June 19, 1956 W. A. SCULLY ET AL 2,750,985

APPARATUS FOR CONVOLUTING THIN WALLED ARTICLES

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Fig. 1.

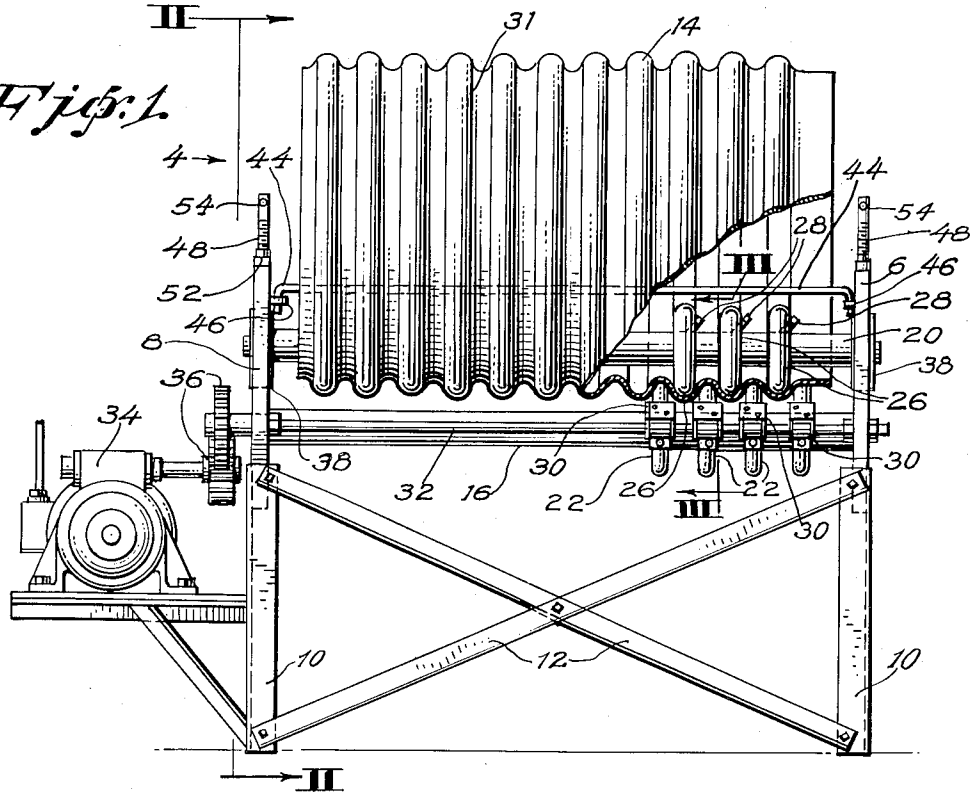


Fig. 2.

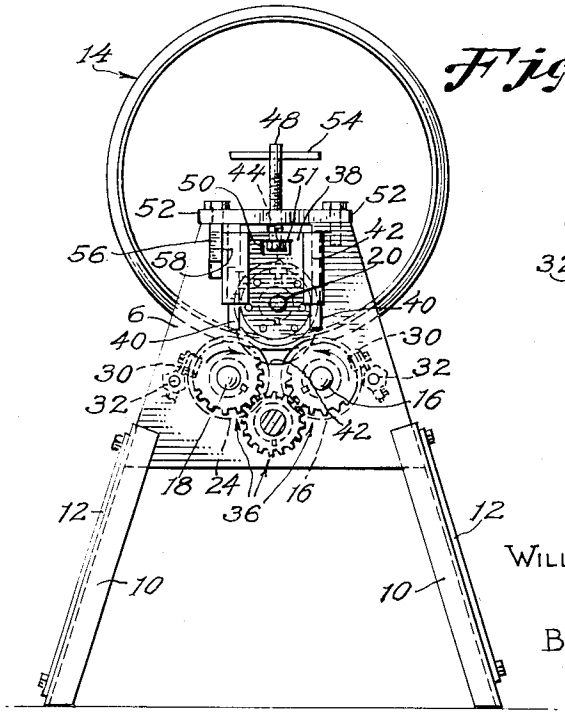
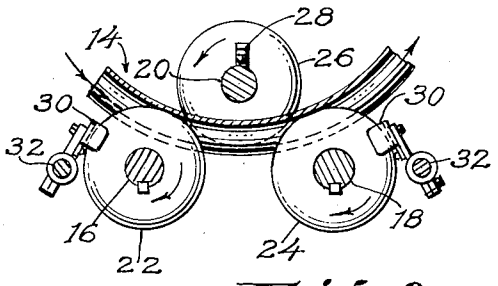


Fig. 3.



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APPARATUS FOR CONVOLUTING THIN WALLED ARTICLES

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3 Claims. (Cl. 153—77)

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This invention may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The invention relates to apparatus for forming convolute shapes.

A hydraulic press with appropriate "tailor-made" dies has been used for convoluting an article formed either in one piece, or in several parts and welded or otherwise joined together. Another method involved externally rolling or spinning a tube blank by the use of a plurality of radially movable dies having the same shape as the finished article. In both of these methods one of the primary objections was the high initial cost of the "tailor-made" dies, and further because a separate die was required for any variation in the size or shape of the article, a large inventory of dies was needed along with their attendant stowage difficulty. Another disadvantage of these methods was an inability to maintain a uniform wall thickness during the rolling process, and, consequently, the completed article frequently contained intermittent weak points throughout the wall area.

Accordingly, a principal object of this invention is to provide apparatus for convoluting articles which is more versatile in use and which will accommodate a greater variety of sizes and shapes of articles.

A further object is to provide apparatus for convoluting thin walled articles and maintaining a substantially uniform wall thickness.

Another object is to provide apparatus for adjusting the distance between convolute centers during the rolling process.

Still other objects are to provide apparatus wherein the centers between adjacent roller dies may be reduced as the depth of the convolution is increased, avoiding the thinning of the blank wall which would otherwise occur; to provide a plurality of roller dies sets which may be used successively to roll a blank, and to provide roller dies which are interchangeable.

These and other objects will be apparent from the detailed description and accompanying drawings.

According to the invention the rolling apparatus is formed of a frame for supporting a plurality of spaced longitudinal shafts on which are mounted roller dies for working the wall of a blank positioned between the dies. The blanks may vary in size and shape and, when a tubular blank is to be convoluted, it has been found preferable to use three shafts, the outer two of which form a support for the outer peripheral wall of the blank, while the third or central shaft is adapted to extend longitudinally through the blank with its roller dies positioned against the interior wall with their working surfaces disposed in opposing and nesting relation to the outer roller dies. The outer and inner roller dies may be fixedly spaced along their respective shafts with the outer roller dies staggered with respect to the inner roller dies. When the axial distance between the outer and inner roller dies is reduced to compress the blank therebetween, the roller dies are mated

and form the convolutions. In the preferred construction, the outer shafts are driven by a suitable prime mover and rotate the blank by frictional engagement with the outer roller dies, and the blank in turn drives the inner roller dies. The inner shaft is freely rotatable and journaled at both ends in reciprocating slide mechanisms which are operated progressively to advance the mating relation of the dies until the desired depth of convolution is obtained. In order to prevent a thinning of the blank wall, such as necessarily would occur if the spacing of the roller dies remained fixed as the depth of the convolution increased, it is a principal feature of this invention to provide roller dies which may be adjustably fixed along their respective shafts and the spacing between adjacent roller dies on each shaft reduced as the depth of the convolution increases.

The preferred embodiment of the invention is illustrated in the drawing of which Fig. 1 is a side elevation of the apparatus showing the worked blank partially in section to demonstrate the action of the inner roller dies. Fig. 2 and Fig. 3 are end views taken along lines II—II and III—III of Fig. 1.

As shown in the drawing, the apparatus has a supporting frame formed of upright end plates **6** and **8** that are supported by legs **10** and by crossbeams **12**. The end plates are spaced apart a distance sufficient to receive the longest contemplated blank **14** to be rolled and they are connected together by parallel shafts **16**, **18** and **20**, on which are mounted roller dies **22**, **24** and **26**, which may be locked to their respective shafts. The blank may be any thin walled article made of metal, plastic or any other workable material and it is supported between the roller dies in the manner presently to be described.

In the preferred embodiment illustrating the convoluting of a tube blank, three shafts are utilized having their rotational axis triangularly disposed in the manner shown in Fig. 3. The two lower or outer shafts **16** and **18** form a base for supporting the exterior wall of the blank, which rests between roller dies **22** and **24**, and the third shaft **20** may be advantageously positioned longitudinally within the tube with roller dies **26** adapted to be positioned against the inner concave wall of the tube in opposing and mating relation to lower roller dies **22** and **24**. As will be described later in detail, outer shafts **16** and **18** may be driven by any suitable prime mover to impart a rotational movement to the blank by frictional engagement with the outer roller dies. Inner shaft **20** preferably is reciprocably mounted in the end plates and driven as an idler by the rotated blank. During the rolling, the inner shaft is gradually moved toward the outer shaft to effect the desired convolution, the tube or blank wall positioned between the inner and outer roller dies being convoluted annularly around its circumference and the triangular disposition of the parallel shafts firmly supporting the tube and maintaining its position in cooperation with the inner shaft.

As the inner shaft is progressively moved toward the fixed outer shafts, the upper roller dies are gradually moved transversely between the mating lower dies (Fig. 1) to increase the depth of the convolution. If the roller dies on each shaft were integrally fabricated and remained longitudinally fixed on their shafts, as has been practiced by the "tailor-made" dies of the prior art, the tube wall would necessarily be elongated and stretched as the depth of the convolution is increased. The thinning of the tube wall would occur because the linear length of the developed convolution is materially greater than the initial length of the uniform tube wall between the inner and outer roller dies. During such operation, the greatest thinning of the tube wall most likely would occur in the span between the tips of the roller dies, with a consequent structural weakness in the tube wall.

It is an important feature of this invention that the original uniform tube wall thickness is maintained during the rolling operation by reducing to a minimum any thinning of the tube wall. This result has been achieved principally by constructing the die sets of a plurality of individual roller dies **22**, **24** and **26** each bored to slide on their shafts with roller dies **22** and **24** keyed to the outer driving shafts to insure a positive connection. Further, each roller die may be adjustably positioned along its shaft and locked in the desired position so that, when the convoluting operation is initiated, the adjacent roller dies can be locked on their shaft a spaced distance equal to the predetermined developed linear length of the convolutions to be formed. As the depth of the convolution is increased during the operation of the machine, the spacing between adjacent roller dies of each shaft is progressively decreased by sliding the roller dies toward each other until the convoluting operation is completed. As the developed linear length of the completed convolute can be made to equal the original spacing of the roller dies, there will be unappreciable thinning of the tube wall. Inner roller dies may be adjustably locked to shaft **20** by locking set screws **28**, and outer roller dies **22** and **24** maintained in their set position by U-clips **30** which may be set to straddle the roller dies and clamped on tie rods **32** supported between the end plates.

The number, shape, or size of the roller dies that may be used will, of course, depend on the particular blank to be rolled. The same number of roller dies may be used as the number of convolutes, however, when rolling long blanks with a limited number of dies available only a portion of the blank may be rolled at a time and the operation repeated successively along the blank in the manner illustrated in Fig. 1 until the entire length of the tube is convoluted. In the embodiment shown, outer shafts **16** and **18** are provided with four pairs of outer roller dies while inner shaft **20** mounts three inner roller dies which are centered between adjacent pairs of spaced outer roller dies. This arrangement of roller dies forms three complete convolutions simultaneously, with one inner roller die and two pairs of outer roller dies forming a die set for each convolute.

As to the details of the shafts and drive mechanism, outer shafts **16** and **18** are journaled in end plates in a fixed position and driven in the same direction of rotation, as indicated in Fig. 3, by any suitable prime mover, such as an air motor **34** and reduction gearing **36** (Figs. 1 and 2). Inner idler shaft **20** is freely socketed in bearings provided in reciprocable slide blocks **38** which ride on slides or tracks **40** formed in recesses **42** of each end plate. To permit an expeditious setting up and removal of the inner shaft from the tube without interference by the slide blocks, the slide blocks are provided with an outward bevel conforming with the bevel of the slides, and the slide blocks are in contact with their slides by a latch bar **44** that extends longitudinally through the tube to engage eyes **46** formed on each of the slide blocks. Removal of the latch bar enables the slide blocks to be outwardly displaced from the inner shaft and the shaft withdrawn through the tube with ample clearance such as might not otherwise be available if the shaft was fixed to the slide blocks.

When so interconnected, the inner shaft and the slide blocks form an assembly or unit that can be moved toward and away from the fixed outer shaft by means of reciprocating feed screws **48**, each of these screws terminating in a fixed nut **50** anchored in a recess **51** in each slide block. The feed screw is threaded through bossed strongbacks **52** bolted to the top of each end plate, and forming closures for the recesses. Rotation of the feed screw handle **54** drives nut **50** against one end of recess and moves the slide block accordingly. The relative position of the movable inner shaft with respect to the fixed outer shafts, or in other words, the depth of the convolutions is indicated by a scale **56** affixed to the end plates and an index line **58** on the reciprocating slide block.

To commence the convoluting operation, the inner and outer roller dies are spaced along and locked to their respective shafts with their center distance equal to the developed linear length of the convolute to be formed. The wall of tube blank is positioned between the inner and outer roller dies and the air motor is started to drive the tube blank by frictional engagement with the outer roller dies.

When convoluting tubes of twelve inch diameters and above, a shaft speed of 2 R. P. M. has been found to be satisfactory. The inner shaft is initially moved toward the outer shafts by the feed screws on each slide block until the inner roller dies engage the inner wall of the revolving tube blank, the idler shaft then commencing its frictionally-driven rotations. Further downward movement of the inner shaft acts to compress the tube wall between the roller dies to commence the convoluting operation. Periodically throughout the rolling operation as the depth of the convolutes gradually increases, the inner and outer roller dies are repositioned on their shafts to decrease the spacing between centers. In this manner, the shaping process advances without any substantial elongation of the tube wall. It is possible that a small degree of stretching or thinning of the tube wall may occur if the roller dies are not repositioned with sufficient frequency, but at most, the thinning will be of a minor proportion and can be controlled. After the convolutes are partially developed, the inner roller dies may be left free to find their own center between the lower roller dies, thereby eliminating the necessity for individual adjustment of the inner roller dies. During the rolling the blanks or tubes may be removed for annealing to make the metal more ductile and prevent work hardening.

By this invention, there is provided a method and apparatus for convoluting thin walled articles, especially hollow tubes without danger of thinning or stretching of the tube wall and the consequent formation of weak spots that may effect the expansion of the hollow convoluted article, or cause a structurally inferior product. This result is accomplished by providing a plurality of individual roller dies forming die sets, which can be adjustably positioned on their supporting shafts and spaced in accordance with the depth of the convolution. The die parts are replaceable and therefore the size and shape of the convolutions, or any other shaping operation, may be infinitely varied without requiring expensive "tailor-made" dies.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

We claim:

1. Apparatus convoluting a tubular blank comprising a standard provided at each side with a pair of outwardly-beveled vertically-disposed tracks, a pair of laterally-spaced lower driven shafts carried by said standard, a reciprocating idler shaft disposed above and between said lower pair, roller dies slidably mounted on said shafts, means for driving said lower pair of shafts, means for reciprocating said idler shaft toward and away from said lower pair of shafts, and bearing means for detachably supporting said idler shaft for reciprocal movement along said standard tracks, said bearing means including a pair of beveled shaft-supporting bearing plates slidably mated with said pair of outwardly-beveled tracks, a tie-bar rigidly and detachably interconnecting said pair of plates for maintaining said mated engagements, and feeding means carried by said standard and detachably secured to each plate for reciprocating said plates, whereby said apparatus can be assembled by releasing said bearing plates and withdrawing the idler shaft laterally through a pair of tracks.

2. Apparatus for convoluting a tubular blank comprising a standard provided at each side with a pair of outwardly-beveled vertically-disposed tracks, a pair of laterally-spaced lower driven shafts carried by said standard, a reciprocating idler shaft disposed above and between said lower pair, roller dies slidably mounted on said shafts, releasable means for locking said dies in adjusted positions on the shafts, means for driving said lower pair of shafts, means for reciprocating said idler shaft toward and away from said lower pair of shafts, and bearing means for detachably supporting said idler shaft for reciprocal movement along said standard tracks, said bearing means including a pair of beveled shaft-supporting bearing plates slidably mated with said pair of outwardly-beveled tracks, a tie-bar rigidly and detachably interconnecting said pair of plates for maintaining said mated engagements, and feeding means carried by said standard and detachably secured to each plate for reciprocating said plates, whereby said apparatus can be assembled by releasing said bearing plates and withdrawing the idler shaft laterally through a pair of tracks.

3. Apparatus for convoluting a tubular blank comprising a standard provided at each side with a pair of outwardly-beveled vertically-disposed tracks, a pair of laterally-spaced lower driven shafts carried by stand standard,

a reciprocating idler shaft disposed above and between said lower pair, roller dies slidably mounted on said shafts, a releasable means for locking said dies in adjusted positions on the shafts, means for driving said lower pair of shafts, and bearing means for detachably supporting said idler shaft for reciprocal movement along said standard tracks, said bearing means including a pair of beveled shaft-supporting bearing plates slidably mated with said pair of outwardly-beveled tracks, a detachable latch bar rigidly interconnecting said pair of plates for maintaining said mated engagements, and feeding means carried by said standard and detachably secured to each plate for reciprocating said plates, whereby said apparatus can be assembled by releasing said bearing plates and withdrawing the idler shaft laterally through a pair of tracks.

References Cited in the file of this patent

UNITED STATES PATENTS

266,976	Daelen	Nov. 7, 1882
865,908	Johnson	Sept. 10, 1907
1,602,550	Pierce	Oct. 12, 1926
2,061,501	Brown	Nov. 17, 1936