United States Patent

Kuypers et al.

[15] **3,656,331**

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[54] APPARATUS FOR PRODUCING ANNULAR CORRUGATED TUBING

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[30] **Foreign Application Priority Data**

Mar. 29, 1969 Germany ..... P 19 16 357.6

[52] **U.S. Cl.** **72/77,** 72/123

[51] **Int. Cl.** **B21d 15/06**

[58] **Field of Search** 72/77, 78, 121, 122, 123, 367

[56] **References Cited**

UNITED STATES PATENTS

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[57] **ABSTRACT**

Apparatus for continuously forming annular corrugations in moving tubing including a rotatable housing, a die holder adjustably mounted in the housing, and a die mounted in the die holder, wherein the die comprises a ring-shaped member with a helical forming rib on the inner edge thereof.

7 Claims, 9 Drawing Figures

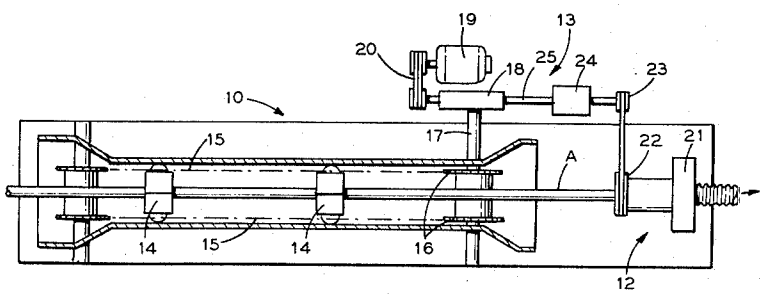

FIG. 1

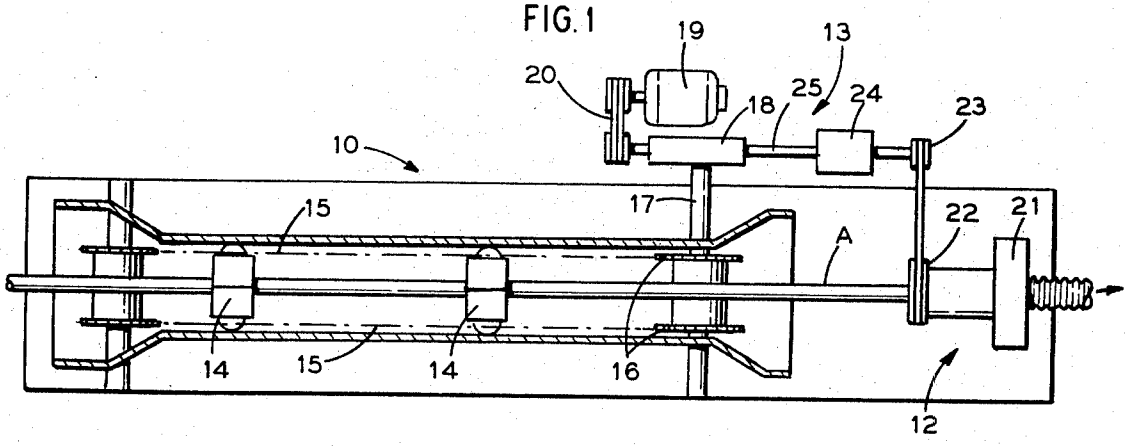

FIG. 5

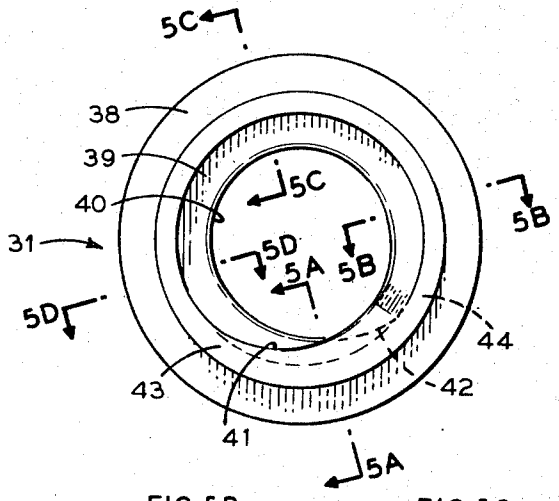

FIG. 5A

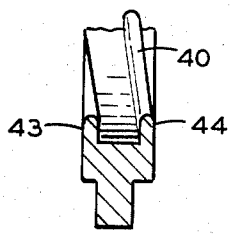

FIG. 5B

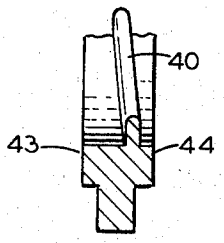

FIG. 5C

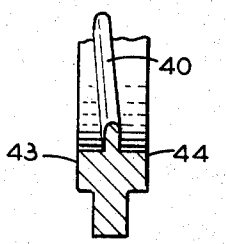

FIG. 5D

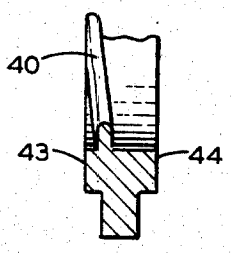

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FIG. 3

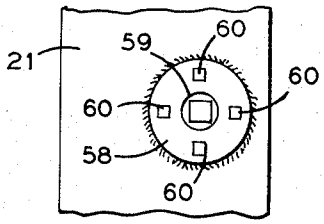


FIG. 2

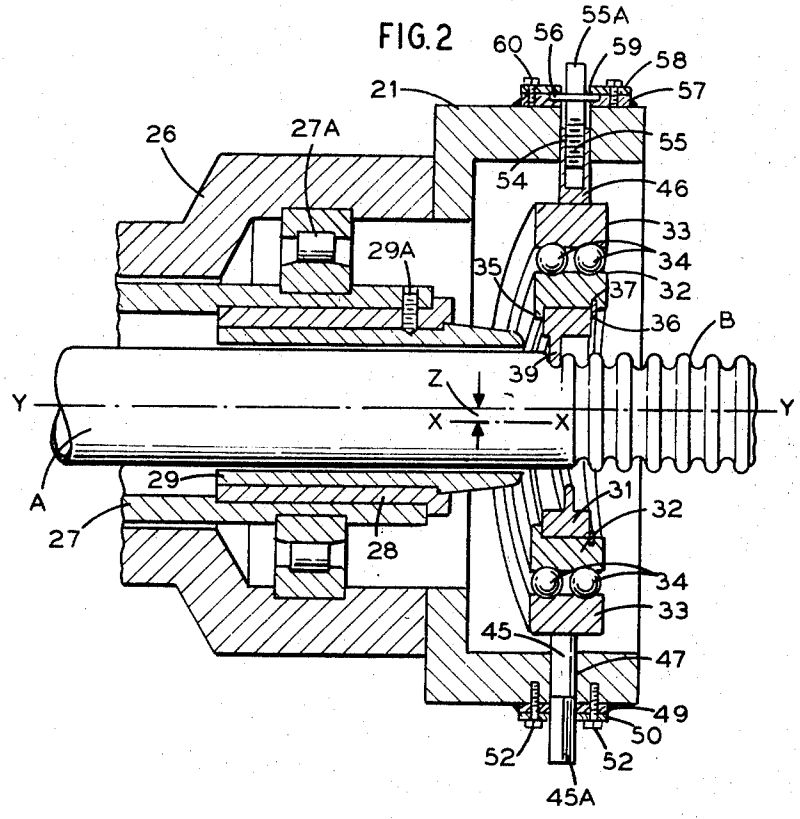
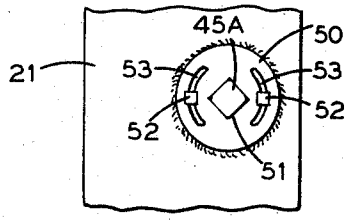


FIG. 4



APPARATUS FOR PRODUCING ANNULAR CORRUGATED TUBING

BACKGROUND OF THE INVENTION

The present invention relates to apparatus for forming annular corrugations on thin-walled, smooth tubing, on a continuous, uninterrupted basis.

It has been known in the art to corrugate tubing, particularly thin-wall metal tubing, so as to obtain helical corrugation of a selected depth and pitch; see German Pat. application No. 1,086,314; German Pat. No. 690,183; U.S. Pat. No. 2,419,678.

Other apparatus is known in the art by which annular corrugations are formed in tubing. Whereas generally speaking a helical corrugation is particularly characterized by a continuous helically extending groove alternating with a continuous helically extending crest; an annular corrugation is characterized by a series of alternating annular grooves and crests. The latter type of corrugation is also known as parallel corrugation, as the annular crests and grooves extend parallel to a transverse plane across the longitudinal axis.

Various forms of apparatus have been suggested for forming annular corrugations in tubing. However, such known apparatus is usually of the intermittent and non-continuous type. Further, such known apparatus inherently has a relatively low production rate. The problem therefore has existed for some time to provide apparatus for forming annular corrugations in tubing on a continuous, uninterrupted, and non-intermittent basis.

Accordingly an object of this invention is to provide apparatus for corrugating tubing which includes improved die means for continuously forming annular corrugations in continuously moving tubing.

Another object of this invention is to provide corrugating apparatus adapted to selectively form helical or annular corrugations in tubing; the forming die means specifically useful for producing annular corrugations being interchangeable with the die means specifically used for forming helical corrugations.

Still another object of this invention is to provide in corrugating apparatus of the character described an improved corrugating die of relatively simple construction and which includes a single unitary annular die body having a helical forming rib integrally related to the inner edge of the body.

Still a further object of this invention is to provide in corrugating apparatus of the character described, improved corrugating annular die means, together with means for mounting die means in a manner to impress or roll successive annular corrugations in a tubing continuously moving through the die.

Still another object of this invention is to provide in corrugating apparatus of the character described, improved corrugating means which includes a rotatable cylindrical housing, a die holder adjustably mounted in the housing and a die mounted in the die holder wherein the die and holder may be adjustably located within the housing, to a selected angle relative to a plane extending transversely to the longitudinal axis of the housing.

Yet another object of this invention is to provide apparatus for corrugating tubing of the character described, improved corrugating means including a housing, a holder and a corrugating die mounted in the holder, together with means for selectively adjusting the position of the die and its holder in a plane transversely related to the longitudinal axis of the housing, whereby to selectively adjust the depth of the annular corrugations formed in the tubing.

Still another object of this invention is to provide apparatus for corrugating tubing and including improved annular corrugating die means having a helical forming rib on the inner edge thereof for passing the tubing through the die for engagement of the wall thereof by the helical rib of the die, the die being so arranged as to be rotatable relative to the housing and thereby to continuously and progressively impress with a rolling motion annular corrugations in the tubing wall.

Other objects of this invention will in part be obvious and in part hereinafter pointed out.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram showing a system for producing annular corrugations in a moving tubing in accordance with the instant invention;

FIG. 2 is a sectional view showing the details of the corrugating die assembly, forming part of said system;

FIG. 3 is a top plan view showing a portion of one adjustment means for the die assembly;

FIG. 4 is a top plan view showing a detail of another adjustment means for the corrugating die assembly;

FIG. 5 is a plan view of the corrugating die incorporated in the die assembly;

FIGS. 5A, 5B, 5C and 5D are transverse sectional views taken on the lines 5A — 5A, 5B — 5B, 5C — 5C and 5D — 5D, in FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring in detail to the drawings, and particularly to FIG. 1, 10 designates a system for continuously corrugating tubing to provide successively annular corrugations therein; in accordance with the instant invention.

System 10 comprises capstan means generally indicated at 11, for transporting smooth wall tubing A in a longitudinal path for corrugation; corrugating means generally indicated at 12; together with means generally indicated at 13 for driving and coupling transport means 11 and corrugating means 12 for conjoint operation.

Tubing transport means 11, may be of the type more specifically shown and described in U.S. Pat. No. 3,085,729. Essentially such transport means or capstan includes a series of split clamps 14 mounted on a pair of parallel endless chains 15 which in turn are driven by sprockets 16. Sprockets 16 are coupled to a drive shaft 17 of a gear box 18, which in turn is connected to a motor 19 by belt drive means 20.

Corrugating means 12 includes a rotatable annular housing 21 open on one face thereof and which is suitably connected to a drive assembly 22, 23; element 23 being coupled to one side of an infinitely variable ratio drive transfer means 24, and other side thereof being coupled by a drive shaft 25 to gear box 18. Thus housing 21 is rotated at a speed proportioned to the linear speed of the moving tube A.

The corrugating means 12 is adapted to pass tubing A axially therethrough for the purpose of impressing successive annular corrugations thereon. Said means 12 comprises a bushing 26 to which the annular housing 21 is suitably attached, as shown in FIG. 2. Concentrically located within bushing 26 is a sleeve 27; the housing 21 and bushing 26 being rotatable relative to said sleeve 27 with bearing 27A deposed therebetween.

A collar 28 is mounted on the inner surface of sleeve 27 and carries a guide sleeve 29, said guide sleeve 29, collar 28 and sleeve 27 being held together by a screw 29A. The tubing A passes axially through guide sleeve 29 and is presented to a corrugating assembly generally indicated at 30 which is mounted within housing 21.

Corrugating assembly 30 comprises a corrugating die 31 which in turn is mounted on the innermost annular bearing member 32 concentrically positioned within outermost annular bearing member 33, with ball bearings 34 therebetween.

The die 31 is mounted on the inner side of the innermost bearing member 32 by way of an annular shoulder 35 projecting radially inward and a split ring 36 received in an annular slot 37 formed on the inner surface of member 32. It is understood that die 31 may be readily separated from bearing member 32 by removing the split ring 36, for the purpose of replacing the same with other selected die members for forming annular corrugations of different dimensions. Furthermore die 31 can be replaced by dies for forming helical corrugations in tubing, rather than annular corrugations, if so desired.

Die 31, as shown in FIGS. 5 and 5A – 5D, comprises an annular portion 38 having a helical forming rib portion 39 extending generally radially inwardly thereof. Rib portion 39 has its apex 40 of uniform radial dimension over an angular extent somewhat less than 360°. The terminal portions 41, 42 of said rib portion 39 are in laterally spaced but overlapping relation. Further said terminal rib portions 41, 42 are of progressively decreasing radial dimension. The pitch of the helical rib portion 39 is predetermined in accordance with the spacing of the desired corrugations in tubing A indicated at *a*.

The terminal portion 41 of rib portion 39 is flush on its outer surface with one face 43 of die member 31; while the terminal portion 42 has its outer surface flush with the other face 44 of the die member 31.

In order that die member 31 be operative to impress successive annular corrugations in tubing A it has been found that the corrugating assembly 30 must be deposed in tilted relation to the longitudinal axis of the housing 21. To this end the assembly 30 is provided with journal shafts 45, 46 extending radially and outwardly from the outermost bearing member 33. Said journal shafts 45, 46 being received in diametrically opposed bearing openings 47, 48 respectively, formed in housing 21.

Means is provided for adjustably moving said assembly 30 by way of journal shafts 45, 46, to selected angular positions.

To this end the journal shaft 45 has the outer end portion thereof of square cross-section as indicated at 45A which portion 45A projects through a circular opening in plate 49 fixed to an outer surface portion of housing 21. A shifting plate 50 having a square opening 51 for passing shaft portion 45A therethrough is movably mounted on plate 49 by means of locking screws 52 passing through opposed arcuate slots 53 formed in said plate 50. It will be apparent that by use of a suitable tool and engaging shaft portion 45A the assembly 30 may be angularly displaced to selected titled positions and retained in such positions by means of locking screws 52.

As the central axis of corrugating assembly 30 must be displaced with respect to the longitudinal axis of the housing 21, so that the corrugating rib portion 39 may engage and impress the annular corrugations in tubing A with a rolling movement; said assembly 30 is movable axially of housing 21 by way of journal shafts 45, 46. To this end the upper journal shaft 46 is formed with axial internally threaded recess 54 for receiving a screw member 55 having a flange 56. A circular recessed plate 57 is fixed to the outer surface of housing 21 and has a circular opening for passing screw member 55 and seating flange 56. A plate 58 having a circular opening 59 for passing the outer end 55A of screw 55 is fixed to plate 57 by screws 60. The outer end portion of said screw 55 being of square cross section to allow the application of a tool thereto for rotating the same and thereby axially moving said assembly 30 to selected positions wherein the central axis X—X thereof is displaced from the longitudinal axis Y—Y of the housing 21 by predetermined distance Z. Thus such adjustment will determine the depth of the annular corrugations in the tubing A.

It is understood that the rotational speed of housing 21 is proportioned to the rate of movement of tubing A by way of transport means 11. Thus the rotational speed of housing 21 expressed in rpm may be substantially determined by dividing the transport speed of the tubing A in inches/minute by the pitch of the corrugation measured in inches. For example with a pitch of the corrugations in tubing A of one-half inch and a transport speed of the tubing A of 600 inches/minute; the speed of housing 21 will be set at 1,200 rpm.

It is understood that the angle of tilt of the assembly 30 is equal to the pitch angle of the helical rib 39. Obviously in making corrugated tubings having different corrugation spacings, suitable dies will be provided having appropriate helical pitch and the tilt of the assembly 30 will be adjusted accordingly.

Tubing which has been corrugated in accordance with the present invention to provide annular corrugations has a number of advantages over tubing formed with helical corrugations. This is particularly apparent in cases where a corrugated tubing serves as a protective sheath or enclosure for a cable. The outwardly extending helical groove in effect establishes a continuous helical channel along the length thereof. If water should leak into the interior of such a cable, the water can flow along such channel. Eventually the entire cable is exposed to the effect of the water even though the leak was confined to a limited area initially.

In the case of annular corrugations formed in tubing as in the instant invention there are no such continuous channels and any leakage of water will be confined to the area of the actual leak and there will be no longitudinal spread of the water. Furthermore, tubings having annular corrugations are most easily sealed at the ends thereof particularly when such tubings are used as fluid conduits. A helically corrugated tubing, when cut in a plane transverse to the axis thereof presents a non-circular contoured front face and the sealing of such terminal end is rather difficult. Finally, it has been found that tubing with annular corrugations has a somewhat higher degree of flexibility than tubing having helical corrugations.

We claim:

1. Apparatus for continuously forming annular corrugations in tubing, comprising a rotatable cylindrical housing for passing said tubing therethrough; annular die holder means rotatably mounted within said housing, corrugating die means mounted within said holder means, said die means comprising a flat annular body with a helical corrugating rib on the inner edge thereof having a selected pitch angle, means for adjustably mounting said holder on said housing in selected tilted positions, wherein (1) the die means is disposed in a plane related to a plane extending transversely of the longitudinal axis of the housing by an angular displacement equal to the pitch angle of the helical rib, and (2) the central axis of the die holder being offset relative to the longitudinal axis of the housing.

2. Apparatus as in claim 1 wherein said holder includes oppositely disposed journal means for mounting said holder within said housing, the axis of the medial transverse plane of the die means being coincident with the axis of said journal means.

3. Apparatus as in claim 2 and further including means for angularly displacing said holder means about the journal axis thereof.

4. Apparatus as in claim 2 and further including means for shifting said holder means longitudinally along the journal axis thereof.

5. Apparatus as in claim 1 wherein said holder means comprises a pair of concentric relatively rotatable annular members, means for mounting the die means on the innermost of said pair of members, means for mounting the outer member of said pair of members on said housing, for selective angular displacement and axial movement relative thereto.

6. Apparatus as in claim 5 and further including bearing means between said pair of concentric members for allowing the die means to rotate independently of the rotation of said housing.

7. Apparatus as in claim 1, further including means for moving the tubing through the housing, means for rotating said housing, and means for proportionately relating the rotational movement of the housing to the longitudinal movement of the tubing.

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