June 11, 1968 S. SHUPPER 3,387,477

APPARATUS AND METHOD FOR ROLL FORMING FLEXIBLE TUBING

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FIG. 1.

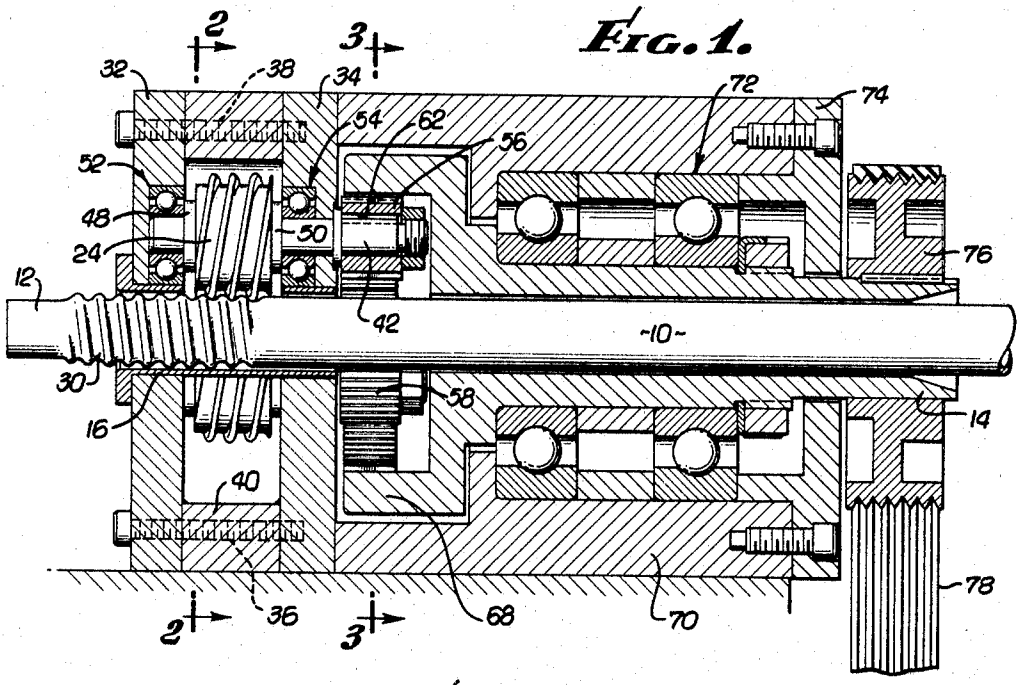


FIG. 2.

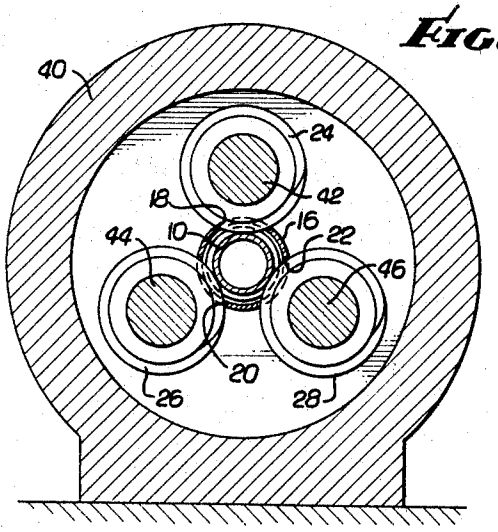


FIG. 3.

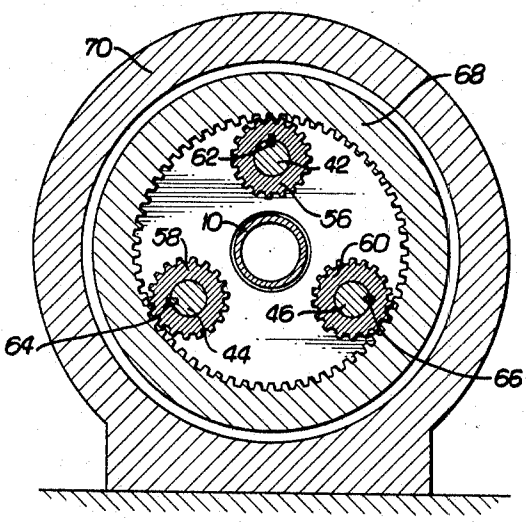
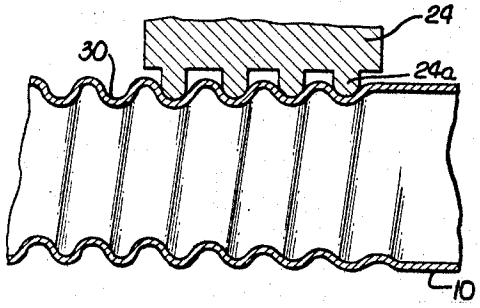


FIG. 4.



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FIG. 5.

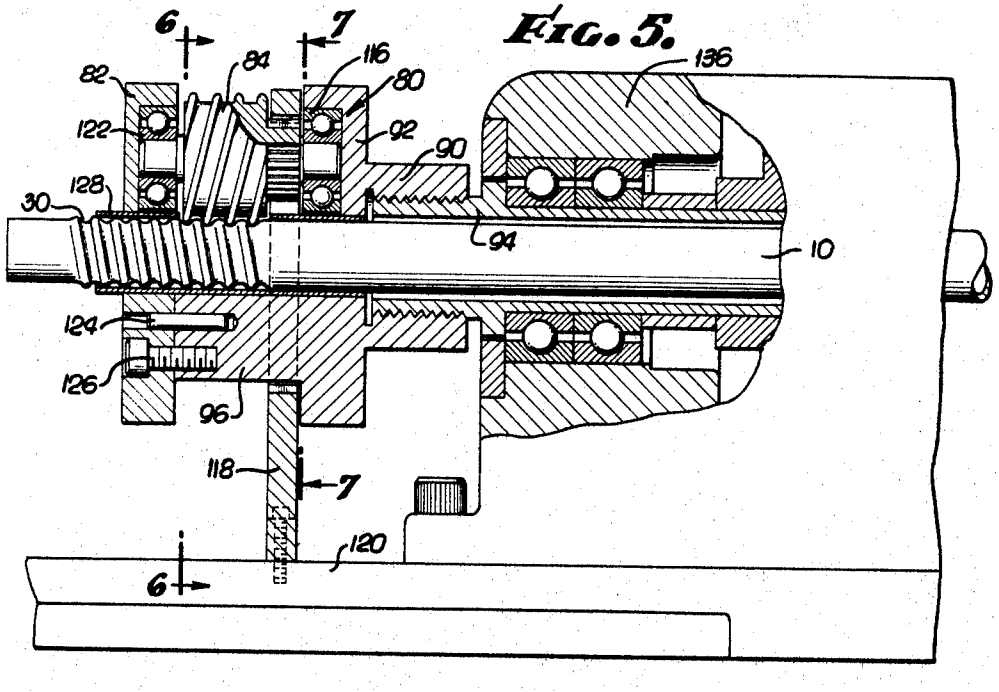


FIG. 6.

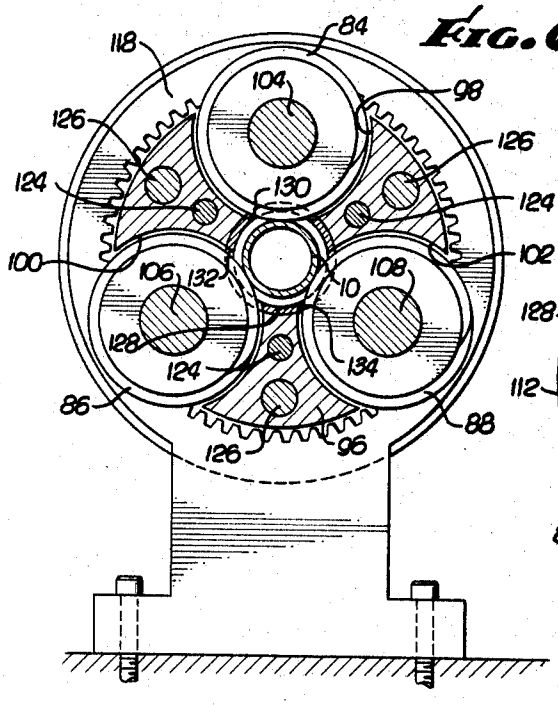
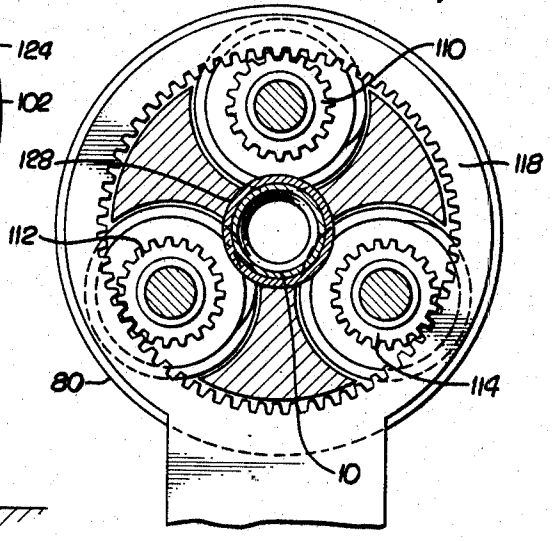


FIG. 7



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APPARATUS AND METHOD FOR ROLL FORMING FLEXIBLE TUBING

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7 Claims. (Cl. 72—77)

ABSTRACT OF THE DISCLOSURE

Hollow tubing 10 is fed through an exterior mandrel 16. The tubing is worked upon by forming rollers 24, 26 and 28 that project through slots 18, 10 and 22 (FIG. 2) in the mandrel. The mandrel prevents the tubing 10 from bulging and no interior mandrel is required.

Brief summary of the invention

This invention relates to flexible metal tubing such as used in connecting a gas range to gas line. More particularly this invention relates to the manufacture of such flexible tubing.

Such flexible tubing has been mass produced by rotating the pipe through fixed dies that extend substantially helically, the diameter of the dies progressively reducing. The difficulty with this method is that the dies are extremely short lived.

It has been proposed to roll form such flexible tubing in order to avoid the excessive wear on the metal forming parts. However, since the pressures exerted by rollers is quite localized, the metal tends to collapse beneath the rollers. The obvious solution is to put a mandrel inside the tube. This is quite satisfactory, except for the fact that the tubing has to be of uniform internal diameter for insertion and removal of the mandrel. This is a problem since the ends of the tubes are often first cylindrically reduced for cooperation with conventional connecting fittings. Furthermore, complicated apparatus may be required for positioning the mandrel and the work if the process is not to be slowed down.

The primary object of this invention is to provide a simple system for roll forming flexible metal tubing in which an internal mandrel is not required. Accordingly, lengths of tubing can be quickly processed even though their ends are first reduced for cooperation with connecting fittings. In order to achieve this result, I use an external mandrel instead of the internal mandrel. This external mandrel prevents the tube from bulging, and since it is prevented from bulging, it cannot collapse beneath the roll forming dies. The external mandrel has slots for permitting the passage of the rollers.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several embodiments of the invention. For this purpose, there are shown a few forms in the drawings accompanying and forming part of the present specification, and which drawings, are true scale. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Brief description of the drawings

FIGURE 1 is an axial sectional view of apparatus incorporating the invention;

FIGS. 2 and 3 are transverse sectional views taken along planes corresponding to lines 2—2 and 3—3 of FIG. 1;

FIG. 4 is an enlarged fragmentary sectional view of the operative portion of one of the rollers;

FIG. 5 is an axial sectional view of apparatus that is a modified form of the present invention; and

FIGS. 6 and 7 are transverse sectional views taken along planes corresponding to lines 6—6 and 7—7 of FIG. 5.

Detailed description

The hollow tubing 10 shown in FIG. 1 has a reduced end 12 for cooperation with a conventional fitting (not shown). The other end (not shown) may be similarly formed. The tubing 10 is fed into the right-hand end of a hollow shaft with respect to which it has at least running clearance. The tubing then enters a hollow mandrel 16 at the left-hand end of the machine, and which, by means hereinafter to be described is supported coaxially of the hollow shaft 14.

The mandrel 16 has a substantially circular internal cross section designed to have slight clearance with respect to the external diameter of the tubing to be formed. As shown in FIG. 2, the hollow mandrel 16 has three angularly spaced slots 18, 20 and 22 located intermediate the ends of the mandrel. Partially projecting into these slots for engagement with the periphery of the tubing 10 are three forming rollers 24, 26 and 28. These rollers are designed cooperatively and progressively to form a single helical groove 30 in the tubing to impart flexibility thereto. These forming rollers are supported for rotation about three axes equiangularly and equidistantly located relative to the axis of the mandrel 16. Each of the forming rollers has a helically extending operative roll forming element the effective diameter of which progressively increases. The starting end 24*a* of the element of one of the rollers 24, for example (FIG. 4), has an effective diameter designed to begin initial penetration of the tubing. As the tubing rotates 120° and advances one-third of the pitch of the helix, the starting end of the second forming roller 26 picks up the groove started, and adds its increment of metal forming. In a like manner, each turn of each forming roller adds its increment of metal forming, whereby the work is distributed.

The forming rollers must be accurately synchronized or timed, as well as accurately positioned in an axial direction in order for the rollers cooperatively and progressively to form the helical groove 30. The forming rollers 24, 26 and 28 and the mandrel 16 are supported by and between bearing blocks 32 and 34. Screws as at 36 and 38 secure the bearing blocks and a spacer 40 together. The mandrel 16 fits in aligned bores of the bearing blocks.

The forming rollers are illustrated as formed integrally with shafts 42, 44 and 46 in order to ensure that the operative elements of the rollers are in precise axial and radial positions relative to their shafts. Other arrangements could be provided. The rollers are all supported in a similar manner. At opposite ends of the roller 24, for example, are intermediate reduced sections 48 and 50 providing shoulders that respectively engage the inner races of ball bearings 52 and 54 that are supported by the bearing blocks 32 and 34. The roller 24 is accordingly restrained from axial movement while it is supported for rotation about its axis.

The shafts 42, 44 and 46 have ends that project through the bearing block 34. These projecting ends (FIG. 3) mount gears 56, 58 and 60 that are coupled to the respective shafts by keys 62, 64 and 66. The gears are all simultaneously engaged and driven by an internal ring gear 68 formed in a cupped enlargement of the hollow shaft 14. Since a common drive gear is provided, and since the keyways for the keys are accurately located, the rollers are precisely timed.

The hollow shaft 14 and the ring gear 68 are supported for rotation by a hollow bracket or housing 70 to one end of which the bearing plate 34 is attached. A roller bearing assembly 72 held in the housing by a retainer 74, mounts the hollow shaft 14 in a conventional manner. A pulley 76 mounted on the projecting end of the shaft 14 serves as a means for transmitting rotary power, applied by the aid of a belt 78.

As the tubing is worked upon, it is caused to rotate as it moves forwardly. The external mandrel 16 so confines the tubing that it is prevented from distorting under the high pressures of the forming rollers, and no internal mandrel is required.

The form illustrated in FIGS. 5, 6 and 7 is quite similar, except that planetary motion is imparted to the forming rollers, and the tubing itself advances without rotation.

A pair of bearing blocks 80 and 82 mount three forming rollers 84, 86 and 88. The bearing block 80 has an internally threaded hub 90 that adjoins one side of a flange 92. This hub 90 is attached to the threaded end of a hollow drive shaft 94. On the other side of the flange 92 is a slightly reduced extension 96 (see also, FIG. 6) that has three arcuate slots 98, 100 and 102 in which the rollers are accommodated. As in the previous form, the rollers are formed integrally with shafts 104, 106 and 108. Each shaft carries a gear 110, 112 and 114 (see also, FIG. 7) that adjoins the inner end of each of the corresponding forming roller. The inner ends of the shafts 104, 106 and 108 are received in the inner races of roller bearings, as at 116 (FIG. 5). These roller bearings are accommodated in recesses that extend inwardly from the ends of the arcuate slots. A non-rotary internal ring gear 118 surround all of the gears 110, 112 and 114, and is mounted upon a base 120.

The other or outer ends of the shafts 104, 106 and 108 are mounted by bearings as at 122 in the bearing block 82. The timing and axial position of the rollers are accurately controlled to ensure proper operation of each of the rollers. The bearing block 82 is accurately located in alignment with the block 80 by the aid of dowel pins 124, and secured against the end surface of the reduced extension 96 by cap screws 126.

Aligned apertures in the bearing blocks 80 and 82 carry an external mandrel 128 that has three slots 130, 132 and 134 (FIG. 6) for passage of the operative elements of the forming rollers, as in the previous form. The hollow shaft is supporting in a housing 136, also attached to the base 120.

Upon rotation of the hollow shaft 94, as by the suitable drive (not shown), planetary motion of the forming roller is imparted by virtue of the non-rotary ring gear 118 and the gears 110. As in the previous form no internal mandrel is required, and the tubing can simply be advanced through the appartus. The mandrel could also be made integrally with the support for the forming rollers. If desired, suitable conveyor apparatus (not shown) may be used for feeding the tubing to the apparatus and for receiving the processed tubing.

The inventor claims:

1. In apparatus for making flexible tubing: a hollow mandrel having a substantially circular internal cross section; a forming roller having an operative element; means supporting the forming roller about an axis located laterally of the mandrel and for rotation about said axis; the axis of said forming roller being spaced laterally of said mandrel; said mandrel having a slot for passage of a section of the operative element of the forming roller; said slot extending only partially around the circumference of the mandrel; and means for imparting rotation to the forming roller to position successive sections of the operative element of the forming roller at said slot; the ends of said mandrel having unobstructed access for passage of tubing therethrough.

2. The apparatus as set forth in claim 1 together with a number of additional forming rollers having operative elements; means supporting said additional forming rollers in angularly spaced relationship about said mandrel and for rotation about their axes; the axes of said additional forming rollers being spaced laterally of said mandrel; said forming rollers being substantially aligned longitudinally of said mandrel; said mandrel having additional slots for passage of sections of the operative elements of said additional forming rollers; said additional slots extending only partially around the circumference of the mandrel; said additional forming rollers being operatively associated with said rotation imparting means whereby said forming rollers are rotated in synchronism.

3. The combination as set forth in claim 2 wherein said supporting means includes a pair of spaced bearing blocks for supporting said forming rollers, said bearing blocks being provided with aligned apertures in which said mandrel is accommodated.

4. The combination as set forth in claim 3 wherein said rotation imparting means includes gears carried by said forming rollers and a common gear in engagement with all of said roller carried gears for rotation of said forming rollers in synchronism.

5. The combination as set forth in claim 4 wherein said rotation imparting means further includes means for rotating said bearing blocks about the axis of the mandrel; said common gear being a stationary ring gear surrounding said roller carried gears and imparting planetary movement to said forming rollers.

6. In apparatus for making flexible tubing: a hollow shaft; means mounting said shaft for rotation about its axis; a support carried at one end of said hollow shaft; a hollow mandrel carried by said support and aligned with said end of said hollow shaft; a plurality of forming rollers arrayed substantially equiangularly about said mandrel, and having shaft ends; bearings carried by said support and rotatably mounting said shaft ends; said forming rollers being confined against axial movement; there being substantially equiangularly located slots in said mandrel through which operative elements of said forming rollers extend for engagement with tubing advanced through said hollow shaft and said mandrel; each forming roller having a gear member on its shaft; and a non-rotary ring gear surrounding said gear members and causing rotation of said forming rollers in synchronism; the relative angular positions of said forming rollers being maintained by engagement with said ring gear.

7. The process of roll forming flexible tubing, which comprises: advancing tubing through an external mandrel; rotating an operative element of a forming roller about an axis located laterally of the mandrel; exposing the tubing in the mandrel to the operative element of the forming roller through an access slot in the mandrel; and deforming the tubing by the action of said operative element.

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