: **Robert H. Meserole,** Toledo, Ohio

[73] Assignee: **Johns-Manville Corporation,** Greenwood Village, Colo.

[22] Filed: **Aug. 28, 1973**

[21] Appl. No.: **392,398**

[52] **U.S. Cl.** **72/50**

[51] **Int. Cl.** **B21c 37/12**

[58] **Field of Search** 72/50, 49, 137

[56] **References Cited**

UNITED STATES PATENTS

2,282,176	5/1942	Fay et al.	72/50
2,314,510	3/1943	Odor	72/50
3,220,234	11/1965	Harper	72/50
3,753,363	8/1973	Tribey	72/50

FOREIGN PATENTS OR APPLICATIONS

1,082,567	6/1960	Germany	72/50

Primary Examiner—Milton S. Mehr

Attorney, Agent, or Firm—Robert M. Krone; John D. Lister

[57] **ABSTRACT**

An apparatus convolutes a corrugated strip material about a mandrel to form a helically wound tubing. A pair of forming rolls nest complementary edge portions of adjacent convolutions together. After the edge portions have been nested, the formation of the seam joining the adjacent convolutions is initiated by the same forming rolls. A separate guide roll contacts the strip material after it has passed through the forming rolls to convolute the strip material about the mandrel and to further close the seam which has been initiated by the forming rolls. After the seam has been further closed by this separate guide roll, the seam of the tubing passes back between the pair of forming rolls where a surface provided with teeth on one roll and a backing surface on the other roll combine to flatten the seam into its final configuration.

10 Claims, 8 Drawing Figures

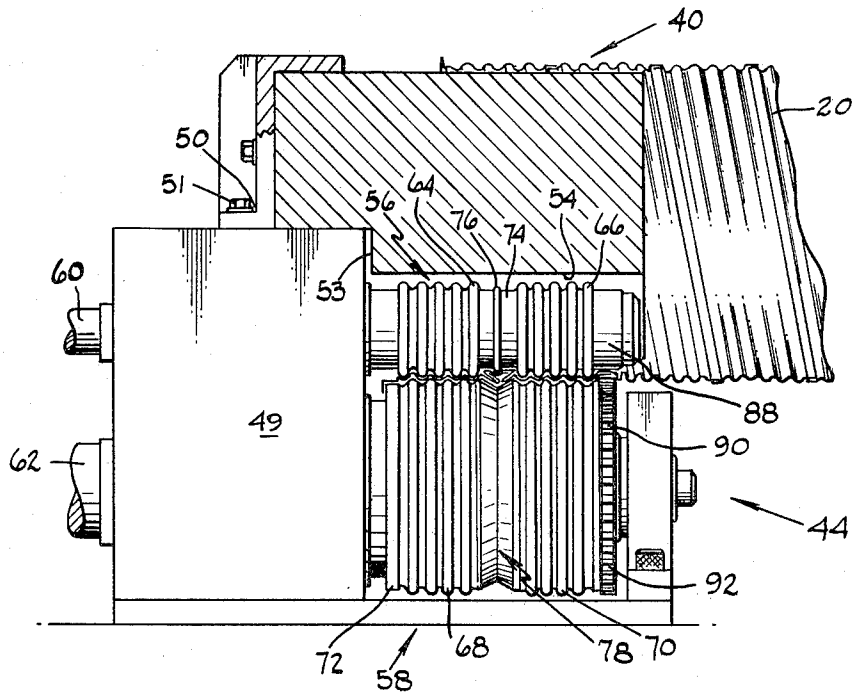


Fig. 1

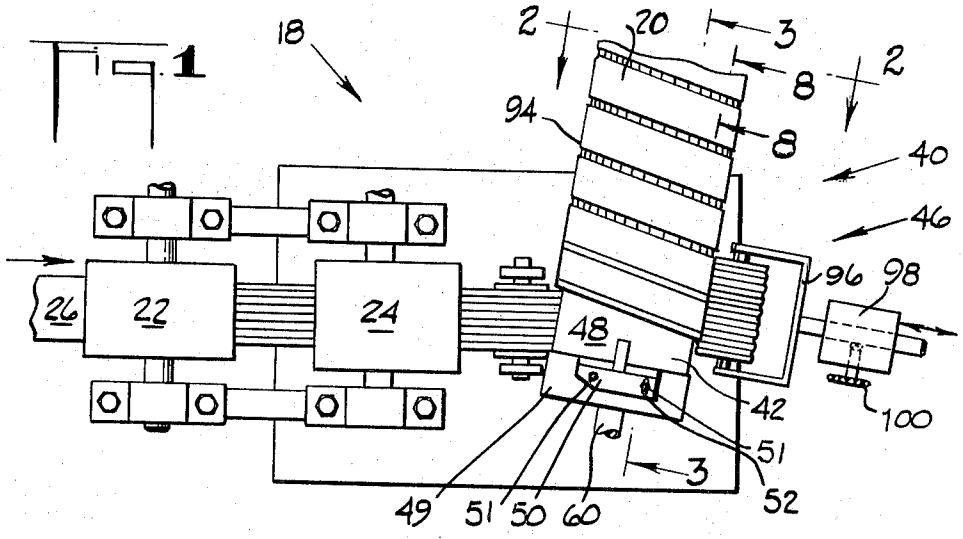


Fig. 2

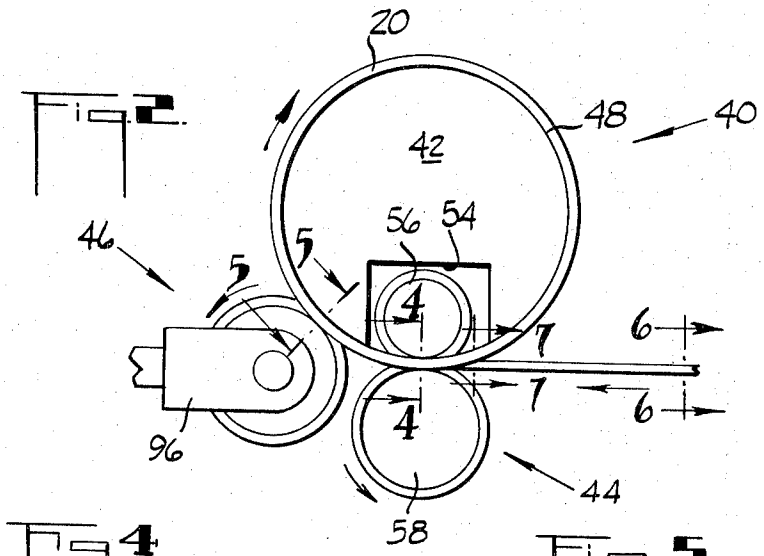


Fig. 4

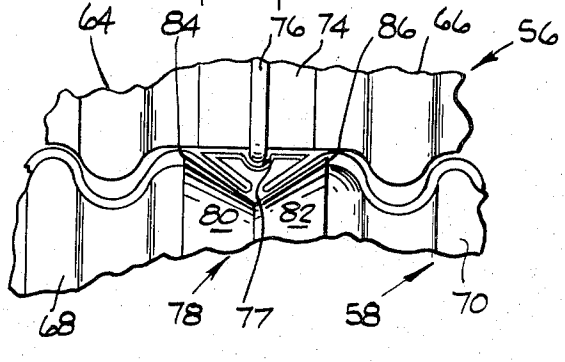


Fig. 5

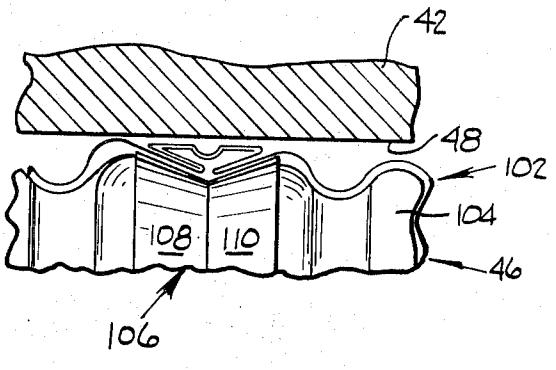


Fig. 3

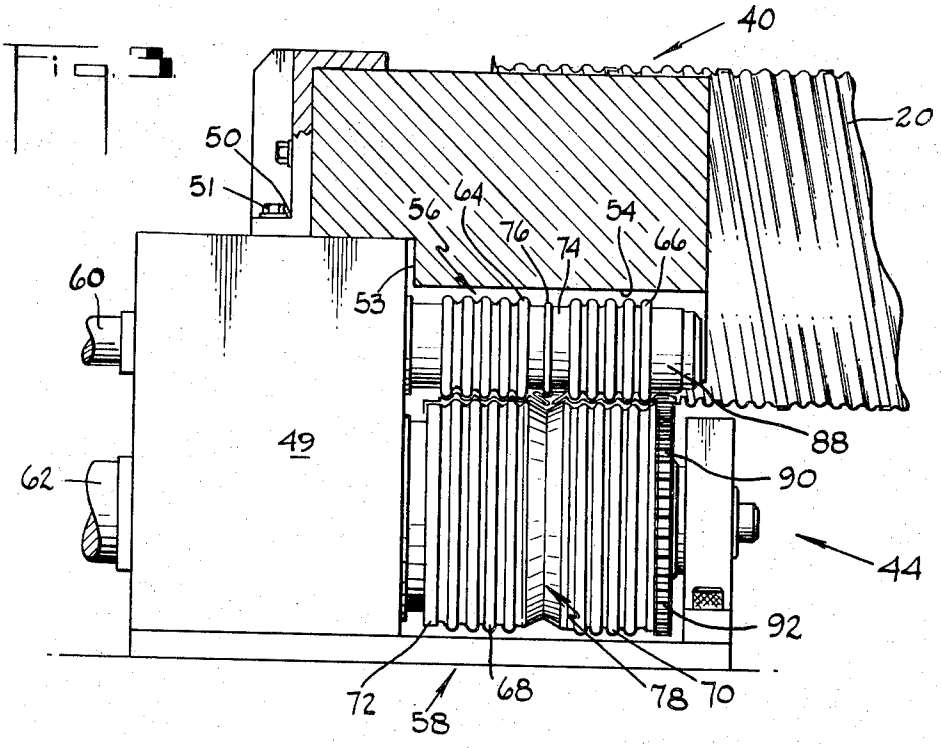


Fig. 6

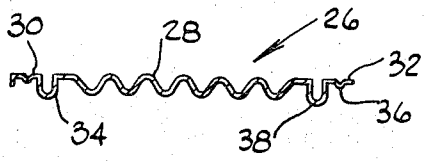


Fig. 7

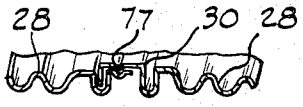
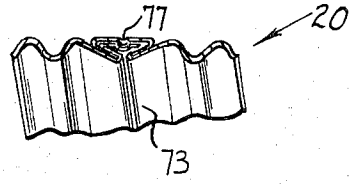


Fig. 8



APPARATUS FOR FORMING CORRUGATED STRIP MATERIAL INTO HELICALLY WOUND TUBING

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for forming corrugated strip material into helically wound tubing and in particular to an improved apparatus for forming helically wound tubing.

U.S. Pat. No. 3,621,884 entitled "Helically Wound Tubing," issued to John Massey Trihey on Nov. 23, 1971, is representative of the general type of apparatus utilized to form helically wound tubing. As shown in FIG. 8 the edge portions of the corrugated strip material are mated together by the central portions of rolls **21** and **22.** Ribs of these edge portions are then turned in by angled deforming rollers **23** to partially form the helical seam of the tubing. The formation of the seam is finished by passing the edge portions between the ends of rolls **21** and **22** which flattens the seam to its final configuration. The apparatus of this patent is also provided with forming heads **17** for guiding the strip material about the mandrel. FIGS. **12** and **17** illustrate variations of this forming apparatus.

In addition to the above patent, applicant is aware of an apparatus wherein a different pair of rolls are substituted for rolls **21** and **22** and the angled deforming rolls **23** are removed. The roll substituted for roll **22** has a generally V-shaped groove centrally located on the roll. The V-shaped groove on this roll has an included angle greater than 90° but the groove is not designed to have an opening equal to or greater than the spacing between outer surfaces of the ribs of the edge portions of the strip material when they are mated together and in addition the mouth of the V-shaped groove is rounded. This roll is designed to cooperate with a second roll which is substituted for roll **21.** This second roll is smooth with the exception of a pair of ribs which straddle the V-shaped groove of the first roll. Due to the narrow width of the mouth and the rounded edges of the mouth of the V-shaped groove, the ribs of the edge portions are not readily deformed inward by the V-shaped groove of these rolls. Instead, the ribs tend to slip out of the groove. In fact the corrugated material tends to become misaligned with respect to the V-shaped groove with the two annular ribs on the one roll not providing the guidance required to maintain the corrugated material in its proper position relative to the forming surfaces of the two rolls.

The present invention provides an apparatus for forming corrugated strip material into helically wound tubing which utilizes a pair of forming rolls for nesting the edge portions of the corrugated sheet material and for effectively initiating the folding over of ribs of the edge portions to partially form the seam connecting adjacent convolutions of the corrugated strip material while accurately guiding the corrugated strip material to prevent the strip material from wandering so that the edge portions remain centered over the forming portions of the rolls.

It is a further object of the present invention to provide a forming surface of one of the rolls with teeth or ribs which cooperate with a backing surface of the other roll to complete the formation of the seam and to provide transverse depressions in the seam to prevent the seam elements from sliding relative to each other

and opening up when the duct is subjected to torsion and to add to the appearance of the duct by disguising any variations in the surface of the seam.

It is a further object of the present invention to eliminate the use of stationary mandrel shoes or forming heads as guides for the strip material and to replace such shoes with a guide roll which will direct the strip material about the mandrel, help form the seam between adjacent convolutions of the tubing and minimize friction between the guide and the strip material.

BRIEF SUMMARY OF THE INVENTION

The present invention is directed to an apparatus for forming corrugated strip material into helically wound tubing wherein the strip material has first and second longitudinal edge portions which are complementary with respect to each other. The second edge portion is adapted to be nested within the first edge portion and each of the edge portions has a longitudinally extending rib spaced inwardly from its longitudinal edges. These ribs are adapted to be folded over toward each other to form a helical seam joining adjacent convolutions of the helically wound tubing. The apparatus includes a wrapping station with a mandrel having a substantially cylindrical surface about which the strip material is convoluted to set the diameter of the tubing. A pair of forming rolls are located adjacent the mandrel at a point where the corrugated strip material is fed into the wrapping station. The rolls are each provided with a series of annular ribs which function to guide the corrugated material and maintain the edge portions of the corrugated material in proper alignment with seam forming surfaces of the rolls. A first set of seam forming surfaces on the rolls comprise a V-shaped groove in one roll and a backing surface on the other roll. Thus, the rolls cooperate to effect the nesting of the edge portions of adjacent convolutions of the strip material and to initiate the formation of the seam by partially folding over the ribs of the edge portions toward each other. The pair of rolls are also provided with a second set of forming surfaces adjacent their trailing ends which complete the formation of the seam. These surfaces include a toothed surface on one roll and a smooth backing surface on the other roll. As the partially formed seam passes between these two surfaces the folding over or flattening of the ribs is completed and transverse notches or depressions are formed in the seam to prevent the seam from separating or pulling apart when the tube is subjected to torsion.

The apparatus is also provided with a guide roll which cooperates with the mandrel to convolute the strip material about the mandrel after it has passed through the first set of forming surfaces of the forming rolls. This roll can be provided with a V-shaped groove which is shallower than the V-shaped groove of the forming rolls and which cooperates with the mandrel to further flatten the ribs of the seam before they are completely flattened by the second set of forming surfaces on the forming rolls.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of the apparatus of the present invention;

FIG. **2** is an end view taken substantially along lines **2—2** of FIG. **2**;

FIG. **3** is a view, partially in section, taken substantially along lines **3—3** of FIG. **1**;

FIG. 4 is a fragmentary view of the forming rolls taken substantially along lines 4—4 of FIG. 2;

FIG. 5 is a fragmentary view of the guide roll taken substantially along lines 5—5 of FIG. 2;

FIG. 6 is a cross-sectional view of the strip material as it is fed into the wrapping station taken substantially along lines 6—6 of FIG. 2;

FIG. 7 is a fragmentary cross-sectional view taken substantially along lines 7—7 of FIG. 2 showing edge portions of the strip material nested together; and

FIG. 8 is a fragmentary cross-sectional view taken substantially along lines 8—8 of FIG. 1 to illustrate the configuration of the seam.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, the apparatus of the present invention is designated by reference numeral 18 and is designed to form corrugated helically wound tubing 20. The apparatus includes a series of forming stations represented by housings 22 and 24 wherein ductile strip material 26 is corrugated and provided with edge configurations such as that illustrated in FIG. 6 by rotating forming rolls (not shown) which are driven by a conventional drive assembly. As shown in FIG. 6, the strip material has a series of corrugations 28 plus a first edge portion 30 and a second edge portion 32. The edge portion 30 has a generally channel shaped configuration with the inner wall of the channel being formed by a rib 34. The edge portion 32 has a flange 36 extending outwardly from a rib 38. However, the edge portion 32 can have a substantially channel shaped configuration as long as the edge portion 32 is complementary in configuration to the edge portion 30 so that it will nest within the edge portion 30 of an adjacent convolution during the wrapping operation.

As best shown in FIGS. 1, 2 and 3 after the strip material has been formed into the configuration illustrated in FIG. 6 it is fed into a wrapping station 40. The wrapping station includes a mandrel 42, a forming roll assembly 44 and a guide roll 46.

The strip material 26 is fed into the wrapping station at an angle with respect to the mandrel 42 with the angle of feed relative to the mandrel depending upon the pitch of the tubing being formed.

The mandrel 42 has a generally cylindrical surface 48 about which the strip material 26 is convoluted. The mandrel can be bolted directly to a support block 49 or affixed to the support block by a bracket assembly 50 which permits the mandrel to be shifted about a pivot point in a horizontal plane to set the pitch of the tubing. As shown in FIG. 1, the bracket assembly 50 is bolted to the support block 49 by a pair of bolts 51. One of the bolts passes through a slot 52 thereby permitting the mandrel to be pivoted about the other bolt when both bolts are loosened To permit the pivotal movement of the mandrel and to help support the mandrel, one end portion of the mandrel has a recess 53 which provides the required clearance between the mandrel and the support block to permit the pivotal movement of the mandrel. With this construction mandrels for different size tubing can be easily installed or removed as required for a particular tube forming operation and the angle of the mandrel can be readily changed to accommodate the pitch of the tubing to be formed.

The mandrel 42 is also provided with a cavity 54 which extends for the length of the mandrel on the underside of the mandrel. The cavity 54 is provided for the forming roll assembly 44 and extends at an angle with respect to the longitudinal axis of the mandrel and perpendicular to the direction of feed of the strip material into the wrapping station. The forming assembly 44 includes an upper roll 56 and a lower roll 58 located directly beneath the upper roll 56. Both of these rolls are driven at the same peripheral speed by conventional drive assemblies (not shown) connected to a motor through drive shafts 60 and 62 respectively. The roll 56 is mounted within the cavity 54 and has an axis of rotation which is horizontal and extends at an angle relative to the longitudinal axis of the mandrel and perpendicular to the direction of feed of the strip material 26 into the wrapping station. This roll is provided with two sets of annular ribs 64 and 66. Successive ribs of each set are spaced from each other so that the ribs extend into the corrugations 28 of the strip material 26 to guide the strip material. The roll 58 rotates on an axis parallel to the axis of rotation of the roll 56 and is also provided with two sets of annular ribs 68 and 70. These ribs are also spaced relative to each other so that the ribs extend into the corrugations 28 of the strip material 26 to maintain the strip material in proper alignment for the seam forming process. The set of ribs 68 included a flattened rib 72 at one end which is received within the channel shaped edge portion 30 of the strip material to help maintain the proper alignment of the strip material.

The sets of ribs on each roll are separated by forming surfaces which initiate the formation of the seam 73 for the helically wound tubing. On the roll 56 the sets of ribs 64 and 66 are separated by a cylindrical forming surface 74 provided with a centrally located annular rib 76. The annular rib 76 extends into nested grooves 77 of the edge portions 30 and 32 to maintain the edge portions in proper alignment for the seam forming operation and to prevent the grooves 77, which add to the strength of the seam 72 from being eliminated from the seam during this stage of the seam forming operation.

The opposing surface on the roll 58 is a V-shaped groove 78. The V-shaped groove 78 is defined by a pair of annular surfaces 80 and 82 which have an included angle of at least 90 degrees and preferably 110 degrees. As best shown in FIG. 4 the outer edges of the surfaces 80 and 82 are not convex. Instead, the surfaces 80 and 82 extend straight out from their juncture to their outer edges 84 and 86 at the mouth of the groove or are slightly concave. The width of the groove 78 is such that the outer edges 84 and 86 of the groove are spaced from each other a distance equal to or greater than the spacing between the outer surfaces of the ribs 34 and 36 of the nested edge portions. Thus, the ribs on the rolls 56 and 58 accurately guide the strip material 26 relative to the forming surfaces 74 and 78 and maintain the edge portions properly centered relative to the forming surfaces 74 and 78. With the edge portions properly centered, the cross-sectional contour of the V-shaped groove and the width of the groove at its mouth are such that the ribs 34 and 38 of the nested edge portions 30 and 32 are forced inwardly by the surfaces 80 and 82 of the groove to initiate the formation of the seam. The ribs 34 and 38 should be folded over to such an extent that the included angle formed between the planes of the ribs is at least 90° and preferably about 110°. The degree to which the ribs can be folded over in this initial phase of the seam forming

process is limited. If the ribs are folded over too much at this initial stage of the seam forming process the edge portions of the strip material may not mate properly.

The rolls **56** and **58** are also provided with a second set of forming surfaces at their trailing ends which are spaced from the first set of forming surfaces a distance (centerline to centerline) equal to the pitch of the seam. In this manner, as the partially formed seam, formed by the first pair of forming surfaces, passes back between the rolls **56** and **58** at the second set of forming surfaces the formation of the seam is completed. The roll **56** has a substantially cylindrical forming surface **88** and the roll **58** is provided with an opposing forming surface **90** having a series of teeth **92** annularly spaced about the surface. The teeth **92** extend parallel to the axis of rotation of the roll **58** and consequently the teeth **92** extend in a direction which is transverse to the helical seam **73** joining the adjacent convolutions of the helically wound tubing **20.** The teeth **92** form spaced apart transverse depressions **94** in the seam which prevent the seam **73** from coming apart when subjected to torsion.

The guide roll **46** is best shown in FIGS. **1, 2** and **5.** The guide roll **46** is rotatably mounted on a bracket or yoke **96.** The bracket **96** is slidably mounted on a block **98** so that it can be moved back and forth in a horizontal plane relative to the rolls **56** and **58** to change the radial distance between the guide roll and the centerline of the mandrel **42.** The guide roll **46** guides the strip material **26** after it has passed through the rolls **56** and **58** to convolute the strip material up and around the mandrel **42** so that the strip will pass back through the rolls **56** and **58** to complete the seam forming operation. The roll **46** is adjustable with respect to the rolls **56** and **58** and the mandrel **42** so that the roll **46** can be properly positioned and locked in place by a locking stud **100** for different size mandrels which are installed on the apparatus. When the mandrel **42** is placed on the apparatus, the roll **46** is adjusted to cooperate with the mandrel with a peripheral surface **102** of the roll and the peripheral surface **48** of the mandrel being separated only enough to allow the strip material **26** to pass therebetween. The peripheral surface **102** of the roll **46** is provided with a plurality of spaced apart ribs **104** which enter the corrugations of the strip material **26** to guide the strip material. In addition, the roll can be provided with an annular V-shaped groove **106** which cooperates with the peripheral surface **48** of the mandrel to further fold over the ribs **34** and **38** of the seam. While such a groove does not have to be utilized, it does help the forming process by folding the ribs farther over in preparation for the final forming operation performed by the surfaces **88** and **90.** The included angle of the surfaces **108** and **110** forming the V-shaped groove **106** is greater than the included angle between the surfaces **80** and **82** of the V-shaped groove **78.** In the preferred embodiment the included angle is about 150°. Again, the spacing between the outer edges of the V-shaped groove **100** is such that the ribs **34** and **38** of the seam are contained between these edges.

In operation, a strip of material **26** is passed through a series of forming rolls until the strip material has a cross-sectional configuration such as that illustrated in FIG. **6.** At this stage of the process the strip has been corrugated and provided with the complementary edge portions **30** and **32.** As the strip material **26** approaches the forming rolls **56** and **58,** the edge portion **32** is nested within the edge portion **30** of a preceding convolution as illustrated in FIG. **7.** As the nested edge portions pass between the forming surfaces **74** and **78** of rolls **56** and **58** the folding over of the ribs **34** and **38** is initiated. The strip material with the partially formed seam then passes between the guide roll **46** and the mandrel **42.** If the guide roll is provided with a forming surface **106** the ribs **34** and **38** of the partially formed seam are folded over even more. Finally after one revolution the partially formed seam passes back between the forming surfaces **88** and **90** wherein the seam **73** is completely flattened and transverse depressions or grooves **94** are formed in the seam to prevent the seam **73** from pulling apart under torsion.

It is to be understood that for the purposes of illustration the spacing between the peripheral surfaces of the rolls **56** and **58,** between the peripheral surfaces of the guide roll **46** and mandrel **42** as well as the spacing between the folds of the seam **73** have been exaggerated for illustrative purposes. In practice the spacings between the forming surfaces are quite small so that the folds of the seam are compacted and flattened to form a very tight seam.

What is claimed is:

1. Apparatus for forming corrugated strip material into helically wound tubing wherein said strip material has first and second longitudinal edge portions which are complementary with respect to each other with said second edge portion being adapted to be nested within said first edge portion and with each of said edge portions having a longitudinally extending rib means spaced inwardly from the longitudinal edges of said strip material with said rib means being adapted to be folded over toward each other to form a seam of the helically wound tubing, comprising:

mandrel means having a surface about which said strip material is convoluted to set the diameter of the tubing, said mandrel means having a longitudinal axis,

forming roll means located adjacent said mandrel means for nesting said second edge portion within said first edge portion and for initiating a folding over of said rib means toward each other to partially form a seam, said forming means including a roll with a V-shaped groove therein having faces which engage said rib means to initiate the folding over of said rib means, said V-shaped groove having an included angle between said faces greater than 90°, and said V-shaped groove having a mouth with a width greater than the distance between the outer faces of said rib means of the nested edge portions, a second roll with a backing surface which opposes said V-shaped groove, said rolls being rotatably mounted on the apparatus, and each of said rolls having a series of spaced apart annular ribs which extend into corrugations of said strip material to guide said strip material so that said nested edge portions of said strip material are centered with respect to said V-shaped groove, and

means for feeding said strip material into said forming roll means and about said mandrel at an angle relative to the longitudinal centerline of said mandrel.

2. Apparatus as defined in claim **1** wherein:

said forming means has flattening means which includes a surface with teeth thereon which engage and extend transversely with respect to the par-

tially formed seam of the helical tubing after the seam has been partially formed by said V-shaped groove to complete the folding over of said rib means and the formation of said seam.

3. Apparatus as defined in claim **2** wherein:

said flattening means has a centerline that is spaced from a centerline of said V-shaped groove a distance equal to the pitch of the seam of the helically wound tubing.

4. Apparatus as defined in claim **1** and further comprising:

a rotatably mounted guide roll located adjacent said mandrel surface for directing said strip material after it passes through said forming means to convolute said strip material about said mandrel.

5. Apparatus as defined in claim **4** wherein:

said guide roll includes a V-shaped groove having faces for engaging said rib means of the partially formed seam formed by said forming means to further fold over said rib means, and said V-shaped groove of said guide roll having an included angle between said faces thereof greater than the included angle of the V-shaped groove of said forming means.

6. Apparatus as defined in claim **1** wherein said faces of said V-shaped groove extend in a straight line from the juncture of said faces to their outer edges.

7. Apparatus as defined in claim **1** wherein:

said included angle is at least 110°.

8. Apparatus as defined in claim **5** wherein:

said included angle of said V-shaped groove of said guide means is at least 140°.

9. Apparatus as defined in claim **5** wherein:

said manrel is replaceably mounted on said apparatus, and

said guide roll is mounted on a support means which can be adjusted to move said guide roll to change the radial distance between the central axis of said mandrel and said guide roll so that said guide roll can be relocated to accommodate different size mandrels.

10. Apparatus as defined in claim **1** including adjustment means for adjusting the angle between the longitudinal centerline of the strip material being fed about said mandrel and the longitudinal axis of said mandrel to enable the mandrel to be set to accommodate the pitch of the tubing being formed.

* * * * *