

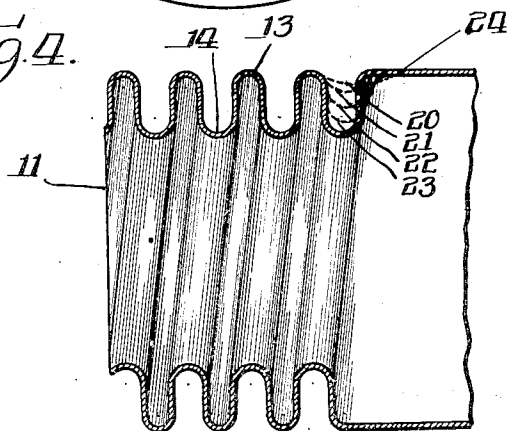
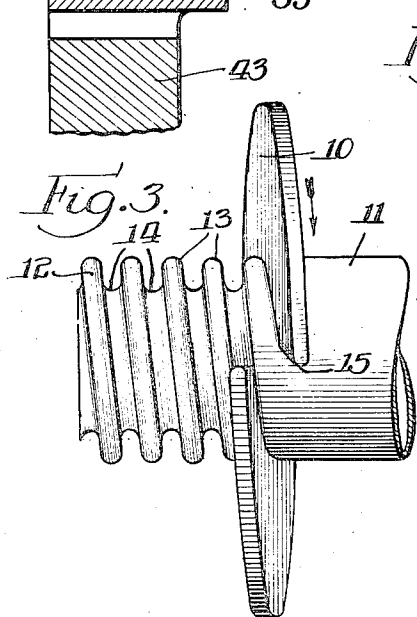
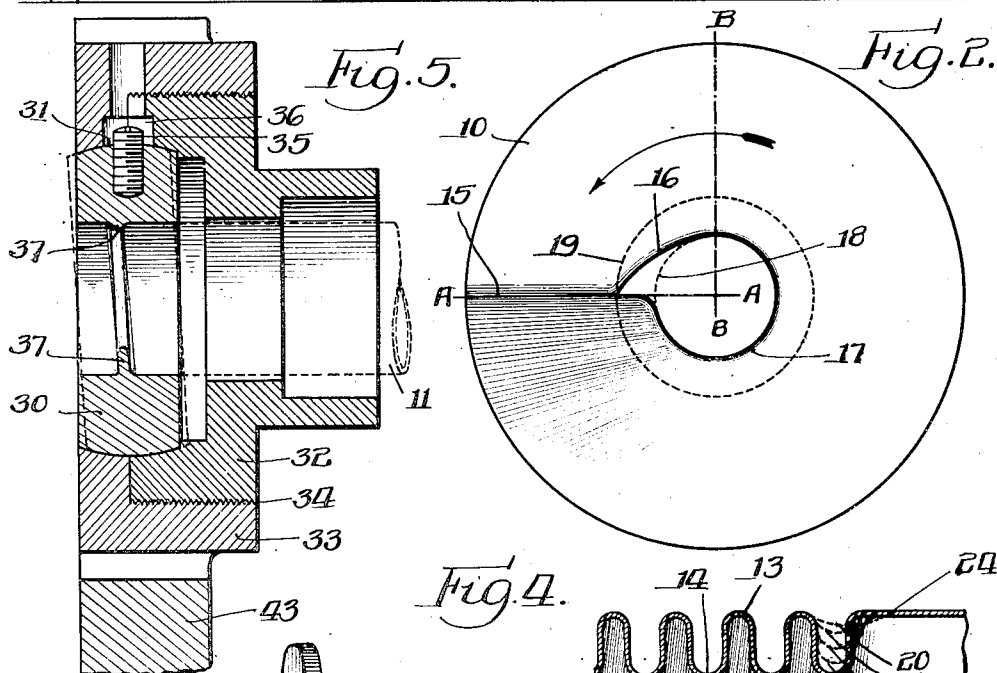
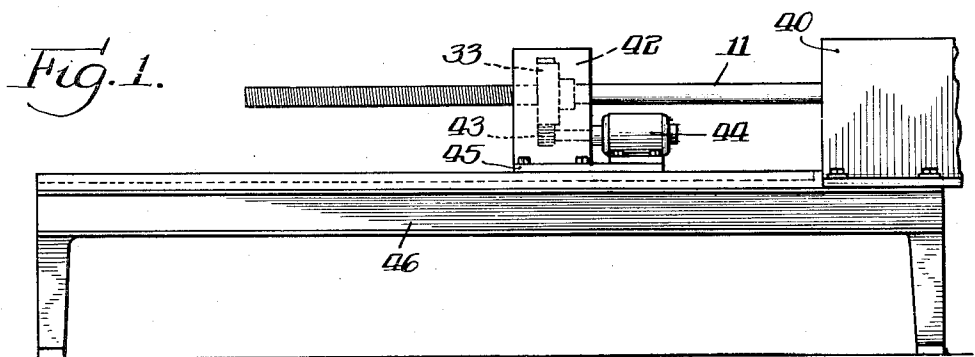
May 9, 1939.

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2,157,598

APPARATUS AND METHOD FOR CORRUGATING METAL TUBING

Filed Oct. 30, 1935



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UNITED STATES PATENT OFFICE

2,157,598

APPARATUS AND METHOD FOR
CORRUGATING METAL TUBING

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Application October 30, 1935, Serial No. 47,366

14 Claims. (Cl. 153—71)

This invention relates to corrugated metal tubing, and more particularly to the apparatus and methods for producing such tubing.

It is an object of the invention to provide new and improved methods and means for making corrugated metal tubing, more specifically tubing of the helically corrugated solid metal type.

Further objects are to provide such tubing with as deep folds as may be desirable and necessary to secure the required tube flexibility without undue crushing, stretching, or spinning of the tube metal; and to provide for the folding or ribbing of the tubing without undue twisting of the tube or undue deformation of the molecular metal structure whereby to avoid hardening of the metal and to preserve the flexibility, quality and life of the tube.

Further objects of the invention are to produce a corrugated metal tube by means of a die having sufficient contact with the tubing to avoid spinning of the metal, but wherein the amount of contact is reduced sufficiently to avoid setting up unnecessary stresses and strains in the metal as the corrugations are formed; and to provide a die which produces a deep and satisfactory groove and yet which yields and conforms substantially to the strains and stresses of the metal in the tube.

Still further objects are to provide for the making of the tube by means of a die which is balanced in action, which reduces the operating forces required to form the tube and the forces required to operate the die to a minimum, which facilitates lubrication of the die in operation, and which permits faster operation while retaining the durability and life of the die.

A still further object of the invention is to provide a flexible mounting for the die to still further reduce the stresses and strains set up in the tube metal during the ribbing or grooving operation.

Other objects and advantages of the invention will be apparent from the following description when taken in connection with the accompanying drawing wherein there are disclosed certain preferred embodiments of the invention.

In the drawing, wherein like reference numerals refer to like parts throughout:

Figure 1 is an assembly view, somewhat diagrammatic in form, showing one means of application of the improved die of the invention.

Figure 2 is a front view of a die member embodying the principles of the invention in its most simple form.

Figure 3 shows the die member of Figure 2 in operation upon a piece of tubing.

Figure 4 is a longitudinal section through the tubing, and

Figure 5 is a view of a modified form of die arranged within a flexible mounting head.

The die in its simplified form, illustrated in Figures 2 and 3, comprises a metal disk 10 shaped into generally helical form. As the die is rotated relative to the tube 11 in the direction indicated by the arrows, it will form in the tubing a continuous helical rib or thread 12 comprising lands 13 and trough portions 14. Substantially the first portion of the die, that is, the portion extending from the line A—A clockwise to the line B—B in Figure 2, is of constantly decreasing pitch with the maximum pitch along the leading edge 15. The remaining or trailing part or portion of the die is of a constant pitch which corresponds to the minimum pitch of the leading part of the die. The leading portion of the die also carries the inwardly tapered working edge 16 whereas the inner edge 17 of the trailing part or portion of the die is of constant diameter. In Figure 2 the position of the trough of the rib, which will be formed in the tube by the die, is indicated diagrammatically by the line 18 and the land portion is indicated by the line 19.

The operation of the die may be best understood by reference to Figure 4. The leading edge of the die, which is of increased pitch, marks off on the tube the metal which is to be depressed inwardly to form the rib. As the working edge 16 is brought along any given portion of the tube, the tube, at such portion, is depressed progressively and formed into the rib as indicated by the lines 20, 21, 22 and 23. The metal which is to form the rib is drawn over from the point 24 as the rib during its formation by the first portion of the die assumes a constantly decreasing pitch and the trough of the rib is depressed inwardly until the pitch of the finished rib is reached. The length of the tube will be materially reduced as a result of the ribbing operation, but no stretching or spinning of the metal takes place and the various walls of the rib remain of the original tube wall thickness. In view of the relatively steep taper upon the working edge 16, the tube metal is pushed helically of the tube a sufficient distance to accommodate for the increased metal within the trough of the rib, thereby further reducing the stresses applied to the metal. The trailing part or portion of the die, which is of constant pitch and trough diameter, merely smooths out and permanently fixes the

rib in the tube. The die is substantially balanced in operation, the forces applied to the working portion of the die being substantially balanced by those applied to the remaining part or portion of the die by reason of its action in setting the rib. As shown, substantially the first quarter of the die is the working portion. However, this portion may be of variable extent depending upon the character of the tube. With many tubes a working portion of one-half the extent of the die gives very satisfactory results. Also the variable pitch of the working portion will be determined by the character of the tube, and in many instances may be substantially constant.

By reason of the fact that the die comprises but a single complete convolution of a helix, it may yield and flex readily to irregularities in the stresses and strains in the tube metal. The operating forces which the die applies to the tube are only those required to form the rib. At the same time the die is of sufficient extent to produce a true and permanent rib upon the tube.

It has been found desirable, when ribbing thick walled tubing, to augment the adaptability of the die by means of a floating mounting for the die such as illustrated in Figure 5. As indicated, the die 30 in this instance has its outer surface 31 formed as the portion of a sphere. The die mounting comprises a pair of holder members 32 and 33 threaded together at 34. The portions of the holders which embrace the die are of spherical form corresponding to the spherical outer portion of the die so that the die is adapted for universal movement within the holders. The die further carries a threaded stud 35 which engages within a slot 36 formed in the holders. The stud precludes relative rotation between the die and its holders around the axis of the tube while permitting a limited angular adjustment of the die relative to the holders, the die being free to move to a position such as indicated by the dotted lines in Figure 5. By this means the die may further conform to irregularities in the metal structure of the tube whereby to reduce unnecessary strains of the die upon the tube to a minimum. However, this flexibility of movement permitted in the die does not interfere with the formation of an accurate rib in the tube. The rib-forming portion 37 of the die of Figure 5 is the same as the inner portion 16, 17 of the simplified form of die shown in Figures 2 and 3.

One manner of ribbing a tube by means of the die of the present invention is indicated in Figure 1. In this instance the tube 11 is being ejected from a welder diagrammatically indicated at 40 by which the tube is formed. The die holder 33 is in this instance rotatable within a housing 42, the holder being driven by means of a gear 43 mounted upon the armature shaft of an electric motor 44. The motor and the housing 42 are mounted upon a sub-frame 45 adapted for sliding movement along the bed 46 of the machine. As the motor 44 is operated, the die will be rotated with respect to the tube as the latter is ejected from the welder 40. The die, by reason of its helical shape, will feed itself axially along the tube as it performs the ribbing operation, and by adjustment of the speed of the motor 44, the die may be caused to move axially along the tube at substantially the same rate that the tube is being ejected from the welder whereby to maintain the frame 45 substantially stationary upon the bed 46. However, the frame 45 is slidable with respect to the bed which will accommodate for any necessary movement of the frame. If

desired, suitable means controlled by movement of the frame along the bed may be provided for controlling the speed of the motor whereby to synchronize the speed of the die with the feed of the tube.

While in Figure 1 the die has been indicated as rotatable and the tube as non-rotatable, it is to be understood that the tube may be rotated within the die, if desired, on any suitable machine such as an ordinary lathe.

Various attempts have been made in the past to provide satisfactory means and methods for producing helical corrugated tubing. According to one method, balls or rolls are applied to the tube and operated helically relative thereto. Such means, however, produce high unit pressures upon the metal of the tube and result in a spinning out of the tube wall. This is avoided by means of the die of the present invention wherein contact is maintained with the tube throughout substantially one complete helical convolution.

Another method which has been proposed to produce the helical ribbing utilizes a multiple convolution die which operatively contacts the tube throughout a series of helical convolutions of variable pitch. Such multiple convolution dies are not adaptable to the irregularities in the stresses and strains of the tubing and set up unnecessary stresses in the tube resulting in the crystallizing of the metal. Moreover, the multiple convolution die produces an appreciable twisting of the tube as the rib is formed which increases the molecular strain in the metal. On the other hand the die of the present invention which comprises substantially one complete helical convolution, is adaptable to irregularities in the tube which precludes the setting up of unnecessary stresses within the tube structure. This adaptability in the case of thick wall tubes may be increased by the provision of the floating mounting illustrated in Figure 5. By means of the die comprising a single helical convolution, a deep rib may be produced without spinning of the metal or without undue crushing or stretching thereof. This eliminates crystallizing of the metal and increases the life of the tube. Whereas in the multiple convolution die each convolution produces an arched trough in the tube which opposes the formation of other troughs, the single convolution die avoids this unnecessary stressing of the metal. The single convolution die allows the axial contraction of the tube to be proportional to the depth of the trough produced whereby to minimize tube twisting and molecular displacement of the metal. The single convolution die of the present invention reduces the operating forces required to a minimum. It facilitates lubrication as all parts thereof are exposed for the application of lubricant. This allows faster operating speeds and yet insures long life of the die. The die can be produced at a minimum of expense in view of its simple character.

It is obvious that various modifications may be made in the precise embodiments of the invention utilized for the purposes of illustration. For example, the die may be constructed of a single piece, as illustrated, or of multiple parts and still retain the operating characteristics defined. The invention is accordingly not to be limited to the structures shown and described, but only as indicated in the following claims.

The invention is hereby claimed as follows:

1. A die for corrugating metal tubing comprising a helical metal rib, the trailing portion of said rib with respect to its operation upon the

work being of constant pitch and the leading portion thereof being of variable pitch.

2. A die for corrugating metal tubing comprising a helical metal rib of substantially one complete convolution, the greater portion of said rib being of constant pitch and the lesser portion thereof being of variable pitch.

3. A die for corrugating metal tubing comprising a helical metal rib of substantially one complete convolution, the greater portion of said rib being of constant diameter and the remainder thereof being of variable diameter.

4. A die for corrugating metal tubing comprising a helical metal rib, one portion of said rib being of constant pitch and constant diameter and another portion thereof being of variable pitch and variable diameter.

5. A die for corrugating metal tubing comprising a helical metal rib of substantially one complete convolution, the greater portion of said rib being of constant pitch and constant diameter and the lesser portion thereof being of variable pitch and variable diameter.

6. A die for corrugating metal tubing comprising a helical metal rib of substantially one complete convolution, approximately three-quarters of said rib being of constant pitch and constant diameter and the remaining portion thereof being of variable pitch and variable diameter and constituting the working portion of said die.

7. Means for corrugating metal tubing comprising a die member having a helical metal rib of substantially one complete convolution adapted to embrace a tube, and means for mounting the die for limited universal movement relative to the axis of the tube.

8. The method of corrugating metal tubing which comprises singly embracing the tube around substantially its complete circumference, and marking out and forming a helical rib on the tube along a portion of the circumference

not exceeding one-half thereof while smoothing out the rib so formed along the remainder of said circumference.

9. The method of helically corrugating metal tubing which comprises embracing the tube circumferentially thereof progressively forming a helical rib in the tube with sufficient abruptness to cause the metal to flow helically as the rib is formed whereby to relieve crowding of the metal in the trough of the rib, and thereafter smoothing out the rib.

10. The method of helically corrugating metal tubing which comprises embracing the tube with a rib-forming die member while leaving the die member free to flex universally with respect to the axis of the tube whereby to allow the die to conform to irregularities in the metal of the tube.

11. A die for corrugating metal tubing comprising a helical metal rib, the leading portion of said rib with respect to its operation upon the work being of variable pitch and variable diameter, and the trailing portion of said rib being of constant diameter.

12. A die for corrugating metal tubing comprising a helical metal rib, the leading portion of said rib with respect to its operation upon the work being of variable diameter, and the trailing portion thereof being of constant pitch and constant diameter.

13. A die for corrugating metal tubing comprising a helical metal rib of substantially one complete convolution, the leading portion of said rib being of variable diameter, and the remainder thereof being of constant diameter.

14. The method of corrugating metal tubing which comprises continuously embracing the tubing circumferentially thereof, and marking out and forming a helical rib on the tube along a portion of the circumference not exceeding one-half thereof.

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