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J. W. MACKLIN ET AL

2,495,533

METHOD AND APPARATUS FOR CORRUGATING METAL TUBING

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2 Sheets-Sheet 1

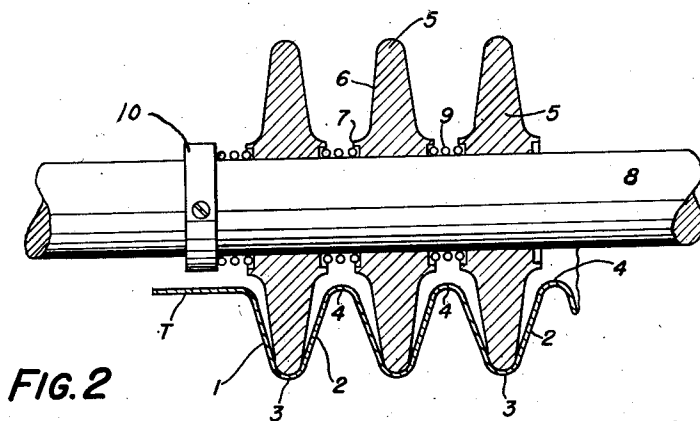
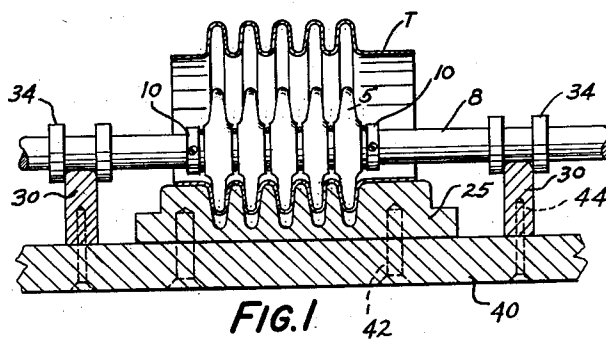
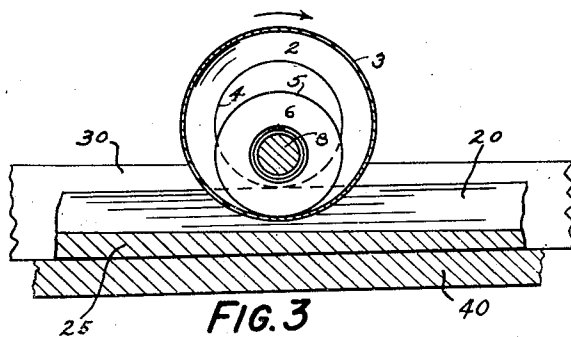
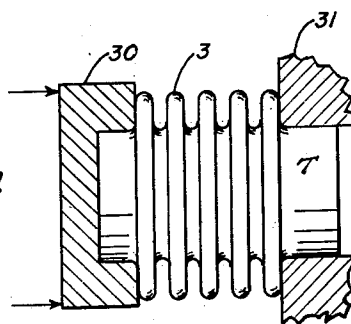


FIG. 4



INVENTORS
JUSTIN W. MACKLIN, AND
WILLIAM H. GRANT
BY
Justin W. Macklin
ATTY

Jan. 24, 1950

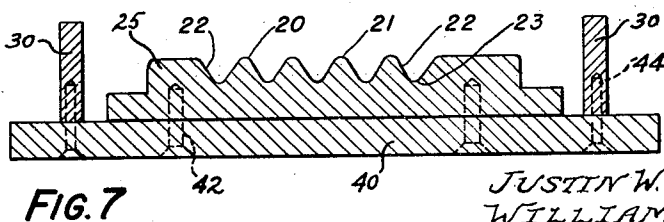
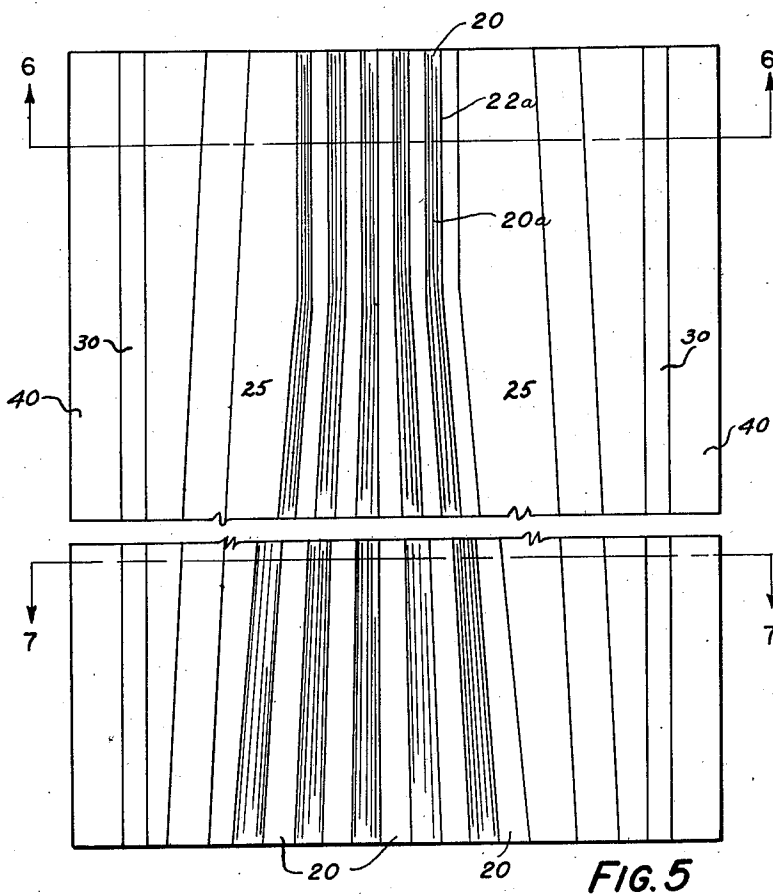
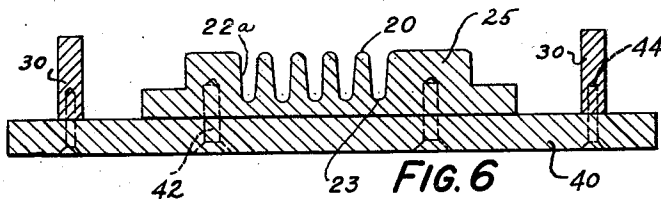
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METHOD AND APPARATUS FOR CORRUGATING METAL TUBING

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2 Sheets-Sheet 2



INVENTORS
JUSTIN W. MACKLIN, AND
WILLIAM H. GRANT,
BY
Justin W. Macklin
ATTY

UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR CORRUGATING METAL TUBING

Justin W. Macklin, Lakewood, and William H. Grant, Cleveland, Ohio

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6 Claims. (Cl. 153-74)

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This invention relates to a method and apparatus for making metallic bellows.

Heretofore, bellows of the type shown and described in our prior patent application have been made by the method such as there described, namely, forming them by fluid pressure.

Various attempts have been made to roll the corrugations without the use of internal pressure, and in other instances rolling has been used for the finishing operation, as described in the expired patent to Bezenberger, No. 1,655,778, granted January 10, 1928.

The primary purpose of the present invention is to provide a simple and efficient method of rolling the corrugations in a single continuous rolling operation, starting with a cylindrical tube and finishing with complete or nearly complete bellows formation. The corrugated bellows thus formed may, if desired, be given an additional collapsing operation bringing the walls of the corrugations into substantial parallelism.

More specific objects of the invention are to effect such rolling and forming in one single continuous motion with internal rollers, after which the rollers are longitudinally removed from the corrugated tube.

Still another object is to arrange these rolls and a coating die, in the nature of converging ribs or rails, so that the spacing at the beginning of the rolling is greater than that of the finished corrugations, and whereby the rollers may progressively move together axially as the corrugations are deepened in progressively deeper and narrower spaces between the rails.

A further object is to so arrange such rollers that they may automatically space themselves to correspond to the spacing of the rib and groove shape and spacing at the beginning of the movement, and whereby when the tube is placed in position over the rollers, the amount of metal between adjacent rollers will provide for the formation of the corrugations with a minimum amount of stretching and drawing, and with a maximum accuracy and uniformity at the end of the rolling motion.

In the Bezenberger patent, above referred to, the preformed bellows, having approximately its finished shape, is placed over a series of small rollers which were spaced to fit between flanges or rollers coating therewith, and then these rollers—the one driven and the other idling—were brought together in a rolling motion effecting what was stated to be a “tempering” and accurate shaping. As was stated in that patent, manual collapsing longitudinally was only ap-

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proximately accurate. However, such rolling required the preforming on an entirely separate machine and by a different method. It should be noted also that the roller flanges were definitely spaced at fixed distances.

Other methods of rolling have been tried in which fixed spaced rollers were rotated—one set inside the tube and the other outside, and then axially moved toward each other while rotating, and by using a series of differently spaced sets of rollers, it has been possible to form fairly crude bellows with relatively sloping side walls for the corrugations, and which could be given approximately the desired shape of the finished bellows by axially collapsing.

The present method, however, not only is more simple, but it allows for predetermining the amount of material of which each corrugation is to be formed, and permits the forming in a single rolling step of a complete bellows which is satisfactory for many purposes.

Further describing our invention in connection with the drawings:

Fig. 1 is a sectional view through the tube and coating form showing the rollers inside at approximately the finishing position.

Fig. 2 is an enlarged sectional detail showing the metal of the tube as partly finished, and showing the interior rollers in sections.

Fig. 3 is a sectional view on a plane at right angles to the plane of Fig. 1.

Fig. 4 shows the bellows being axially collapsed.

Fig. 5 is a plan of the stationary rail plate showing the forming ribs, the view being broken (shortened) for convenience of illustration.

Fig. 6 is a transverse section through the finishing portion as on a plane indicated by the line 6-6 of Fig. 5.

Fig. 7 is a similar section on a plane, indicated by the line 7-7 of Fig. 5.

Referring to the drawings, T designates a tube shown as open at both ends, and which, starting as a cylindrical form has been shaped to form the corrugations comprising side walls 1 and 2, joined at the outer diameter by the curved bend at 3, and at the inner diameter at the bends 4.

The radial length, or more accurately the difference between the inner radius and outer radius of the fold surfaces 1 and 2, is a guide to establishing the original spacing for forming rollers. These internal forming rollers 5 are shown as having tapered or sloping surfaces 6 and rounded peripheries, and as having a diameter such that they will pass inside of the unformed tube blank,

contact with the tube, and by rolling action effect a folding and axial shortening of the tube to an amount equivalent to the width or depth of the corrugations.

The forming rollers 5 are carried on a shaft 8 and are separated by springs 9 at distances determined as follows:

The radial width of the folded portions 1 and 2 and the bend 3 should be formed with a minimum of outward stretching. Thus, if the inner diameter of the tube blank is one inch, the inner folds 4 are one inch. When finished the outer folds or bends 3 may be, for example, one and five-eighths inches. At the finish of the rolling operation the spacing of the folds and bends 3 may be one-fourth of an inch. Thus, the distance between rollers at the start to effect the folding action disregarding stretch for circumferential enlargement should be at least one-half inch. The increase in diameter being five-eighths of an inch, less one-eighth, the width of one corrugation, would allow one-half of an inch longitudinal distance to compensate for the folding outwardly of the wall portions 1 and 2 of each corrugation.

There is some stretching and thinning of the wall of the metal due to the increased diameter. This stretch should be distributed from the bend at 4 to the bend at 3. Thus, the reduction of wall thickness will not be sufficient to unduly weaken the finished bellows.

The shaft 8 extends out of the tube at each end. Any suitable bearings, or like means not shown, may engage the projecting ends of the shaft for moving the rollers as a unit. Assuming now that the rollers are spaced by the springs 9 and adjustable collars 10, and are positioned within the tube, they may be brought over the wide ends of converging ribs 20, shown as formed in a plate 25. At one end of the plate these ribs present upper edges or curves 21, spaced approximately the same as the spacing of the rollers at the start of the operation. The ribs are shown as having their side walls sloping, for example, at a forty-five degree angle or greater. These side walls may converge to include an angle of, say, only fifteen degrees while increasing in depth as indicated at 22a in Fig. 6 for the finishing of the rolling operation.

The curvature of the bottom of the spaces or grooves between the ribs, designated 23, may be formed on approximately the same radius throughout their length, and which may correspond to the curvature of the folds 3.

At this point it may be noted that it is not necessary to "bottom" the rolls in the grooves between the rails to effect the stretching and folding during the rolling operation.

Downward pressure applied to the tube through the rollers 5, beginning at the wider spaced ends of the ribs 20, and continued as the rolls are advanced along the grooves, causes the rolls to enter the grooves, folding and enlarging the corrugations, shortening the tube correspondingly through various stages, an intermediate stage of which is illustrated in Fig. 2. This is continued until parallel portions 20a of the ribs are reached, at which time the tube formation corresponds to that illustrated in Fig. 1. From this point it is necessary to continue the rolling for at least one complete turn to attain circumferential uniformity of each corrugation.

The bellows thus formed may be then removed from the rollers, and after the tube has been moved free from the forming ribs a collapsing operation may be manually or otherwise effected.

For example, a ring blank, such as shown at 30 in Fig. 4, may engage one end of the tube, while a ring or block 31 similarly engages the other end. By moving these together the corrugations may be brought into touching position.

When using brass tubing, for example, of a few thousandths of an inch thickness, there will be some considerable resiliency, and after such an axial collapsing operation of the tube, when it is released it will assume approximately the position shown in Fig. 4 with the side walls 1 and 2 of the corrugations approximately parallel.

Modifications of the above steps may include bringing the rollers 5 together to a position where shoulders 7, outside of seats for the ends of the springs 9, are brought into contact, and at which point curved faces on the rollers meet to conform to the curves of the inner bends 4 of the blank. Likewise, and as an alternative, the rollers may bottom at the bottom of the grooves 23 to finish forming the outer folds of the convolutions.

For practical purposes great accuracy would be required to simultaneously "bottom" at both inner and outer curves, and we find that this is usually unnecessary.

As a simple means for correlating the progressive increase in the radial depth of the fold with the longitudinal travel of the rollers 5 along the ribs 20, we may provide guideways permitting the shaft and rollers to move toward the plate 25 but which limit the depth to which the rollers 5 may be pressed at any one point along the rails.

As an illustration, we have shown guide rails 30 secured to a mounting plate 32 on which the die member having the ribs 20 may be mounted. The upper surfaces of the guide rails 30 are the highest at the starting position, and they slope equally and gradually toward the level of the top of the forming ribs 20 at the finishing position. The upper surfaces of the guide rails may contact the shaft 8 outside of the ends of the tube T. Guide collars 34 may be spaced on the shaft 8 to engage the sides of the rails 30 to prevent axial shifting of the shaft 8.

The ribbed die plate may be of any suitable material, and in some instances may be cast by modern precision casting methods. For convenience, it is shown as mounted upon a base plate 40 of larger area and held as by screws 42 extending from beneath the plate 40 into the ribbed member 25. The rails 30 may be similarly held by screws, indicated at 44. The upper surfaces of the rails 30 may lie in a plane parallel to the plane of the upper surfaces of the ribs 20 at the finishing end, or may stop short of this finishing position if desired.

Having thus described our invention, what we claim is:

1. A plurality of relatively axially movable rollers and spaced apart rigidly mounted converging rails having curved edges lying in a uniform surface and presenting progressively deepening grooves having increasingly abruptly sloping surfaces against which the metal of a tube blank may be worked as the rollers are moved along the rails and pressed to project the rollers and the metal of the tube therebetween.

2. A plurality of disk-like rollers having rounded peripheries and surfaces diverging toward the axis, a shaft on which said rollers are slidably mounted, springs normally separating said rollers while permitting them to move.

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axially, and coacting means for progressively forming folds in the wall of a tube between said rollers, said coacting means comprising ribs and grooves formed on a die plate presenting progressively deepening and progressively more abruptly sloping surfaces.

3. An apparatus for rolling corrugations in a tube to form a bellows comprising a shaft, disk-like rollers slidably mounted on the shaft having rounded peripheries and the surfaces diverge toward the axis, springs normally separating the rollers, coacting means for progressively forming folds in the wall of the tube comprising a support, converging rails fixed on the support and guide members in fixed relation to the support and rails progressively limiting the depth to which the rollers may be pressed between the rails.

4. An apparatus for forming the convolutions of a metal bellows from a cylindrical tube blank comprising a plurality of rollers, a shaft upon which said rollers are slidably mounted, springs between the rollers normally spacing them at predetermined distances corresponding to the metal of the tube folded into the convolutions, a support and a plurality of spaced apart rigidly mounted converging rails presenting sloping surfaces against which the metal of the tube may be progressively worked as the rollers are moved along the rails and guideways engaging the shaft and having fixed relation to the support to control the progressive increase in the depth of the folds formed in the tube.

5. An apparatus for rolling corrugations into a cylindrical tube blank by projecting them essentially outwardly from the normal diameter of

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the blank, including a shaft, rollers slidably mounted thereon, a plurality of converging rails lying in a uniform surface parallel with the axis of the rollers, a supporting plate on which said rails are rigidly fixed in a common plane and said rails converging through a distance permitting three or more rolling turns of the tube, and having rigid parallel portions permitting continued rolling for one or more turns to complete the formation of the convolutions of a bellows.

6. A method of forming metal bellows from a cylindrical tube blank comprising the steps of engaging the interior of the blank with a plurality of axially movable spaced apart rollers on a shaft, and then pressing the rollers against the interior of the tube blank toward a plurality of rigidly fixed converging rails having progressively deepening grooves therebetween, and moving the rollers uniformly toward the groove surfaces while moving them longitudinally of the rails and groove surfaces along increasingly narrowing spacing portions, and continuing the rolling along parallel portions of the ribs and grooves to form the bellows in a single rolling operation.

JUSTIN W. MACKLIN.
WILLIAM H. GRANT.

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