United States Patent [19]

Meserole

[11] 3,865,146

[45] Feb. 11, 1975

[54] **HELICALLY WOUND TUBING AND METHOD OF FORMING THE SAME**

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

[22] Filed: **Mar. 22, 1974**

[21] Appl. No.: **453,621**

[52] **U.S. Cl.** **138/154,** 138/173, 72/50

[51] **Int. Cl.** **F16l 9/16,** B21c 37/12

[58] **Field of Search** 72/49, 50, 368, 370, 371, 72/379; 138/154, 144, 135, 173

[56] **References Cited**

UNITED STATES PATENTS

3,621,884 11/1971 Trihey 138/154

Primary Examiner—Richard J. Herbst
Assistant Examiner—Robert M. Rogers
Attorney, Agent, or Firm—Robert M. Krone; John D. Lister

[57] **ABSTRACT**

A tube is formed by spirally winding a metal strip with the lateral edges of adjacent convolutions of the strip overlapping and being locked together with a seven-fold seam. The strip utilized to form the tube is corrugated for strength and transverse crimps are placed in the seven-fold seam to increase the torsional strength of the seven-fold seam.

6 Claims, 9 Drawing Figures

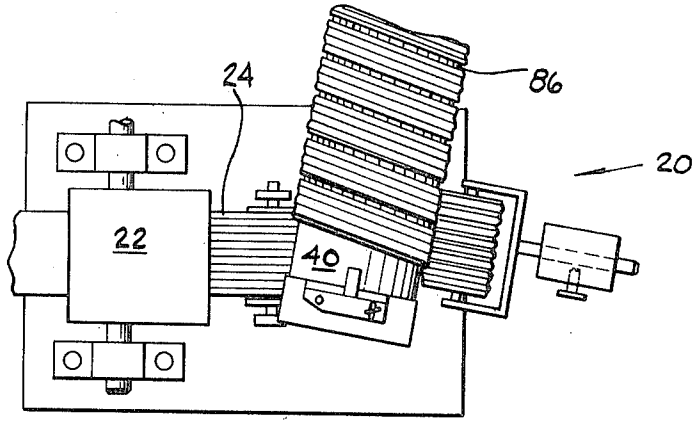


Fig. 1

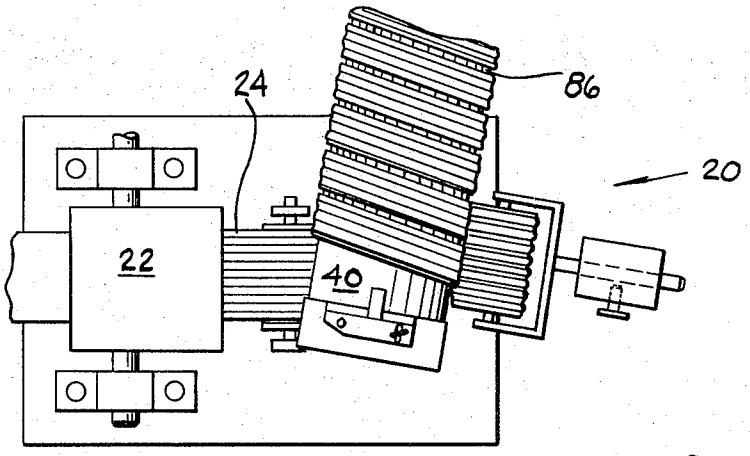


Fig. 9

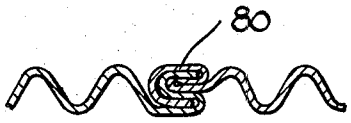


Fig. 2

Fig. 3.

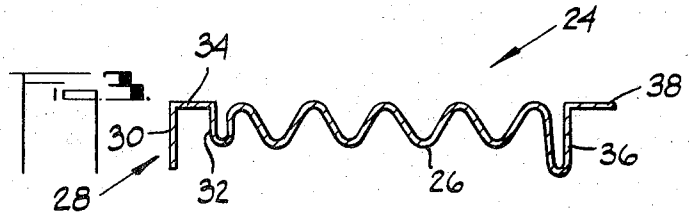


Fig. 4.

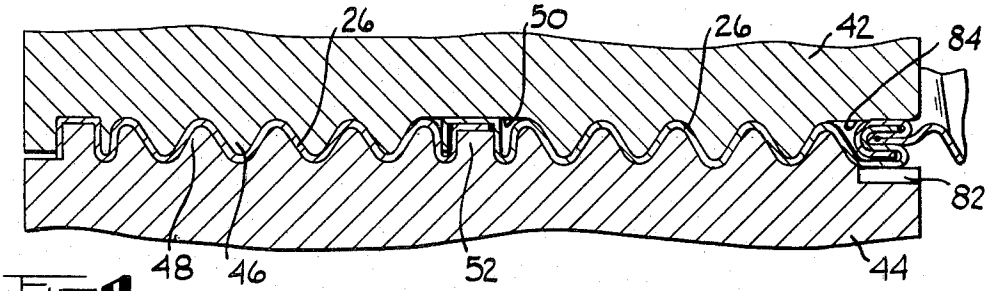


Fig. 5.

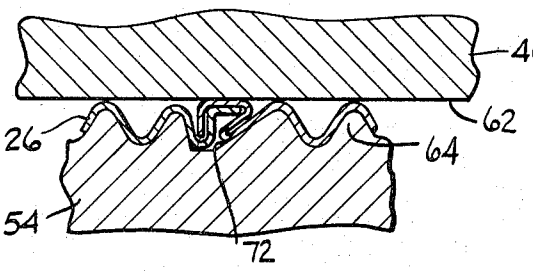


Fig. 6.

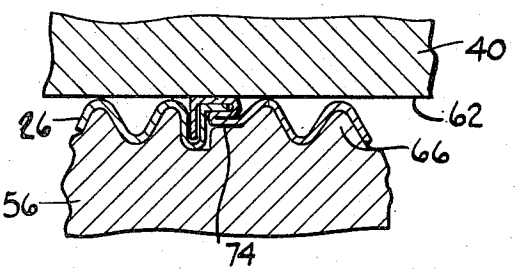


Fig. 7.

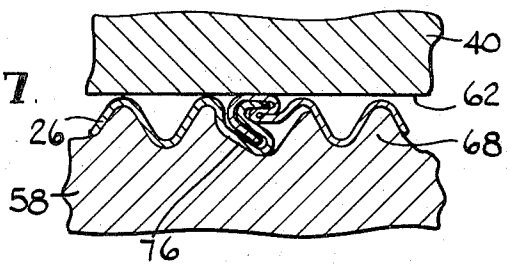
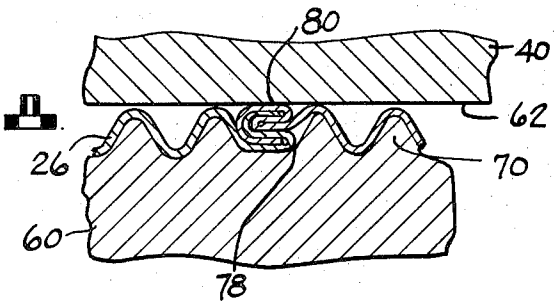


Fig. 8.



HELICALLY WOUND TUBING AND METHOD OF FORMING THE SAME

BACKGROUND OF THE INVENTION

The present invention is directed to a method of forming a tube of helically wound strip material and in particular to a tube with a seven-fold seam and an improved method of forming a tube with a seven-fold seam.

U.S. Pat. No. 3,435,852 issued Apr. 1, 1969 to J. M. Trihey and U.S. Pat. No. 3,621,884 issued Nov. 23, 1971 to J. M. Trihey are representative of the helically wound tubing utilizing seams formed by methods of the prior art. U.S. Pat. No. 3,435,852 utilizes a seven-fold seam. However, the method of forming the seven-fold seam utilized in U.S. Pat. No. 3,435,852 poses certain problems which the method of the present invention overcomes.

The method shown by U.S. Pat. No. 3,435,852 utilizes a deep narrow corrugation and complementary flange which are folded over twice to form the seven-fold seam. Thus, this method requires substantial drawing and reforming operations. While this method would be practical for a ductile metal such as aluminum, the use of less ductile metals such as steel and stainless steel could result in buckling or wrinkling of the metal at the seam or other forming problems.

The method of the present invention utilizes a pair of narrow corrugations rather than one corrugation. These corrugations do not have to be as deep as the corrugation used in the method of U.S. Pat. No. 3,435,852. Thus, the method of the present invention greatly reduces the amount of drawing and reforming required to form the seam and makes less ductile metals such as steel and stainless steel more readily usable for a duct with a seven-fold seam.

BRIEF SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method of forming helically wound tubing wherein the seven-fold seam is formed by the use of simple bending and pressing operations which make the method suitable for use with materials such as steel and stainless steel as well as more ductile materials such as aluminum.

The method of the present invention comprises forming a tube by spirally winding a metal strip while overlapping lateral edges of adjacent convolutions of the strip and locking them together with a seven-fold seam. The improvement in the method of forming the seam includes forming a longitudinally extending channel in a first lateral edge of the strip. The channel is defined by an outer wall, an inner wall which is a corrugation, and a web which joins the inner and outer walls. The second lateral edge of the strip is formed with a longitudinally extending corrugation and a flange extending outward from the corrugation. The strip is convoluted with the edges overlapping. The flange of the second edge is received within the channel of the first edge and the outer wall of the channel is received within the corrugation of the second edge. One of the corrugations is folded over toward the other corrugation and upon the flange. Next, the other corrugation is folded over upon the one corrugation and a seven-fold seam is formed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of an apparatus for carrying out the method of the present invention with some of the forming rolls omitted;

FIG. 2 is an end view of the apparatus taken substantially along lines 2—2 of FIG. 1;

FIGS. 3–8 are cross-sectional views taken along lines 3—3 through 8—8 of FIG. 2 to illustrate the formation of the seam by the method of the present invention;

FIG. 9 is a longitudinal cross-sectional view through a portion of a duct formed by the method of the present invention to illustrate the finished seam.

DETAILED DESCRIPTION AND PREFERRED EMBODIMENTS

FIGS. 1 and 2 illustrate an apparatus 20, similar to the apparatus disclosed in my copending application Ser. No. 392,398 filed Aug. 28, 1973, for forming helically wound tubing by the method of the present invention. The apparatus 20 includes a series of forming rolls represented by box 22 for forming a flat strip of aluminum, steel, stainless steel or other formable material into a strip 24 having a series of longitudinally extending corrugations 26.

As shown in FIG. 3, a first lateral edge of the strip 24 is provided with a longitudinally extending channel 28. The channel is defined by an outer wall 30 extending at substantially right angles to the plane of the strip, an inner wall 32 defined by a narrow corrugation and extending generally perpendicular to the plane of the strip and a web 34 extending between and joining the inner and outer walls. The other lateral edge of the strip is provided with a narrow corrugation 36 which extends generally perpendicular to the plane of the strip and a flange 38 which extends outward from the base of the corrugation 36 in a direction generally parallel to the plane of the strip.

As illustrated in FIGS. 1 and 2, the strip 24 is convoluted about a cylindrical mandrel 40. As a portion of the strip is introduced onto the mandrel, rotatably driven forming rolls 42 and 44 cause the flange 38 of the strip 24 to nest within the channel 28 of a preceding convolution of the strip and the outer wall 30 of the channel of the preceding convolution to nest within the corrugation 36 of the portion of the strip being introduced onto the mandrel. As shown in FIG. 4, the forming rolls 42 and 44 are provided with corrugations 46 and 48 which are complementary in configuration to the corrugations 26 of the strip 24. The roll corrugations 46 and 48 engage portions of adjacent convolutions of the strip 24 on either side of the lateral edges being nested to assure that the lateral edges are properly aligned for nesting. An annular groove 50 in the roll 42 and an annular rib 52 in the roll 44 cooperate to nest the lateral edges of the strip 24 before any deformation of the edges is commenced as the formation of the seam proceeds.

Once the adjacent convolutions of the strip 24 are nested by rolls 42 and 44, the nested portions of the convolutions are passed between the mandrel 40 and rotatably mounted forming rolls 54, 56, 58, and 60. Each of these rolls cooperates with the smooth peripheral surface 62 of the mandrel 40 to complete the formation of the seam. As best shown in FIGS. 5–8, the rolls 54, 56, 58, and 60 are provided with annular corrugations 64, 66, 68, and 70, respectively. These corrugations are complementary in configuration to the corrugations 26 of the strip 24 and are located on both sides of annular forming surfaces 72, 74, 76, and 78 of

the rolls to assure that these forming surfaces are properly aligned with the nested edge portions of the adjacent strip convolutions to carry out the seam formation.

As shown in FIG. 5, after the lateral edges of the adjacent convolutions of the strip have been nested, the lateral edge portions are passed between the forming roll 54 and the mandrel 40. The forming surface 72 of the roll is a frusto conical surface extending at an angle of about 45° relative to the axis of the roll. The surface 72 engages the corrugation 32 and bends the corrugation 32 from its original perpendicular position to a position where the corrugation 32 extends over the flange 38 at an angle of about 45° relative to the plane of the strip.

The nested lateral edge portions are then passed between the forming roll 56 and mandrel 40. The forming surface 74 of the roll is cylindrical and the clearance between surface 74 and the surface 62 of the mandrel is such that the corrugation 32 is folded down tightly upon the flange 38 to complete the folding over of the corrugation 32 to lock the flange 38 in place.

Once the corrugation 32 has been folded over, the nested portions of the strip are passed between forming roll 58 and mandrel 40. The corrugation 36, with the outer wall 30 of the channel 30 located therein, is folded over toward the corrugation 32 by the frusto conical forming surface 76 of the roll 58. In this step the corrugation 36 and wall 30 are bent from their substantially perpendicular position to a position of about 45° relative to the plane of the strip.

Next, the nested portions of the strip are passed between the forming roll 60 and the mandrel 40 to complete the formation of the seam. The forming surface 72 of this roll is cylindrical. The forming surface 72 engages the corrugation 36 and bends it over flat upon the corrugation 32 thereby forming a seven-fold seam 80.

As shown in FIG. 4, if additional torsional strength is desired for the seam 80, the seam can be passed back between forming rolls 42 and 44 wherein a toothed peripheral surface 82 on the roll 44 cooperates with a cylindrical anvil surface 84 on roll 42 to put a series of transverse crimps 86 in the spiral seam. These transverse crimps give the duct greater torsional strength by resisting movement of one seam element relative to the other in a direction parallel to the longitudinal centerline of the seam 80.

As best shown in FIG. 9 the seam 80 formed by the method of the present invention includes seven folds. The outer wall 30, the inner wall 32 which is defined by a corrugation, and the web 34 form four folds of the seam. The flange 38 and the corrugation 36 form the other three folds of the seam. If both of the lateral edges are given a channel-shaped configuration, the method of the present invention can be utilized to form an eight-fold seam. While the seam shown in FIG. 9 has the inner wall 32 folded over upon the flange 38, the corrugation 36 can be folded over upon the flange 38 to form a seven-fold seam with a somewhat different configuration. However, the illustrated seam is preferred in that it forms a seam which is less susceptible to leakage. In either case the corrugation which is folded over upon the other corrugation should be somewhat deeper than the other corrugation so that when it is folded over it will cover the other corrugation.

It is to be understood that for the purposes of illustration the spacing between the peripheral surfaces of the rolls 42 and 44; between the peripheral surfaces of the mandrel 40 the forming rolls 54, 56, 58 and 60; and the spacing between the folds of the seam 80 have been exaggerated. 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 I claim is:

1. In a method of forming a tube comprising spirally winding a metal strip, overlapping lateral edges of adjacent convolutions of the strip and locking together the lateral edges to form a locking seam, the improvement comprising:
   a. forming a longitudinally extending channel in a first lateral edge of the strip, said channel having an outer wall and an inner wall extending at substantially right angles to the plane of the strip, and said inner wall being a first corrugation;
   b. forming a longitudinally extending second corrugation and a flange in a second lateral edge of the strip, said second corrugation extending at substantially right angles to the plane of the strip and said flange extending outward from said second corrugation and generally parallel to the plane of the strip;
   c. convoluting the strip and overlapping the lateral edges of adjacent convolutions with the flange being received within the channel and the outer wall of said channel being received within said second corrugation;
   d. folding over one of said corrugations toward the other of said corrugations and upon the flange; and
   e. folding over the other of said corrugations upon said one of said corrugations.

2. The improvement as defined in claim 1 wherein:
   a. said first corrugation is folded over first; and
   b. said second corrugation is folded over upon said first corrugation.

3. In a tube comprising a spirally wound metal strip wherein lateral edges of adjacent convolutions of the strip overlap and are locked together by a seam, the improvement in the seam comprising
   a. a first lateral edge of the strip forming a first element of said seam, said first lateral edge comprising a first fold which terminates at the first lateral edge of said strip, a second fold, a third fold and a fourth fold, said third and fourth folds forming a corrugation which is connected to said first fold by said second fold,
   b. a second lateral edge of the strip forming a second element of said seam, said second lateral edge comprising a fifth fold which extends from sixth and seventh folds that form a second corrugation, and
   c. said first fold being received within said second corrugation, said second and said fifth folds being adjacent seam folds, one of said corrugations being folded over upon said fifth fold and the other of said corrugations being folded over upon the one corrugation with all of said folds extending substantially parallel with respect to each other.

4. The improvement as defined in claim 3 wherein: said fifth fold terminates at the second lateral edge of said strip.

5. The improvement as defined in claim 4 wherein: said first corrugation is folded over upon said fifth fold.

6. The improvement as defined in claim 3 wherein: said first corrugation is folded over upon said fifth fold.

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