Sept. 30, 1952 C. F. SEIBERT 2,612,205

APPARATUS FOR FORMING TUBULAR L'S

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Fig. 2.

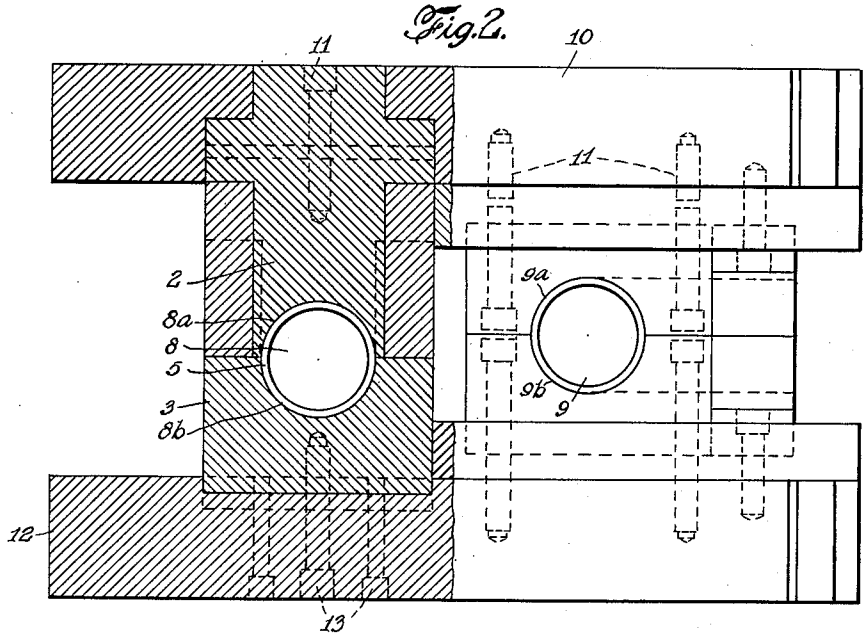
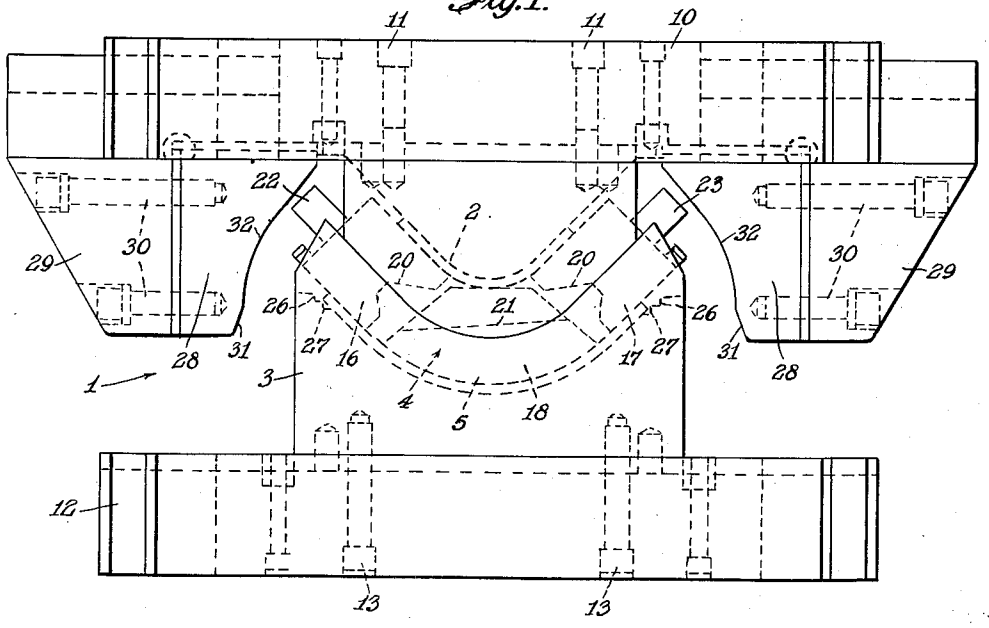



Fig. 1.




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Fig. 4.

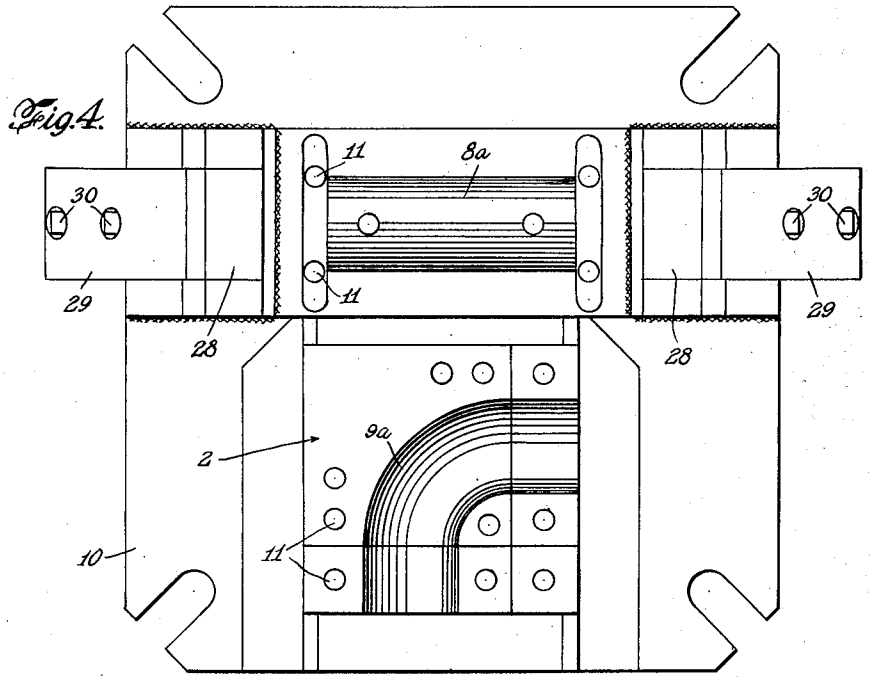
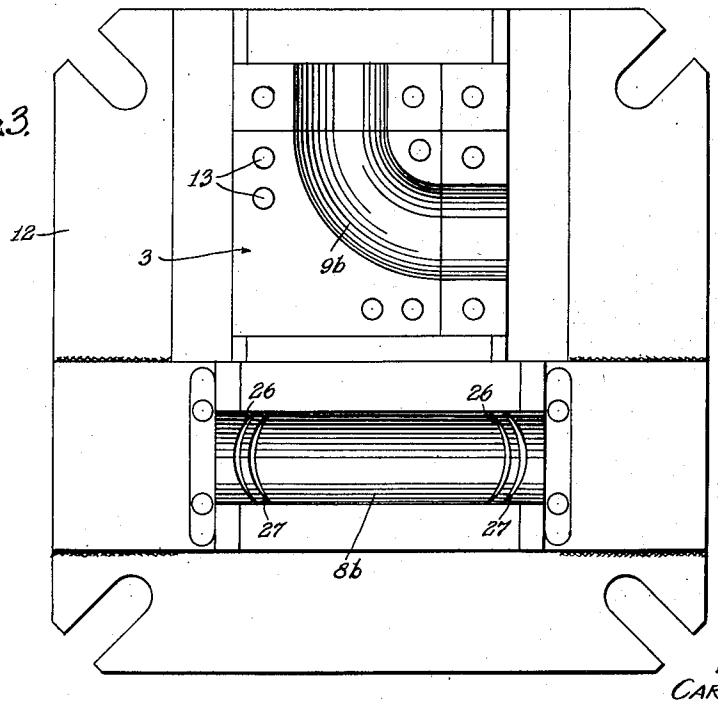



Fig. 3.




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Fig. 5.

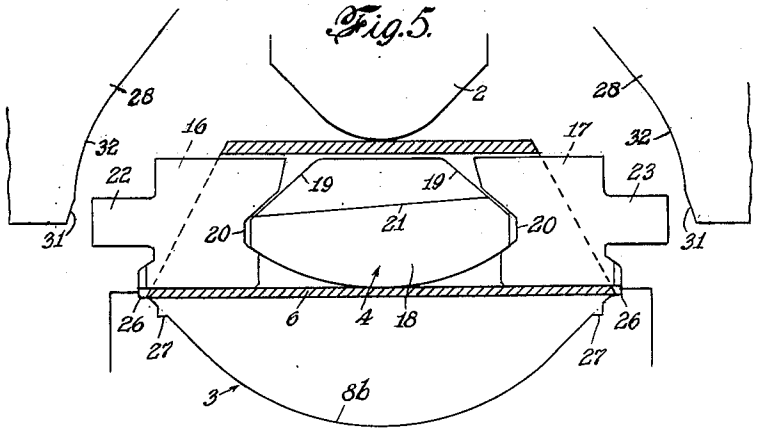



Fig. 6.

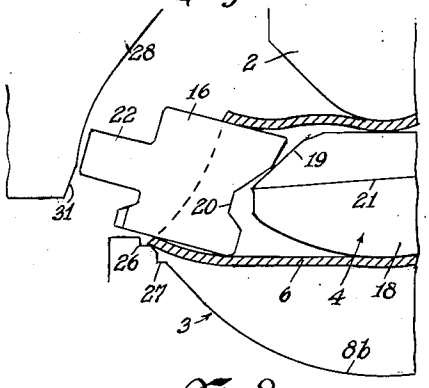



Fig. 7.

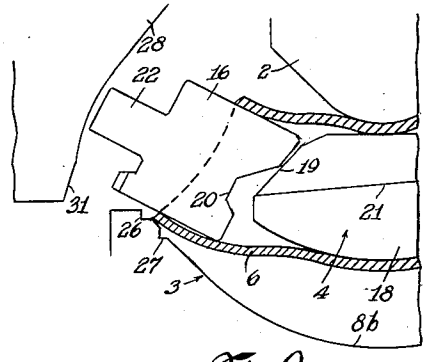



Fig. 8.

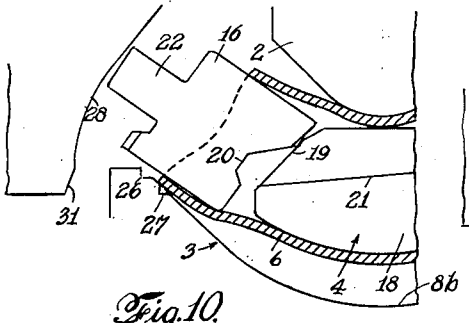



Fig. 9.

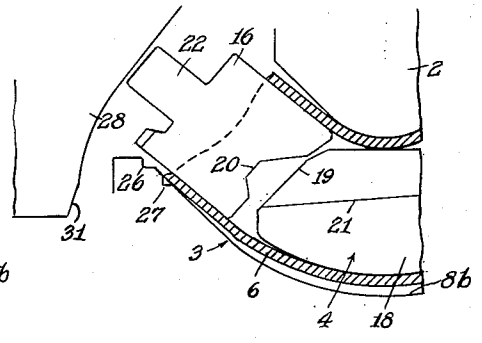
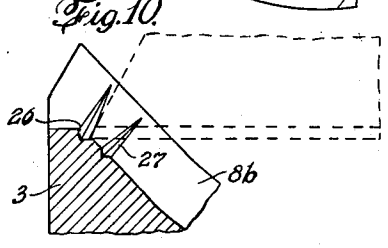



Fig. 10.




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# UNITED STATES PATENT OFFICE

2,612,205

## APPARATUS FOR FORMING TUBULAR L'S

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Application August 31, 1946, Serial No. 694,351

10 Claims. (Cl. 153—48)

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The present invention relates to the manufacture of tubular L's, the term "L" being used generically to comprise not only ninety degree turns, but also turns of other angles greater or less than ninety degrees. The invention is particularly adaptable to the forming of tubular L's of relatively short radius, for example, L's having a center line radius not more than about twice the nominal diameter of the pipe or tube.

Various methods have been heretofore utilized to bend suitable lengths of tubing into L's, among which is a method and apparatus for forming tubular L's disclosed in a copending application for Letters Patent, Serial No. 593,931, filed May 15, 1945, by Clyde J. Martin, now Patent No. 2,528,315, granted October 31, 1950. In that application an internal flexible mandrel is positioned in a blank to support, mold and shape the internal surface of the blank while the external surface of the blank is being subjected to the action of opposed dies in the forming of the blank into a tubular L. In making L's by this method it has been found that malformation of the L's and die breakage has, in some instances, occurred. These troubles appear to have been caused by improper initial positioning of the blanks, mandrel, or both, in the dies, and, in the failure of the blanks, mandrel or both to be maintained in proper position during the forming operation.

An object of the invention is to provide centering means for accurately positioning the blank in an apparatus for forming tubular L's from a straight blank.

Another object of the invention is to provide means for maintaining the blank in proper position during the forming of the blank into a tubular L.

A further object of the invention is to provide means for maintaining a flexible mandrel in correct position within a blank during the forming of the blank into a tubular L.

A still further object of the invention is to provide an improved method of, and apparatus for, forming and finishing a tubular L between opposed die sections.

The present invention aims to overcome the foregoing difficulties and accomplish the foregoing objects by providing an apparatus for initially centering the blank and mandrel in proper position between the opposed dies and for maintaining the blank and mandrel in proper position during the forming operation. The invention further provides a method and apparatus for simultaneously forming a blank and for sizing or finishing another blank.

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In accordance with the invention the initial centering of the blank is accomplished by providing lateral grooves adjacent the ends of the cavity of the concave die. The grooves are spaced by a distance equal to the length of the straight blank. The blank, to be formed into an L, is positioned in the die, the grooves assuring that the blank is properly centered and is maintained in centered position. As the blank is being formed into the desired shape, the straight line distance between the ends of the blank gradually becomes shorter and the blank is then forced into another set of grooves between the initial centering grooves. The blank is thus maintained in a properly centered position during the entire forming operation.

The centering of the mandrel is accomplished by providing curved guide members adjacent the ends of the cavity of the convex die and movable therewith. The mandrel is provided with projecting ends which are guided in the desired path. As the opposed dies approach together the mandrel is initially correctly positioned, and as the bending operation proceeds the curvature of the guideway is such as to maintain the mandrel in proper position during the entire forming operation.

The particular advantage of the method in accordance with the invention is that malformation of the L and breakage of the die are practically eliminated. In addition the forming operation may be performed more rapidly than by previous methods even though the operation is performed by operators of low skill.

In accordance with the invention the simultaneous forming of one blank and the finishing of a second blank are accomplished by providing opposed dies having composite die cavities. One set of die cavities forms the straight blank into a curved blank of the desired curvature. The other set of die cavities finishes the curved blank to the desired size and smoothes out any irregularities in the blank which may have been caused during the forming operation.

The particular advantage of this apparatus is that it permits greater speed in the manufacture of the L's. Labor, time, and equipment are saved as a forming operation and a finishing operation are performed simultaneously by a single set of dies and in a single press. Moreover, no storage facilities or transportation facilities for the partially formed L's are required as the formed L is merely transferred from the forming die cavity to the adjacent finishing die cavity for the finishing operation. By this method the chance of unfinished L's being supplied is mini-

mized as the finishing operation is performed immediately after the forming operation.

Apparatus for carrying out the method of the invention is illustrated in the accompanying drawings. It will be understood that this embodiment of the invention is shown merely by way of example, and that the invention is in no way limited to the use of the specific apparatus illustrated.

In the drawings,

Fig. 1 is an elevational view of cooperating forming dies showing blank and mandrel positioning means, in accordance with the invention, a formed tubular L being shown in position in the closed die and a mandrel being shown in position in the blank.

Fig. 2 is an end view partly in section and partly in elevation, showing the composite dies for forming and finishing the L's.

Fig. 3 is a plan view of the lower section of the composite die showing the two die cavities.

Fig. 4 is a plan view of the upper section of the composite die.

Fig. 5 is a longitudinal sectional view of a straight blank with a mandrel therein positioned in the forming die cavity of the lower section.

Figs. 6 through 9 illustrate various positions assumed by the blank and mandrel during the forming operation.

Fig. 10 is a detailed longitudinal section of a portion of the forming die cavity showing the positioning grooves for the blank.

Referring to the drawings, there is shown in Fig. 1 a composite die 1 comprised of upper die section 2 and lower die section 3. A flexible mandrel 4 is shown in position in a formed L 5 which has been shaped into the desired curvature from a straight cylindrical blank by the action of the opposed die sections and the mandrel.

The upper die section 2 is provided on its face with a forming die cavity 8a and a finishing die cavity 9a. The forming die cavity corersponds generally in shape to the inner half of the tubular L 5, i. e., the half on the inner side of the bend or curvature of the L. The forming die cavity 8a is arcuate when viewed in a vertical section through the longitudinal center line of the L 5, as shown in Figs. 1 and 2. The cavity is straight as viewed in a section at right angles to the vertical section through the longitudinal center line of the L 5. The finishing die cavity corresponds generally in shape to a half of the finished L, i. e., the half on one side of the plane through the radius of curvature of the L, and is located adjacent, and positioned approximately at right angles to the longitudinal axis of the forming die cavity. The finishing die cavity 9a is acruate as viewed in the horizontal section taken through the longitudinal center line of the L 5 and straight if viewed in a vertical section through the longitudinal center line at right angles to the horizontal section. For convenience of manufacture, the die section 2 is made up of a plurality of parts and elements removably secured to a base portion 10 by machine screws or bolts 11, as may be seen in Fig. 4, for instance, the forming die cavity 8a and the finishing die cavity 9a are formed of separate die blocks. The die may be provided with a variety of die elements which are interchangeable with one another.

The lower die section 3 is provided with a forming die cavity 8b and a finishing die cavity 9b, which are formed from separate die blocks and attached to a base portion. The forming die



cavity corresponds generally in contour to the outer half of the exterior surface of the L, i. e., the half on the outer side of the bend or curvature of the L. The die cavity 8b, like cavity 8a, is arcuate when viewed in a vertical section through the longitudinal center line of the L 5, and is straight as viewed in a section at right angles to this vertical section and through the longitudinal center line of the L. The lower die section also has a finishing die cavity 9b which is located adjacent the forming die cavity and positioned approximately at right angles to the longitudinal axis of the forming die cavity. The finishing die cavity 9b, like the cavity 9a is arcuate as viewed in a horizontal section through the longitudinal center line of the L 5, and straight if viewed in a vertical section through the longitudinal center line. The lower die section 3 like the upper die section 2 is shown as being made up of a plurality of parts or elements which are removably and interchangeably secured to a base portion 12, for example, by suitable bolts or machine screws 13.

It will be seen that when the composite die 1 is closed, the die cavities 8a and 8b cooperate to form the die cavity 8 corresponding approximately to the desired shape of the formed L. The die cavities 9a and 9b cooperate to form the die cavity 9, which is shaped to more accurately form the L to the desired shape.

It may be necessary in some instances, particularly when forming L's from resilient material, to perform more work on the L in the finishing operation. This may be accomplished by forming the finishing die cavity 9 with a generally elliptical shape. The cross sections of cavities 9a and 9b will then be semi-elliptical in shape, the minor axis of the ellipse being in a vertical plane so that the walls of the partly formed L all may be worked beyond the yield point of the material in the finishing operation.

Suitable means is provided for moving the upper and lower die sections 2 and 3 toward and away from one another to open and close the die, for example, the die sections may be mounted on opposed members of a suitable hydraulic or other press.

The flexible mandrel 4, which cooperates with the die sections 2 and 3 in forming the blank to the desired shape, comprises a plurality of sections which are pivoted relative to one another to form an articulate and flexible structure. The mandrel conforms to the inner surface of the blank and bends with the blank as it is being formed by the die sections affording substantially continuous internal support to the blank throughout its extent, or at least throughout the portion acted on by the die and cooperating with the die to form the blank to the desired shape. The mandrel comprises a plurality of spaced end sections 16 and 17 and an intermediate central section 18. The end sections 16 and 17 are substantially straight, the surfaces of said sections being approximately cylindrical. The diameter of the end sections 16 and 17 is approximately equal to the inside diameter of the tubular blank so that the mandrel will fit into the blank snugly but with sufficient clearance to prevent binding. The intermediate section 18 is arcuate or curved longitudinally, the surface corresponding to the shape of the form L. The ends of the arcuate central section 18 are cut off at the angle 19 thus forming approximately V-shaped ends which are received in V-shaped recesses 20 provided in the adjacent ends of the sections 16

and 17. The inter-fitting portions of the respective sections of the mandrel serve as pivotal connections between the sections which are thus maintained in proper operative position relative to one another during the forming operation. To facilitate removal of the mandrel from the L after the latter has been formed the central section 18 may be split lengthwise, for example, along the plane of the longitudinal curvature of the section or at a slight angle thereto as indicated at 21. The end sections of the mandrel are preferably formed with lugs or ears 22 and 23 for a purpose to be described later.

In accordance with the invention, centering or positioning grooves 26 are provided in the forming die cavity 8b to assure the initial correct placement of the blank in the die cavity. The grooves 26, as may be seen in detail in Fig. 10 extend transversely of the die cavity and are approximately L-shaped in cross section, the outward sides of the grooves being in a vertical plane while the bottoms of the grooves are in a horizontal plane. The grooves may taper from a maximum depth at the center of the cross section of the die cavity to a minimum depth at the surface of the die member. The grooves are spaced apart at distances corresponding to the length of the straight tubular blank. The straight outer sides of the grooves prevent movement of the blank out of the die cavity during the forming operation, while the flat bottoms of the grooves allow the ends of the blank to slide inwardly into the die cavity during the course of the forming operation. A further set of transverse grooves 27 is positioned inwardly from the initial positioning grooves 26 and serve to position the blank during the latter part of the forming operation. These grooves are likewise generally L-shaped in cross section, and, like the initial centering grooves 26, may taper from a maximum depth at the center of the cross section of the die cavity to a minimum depth at the surface of the die member, so as to be crescent shaped in elevation (Figure 3).

The centering of the mandrel is accomplished in accordance with the invention by providing curved guide members 28 which may be affixed to an extension 29 of upper die section 2, for example by means of bolts or screws 30. The guide members 28 have surfaces 31 which flare outwardly at the bottom thereof, and are adapted to guide ends 22 and 23 of mandrel 4 into a correctly centered position before the upper die section 2 has contacted the blank. Other guide surfaces 32 are provided to guide the mandrel during the forming operation. The shape of the guide surfaces is such as to correspond with the path taken by the ends 22 and 23 of mandrel 4 during the forming operation. It is not essential that the guide surfaces 32 be in actual contact with the ends of the mandrel excepting in case one or both of the ends of the mandrel should be out of position. In other words, if the mandrel is positioned perfectly centrally of the blank, with the mandrel ends in proper relation to the center, there may be a slight clearance between each of the outer portions of the end sections 22 and 23 and the guide surfaces 32, the clearance being an amount representing the maximum allowable shifts of either of the ends sections of the mandrel during the forming operation.

In forming a tubular L with the apparatus shown in Figs. 1 to 4, a straight blank of tubular stock 6 is positioned in the open forming die 8 with its ends in the centering grooves 26. The



mandrel 4 has been placed in the blank 6 with the straight side of the central section of the mandrel up, while the arcuate side is down. The opposed die sections are then brought together by suitable means such as a press, the direction of the force applied to the blank by the dies being in the plane of curvature of the desired L. The formed L is shown in the die sections in Fig. 1.

The operation of the dies, mandrel, blank centering means and mandrel guiding means is illustrated more fully in Figs. 5 through 9 which show representative positions of these parts during the forming of the L. In Fig. 5 the straight blank 6 is shown in position in the grooves 26 with mandrel 4 in place in the blank. There is a slight clearance between guiding surfaces 31 of guiding members 28 and the ends 22 and 23 of mandrel 4. The grooves and guiding surfaces have cooperated to properly center the mandrel and blank within the die cavity. The grooves have centered the blank with respect to the dies. The guiding surfaces have centered the mandrel both with respect to the blank and with respect to the dies. Although Figs. 6 through 9 show only one end of the blank and dies, it is understood that the action of the blank and dies at the other end is similar. In Fig. 6 the dies have started to bend blank 6, the ends of the blank starting to leave centering grooves 26. The vertical side wall of the L-shaped groove 26 has prevented the end of blank 6 from slipping endwise out of centered position in die cavity 8a, while the surface 32 of guiding member 28 has prevented the end 22 of mandrel 4 from shifting from its centered position in blank 6. In Fig. 8 the end of the blank has moved into grooves 27. In Fig. 9 the forming operation is practically completed, the end of blank 6 remaining in groove 27. It will be noted that during the bending operation the end sections 16 and 17 of mandrel 5 have pivoted about the center section 18 aiding the opposed die sections 2 and 3 in molding and shaping the internal surface of the blank while supporting the walls of the blank against collapse, wrinkling or bulging.

The formed L, after being partially shaped by the forming portion of die sections 2 and 3, is rotated about ninety degrees and placed in the adjacent finishing portion of the die sections and another straight blank is placed in the forming portion of the die sections. The die sections are again brought toward one another finishing the formed L 5 into a more accurately formed L, and simultaneously forming another straight blank into a formed L, the direction of the force applied by the dies to the formed L being perpendicular to the plane of the bend, while the force applied to the straight blank is in the plane of the desired bend.

While certain forms of apparatus for carrying out my invention have been shown in the drawings and particularly described, it will be understood that the invention is in no way limited to this specific apparatus or to the particular steps described, but is subject to various modifications and variations. For example, a greater number of grooves may be employed, each set of grooves acting during a portion of the forming operation. The invention is equally applicable to the forming of tubular L's of circular or other cross section. Although for convenience in nomenclature, certain dies have been referred to as upper, and other as lower dies, the position of the dies can be reversed, or the dies

can be turned at any desired angle. Still other embodiments and variations of the invention within the scope of the appended claims will be obvious to persons skilled in the art.

What I claim and desire to secure by Letters Patent is:

1. In apparatus for forming a tubular L from a blank of tubular stock, the combination of a flexible mandrel insertable in the blank, the mandrel having ends projecting beyond the ends of the blank, opposed die members having cooperating concave and convex die cavities corresponding in contour to the formed L, means retaining the blank in position formed in the cavity of the concave die member, and mandrel positioning means movable with the convex die member adapted to operatively engage the ends of the mandrel.

2. In apparatus for forming a tubular L from a blank of tubular stock, the combination of a flexible mandrel having ends projecting beyond the ends of the blank, opposed die members having cooperating concave and convex die cavities corresponding in contour to the formed L, the concave die member having a pair of spaced transverse positioning grooves formed in the die cavity each adjacent an end thereof adapted to receive and longitudinally hold the blank in position in the concave die member, and mandrel positioning means movable with the convex die member adapted to operatively engage the ends of the mandrel.

3. In apparatus for forming a tubular L from a blank of tubular stock, the combination of a flexbile mandrel having ends projecting beyond the ends of the blank, opposed die members having cooperating concave and convex die cavities corresponding in contour to the formed L, the concave die member having a pair of spaced transverse positioning grooves formed in the die cavity each adjacent an end thereof adapted to receive and longitudinally hold the blank in position in the concave die member, a second pair of transverse grooves formed in the concave die cavity between the first pair of grooves, the second pair of grooves being positioned to receive the ends of the blank after the forming operation has caused the ends of the blank to travel inwardly towards the center of the cavity of the concave die member, and mandrel positioning means movable with the convex die member adapted to operatively engage the ends of the mandrel.

4. In apparatus for forming a tubular L from a blank of tubular stock, the combination of a flexible mandrel insertable inside the blank, the mandrel having ends projecting beyond the ends of the blank, opposed die members having cooperating concave and convex die cavities corresponding in contour to the formed L, means retaining the blank in position formed in the cavity of the concave die member, and mandrel positioning means comprised of guiding members arranged to move with the convex die member, the guiding surfaces of the members being continuous smooth surfaces shaped to conform to the desired path of the ends of the mandrel during the forming operation and to prevent deviation of the ends of the mandrel from said desired path.

5. In apparatus for forming a tubular L from a blank of tubular stock, the combination of a flexible mandrel insertable in the blank, the mandrel having ends projecting beyond the ends of the blank, opposed die members having cooperating concave and convex die cavities corresponding in contour to the formed L, means retaining the blank in position formed in the cavity of the concave die member, and mandrel positioning means comprised of guiding members arranged to move with the convex die member, the guiding surfaces of the members being positioned and shaped to guide the ends of the mandrel into the desired path before the convex surface of the die member contacts the blank and to maintain the ends of the mandrel in the desired path during the forming operation.

6. In apparatus for forming a tubular L from a blank of tubular stock, the combination of a flexible mandrel insertable in the blank, the mandrel having ends projecting beyond the ends of the blank, opposed die members having cooperating concave and convex die cavities corresponding in contour to the formed L, the concave die member having a first pair of spaced transverse positioning grooves formed in the concave die cavity each adjacent an end of the cavity thereof so constructed and arranged as to receive and longitudinally hold the blank in position in the concave die member, a second pair of transverse grooves formed in the concave die cavity positioned between the first pair of grooves, the second pair of grooves being positioned to receive the ends of the blank after the forming operation has caused the ends of the blank to travel inwardly towards the center of the cavity of the concave die member, and mandrel positioning means comprised of guiding members arranged to move with the convex die member, the guiding surfaces of the members being positioned and shaped to guide the ends of the mandrel into the desired position before the convex surface of the die member contacts the blank and to maintain the ends of the mandrel in the desired path during the forming operation.

7. In apparatus for forming a tubular L from a blank of tubular stock, the combination of a flexible mandrel insertable in the blank, opposed die members having cooperating concave and convex die cavities corresponding in contour to the formed L, means for centering the blank relative to the die cavities comprising a pair of transverse positioning grooves in the wall of the concave die cavity spaced apart a distance equal to the length of said blank, and means for centering said mandrel relative to said die cavity and blank.

8. In apparatus for forming a tubular L from a blank of tubular stock, the combination of a flexible mandrel insertable in the blank, opposed die members having cooperating concave and convex die cavities corresponding in contour to the formed L, the concave die member having a first pair of spaced transverse positioning grooves formed in the concave die cavity each adjacent an end of the cavity thereof so constructed and arranged as to receive and longitudinally hold the blank in position in the concave die member, a second pair of transverse grooves formed in the concave die cavity positioned between the first pair of grooves, the second pair of grooves being positioned to receive the ends of the blank after the forming operation has caused the ends of the blank to travel inwardly towards the center of the cavity of the concave die member, and means for centering said mandrel relative to said die cavities and blank.

9. In apparatus for forming a tubular L from a blank of straight tubular stock, the combination of a flexible mandrel insertable in prede-

termined position in the blank and opposed die members having cooperating concave and convex die cavities corresponding in contour to the formed L, the concave die member having a first pair of opposed spaced transverse positioning grooves formed in the concave die member adjacent the opposite ends of the die cavity and so constructed and arranged as to receive the blank and hold it in position in relation to the cavity and a second pair of transverse grooves formed in the concave die cavity at points spaced inwardly from the first grooves, the second pair of grooves being positioned to receive the ends of the blank after the forming operation has caused the ends of the blank to travel inwardly towards the center of the cavity of the concave die member and to reposition the blank relative to the die members in the event it has become off center during said travel.

10. In apparatus for forming a tubular L from a blank of tubular stock, the combination of opposed die members having cooperating concave and convex die cavities corresponding in contour to the formed L and movable toward one another in a direction approximately radial to the curvature of the formed L, abutments engaging the ends of a blank to retain the blank in predetermined lengthwise position relative to said die cavities, an articulated mandrel insertable in the blank and comprising a plurality of sections including a rigid section having on one side a curved surface conforming to the shape of the formed L and on the opposite side a substantially cylindrical surface, said mandrel cooperating with the concave die cavity to press the blank into predetermined shape and means for guiding the opposite ends of the mandrel in converging curved paths to maintain said mandrel centered relative to said die cavities and blank during the forming operation.



CARL FREDERICK SEIBERT.


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