

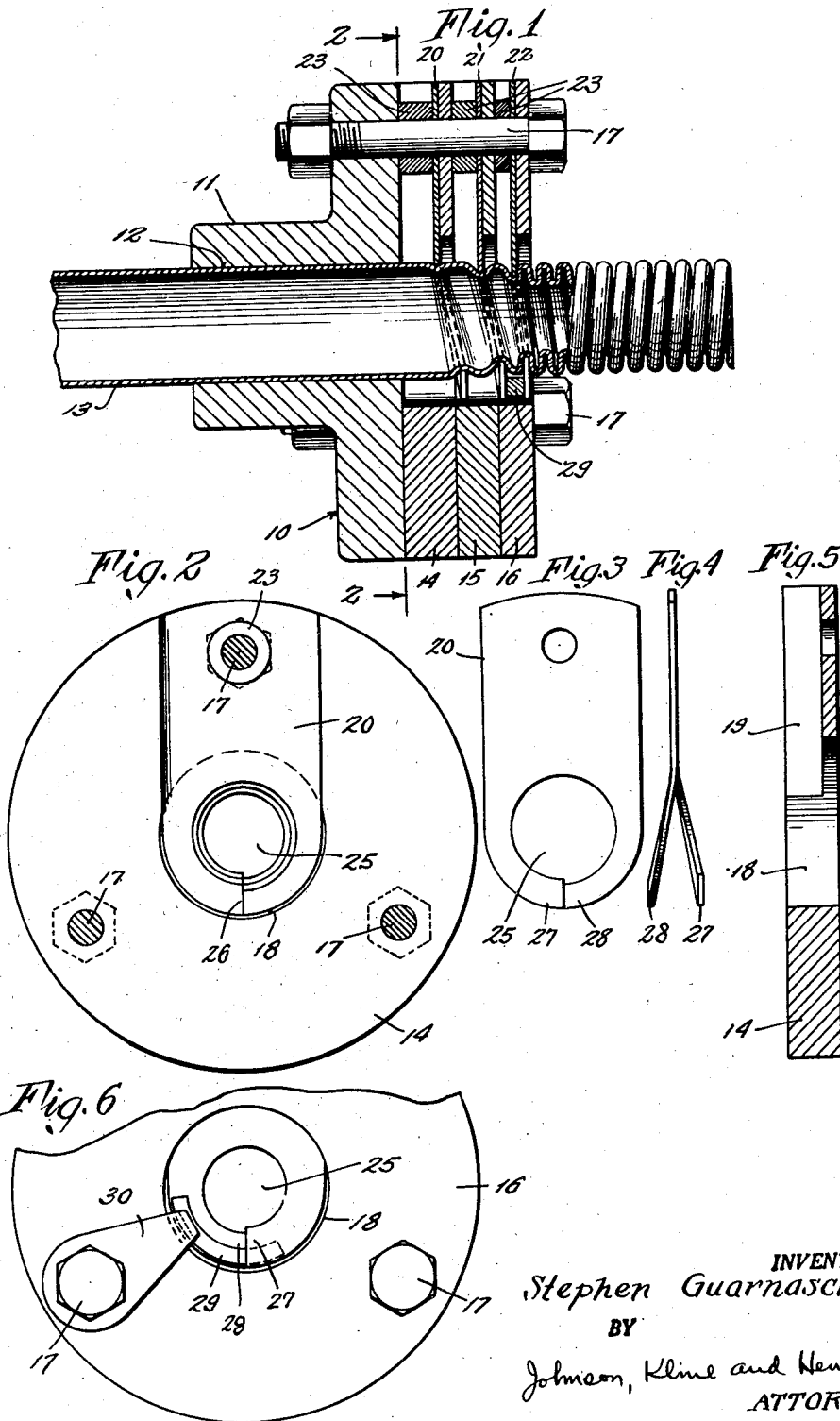
Feb. 7, 1950

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2,496,790

APPARATUS FOR MAKING FLEXIBLE METAL HOSE

Filed March 11, 1947



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2,496,790

APPARATUS FOR MAKING FLEXIBLE
METAL HOSE

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Application March 11, 1947, Serial No. 733,841

13 Claims. (Cl. 153—71)

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This invention relates to apparatus for forming helical convolutions or corrugations in straight-walled tubing of ductile metal or other ductile material, particularly for use in making flexible metal hose.

It has been proposed heretofore to form helical convolutions in ductile tubing by passing it through a rotary die having helical convolution-forming die members of progressively reduced radius and pitch or axial spacing. After the tubing is started through the die, the latter is rotated relative to the tube and the walls thereof are progressively swaged into helical convolutions as the tube is fed through the die.

In some forms of apparatus employed for forming helical convolutions, the die members must engage the inner as well as the outer walls of the tube. The die members comprise for example a pair of rollers, but such devices have the disadvantage that the internal die member must be supported from at least one end of the tube, and accordingly, only limited lengths of tubing can be corrugated.

It has also been attempted to form helical convolutions in ductile tubing solely by means of external rollers which indent the tube along a helical line. Such apparatus, however, has proven unsatisfactory in that the deforming action is not continuous and the unequal strains produced thereby generally collapse, twist or otherwise mutilate the tube.

The most satisfactory method for forming helical convolutions in continuous ductile tubing involves passing the tubing through a die having a substantially continuous helical groove-forming edge or surface of progressively reduced radius and progressively reduced axial spacing or pitch, engaging the outside of the tubing wall, so as to form the convolutions progressively in the tubing, the pitch being reduced to bring the convolutions together. As a result, substantially rigid tubing can be converted into flexible hose.

The manufacture of dies of the aforesaid type has presented serious difficulties, because of the irregular shape thereof. Construction of such dies in a single piece or in segments is so expensive as to be entirely impractical; since in use, the relatively rapid wear to which the dies are subject and the high cost of their replacement renders their use prohibitively expensive.

To remedy this situation, it has been proposed to provide a die block having a tube-receiving passage therein, separated along an axial plane into two halves, each half of the block having slanting grooves in the walls of the tube-receiv-

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ing passage, which combine to form a helical groove of decreasing pitch when the halves of the block are secured together. The aforesaid slots are adapted to receive thin plate-like die members having inner arcuate edges which form the desired helix when they are inserted in the slots and the halves of the block are secured together.

This form of die has the advantage that the die plates are readily replaceable as they wear out, and the die can also be used on any length of pipe. However, slight variation in the shape of the die members from the required helical form are preserved by the rigid mounting thereof in the slots of the die blocks, said die plates being substantially immovably mounted during the tube-corrugating operation. Variations in the character (e. g. hardness or thickness, or other dimensions) of the tubing, when engaged by the rigidly supported die plates causes excessive wear, and sometimes the strain occasioned thereby causes mutilation or fracture of the tubing.

It is an object of this invention to provide an improved die for forming helical convolutions in ductile straight-walled pipe, wherein the die members can be readily and cheaply made, and easily replaced in the die.

It is also an object to provide such apparatus in which the die members are movable to limited extent during the tube-corrugating operation, so as to compensate for variations in the character of the tubing or its dimensions, and thereby avoid any tendency to mutilate, weaken or otherwise spoil the tube.

In connection with these objects, it is also an object to provide die members which form a substantially continuous helix and which are held in the desired relation by the tubing itself.

Thus, in accordance with this invention, the die members comprise a plurality of plates of suitably hardened metal, arranged in spaced parallel face-to-face relation, and supported at one end thereof by appropriate mounting means. The opposite unsupported end of each plate is provided with an aperture corresponding in outline to a segment, preferably representing a single revolution of a spiral, the outlines of the apertures in successive plates corresponding to consecutive revolutions or segments of the spiral. The side portions of each plate forming the outline of its aperture and extending around the aperture therein to the termini of the spiral segment are offset or bent in opposite directions from the plane of the plate so that the edges of the aperture form in effect a segment of a conical or spiral helix. Preferably, the plate is split from

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the aperture to the outer edge at the termini of the spiral segment so that the offset ends are no longer interconnected.

When the plates are mounted, with the apertures therein coaxially disposed, and the offset ends coinciding respectively with an offset end of an adjacent plate, the edges of the apertures in the series of plates form a substantially continuous spiral or conical helix, i. e. a helix of progressively reduced radius.

The die plates of this invention can be conveniently and economically made from flat plates of suitable die metal by forming a spiral aperture therein, adjacent one end thereof, splitting each plate at one side of its aperture between the termini of the spiral segment forming the outline of the aperture, and bending the split ends outward on opposite direction from the plane of the plate. The die plates thus formed are mounted in the required spaced relation, such spacing being wider at the broader end of the spiral helix, and closer at the smaller end of the helix. Preferably, the plates are rigidly supported at one side of the aperture, opposite the offset ends, particularly by means of a lateral extension on this side of each plate. The plate end forming the sides of the spiral aperture is thereby free to flex slightly in axial direction so that their offset ends are readily brought into coincidence with the ends of adjoining plates by the corrugation formed in the pipe itself, and are thus adapted to accommodate minor variations in the resistance of the pipe to the corrugating effect as it is passed through the helical die. Moreover, sufficient clearance is preferably allowed for the offset ends of the plates to flex apart in radial direction to a limited extent, likewise reducing the possibility of jamming of the tube therein.

In the preferred form of die, in accordance with this invention, the die plates are mounted on a series of die blocks secured together in face-to-face relation, and having a central tubing-receiving passage through the assembly. Each block has a channel in its face extending from said passage to the periphery of the block. The die plates extend through said channels into the central aperture and are supported solely within the channels at one side of the aperture. The spacing between the die plates can be controlled by constructing the die blocks of graduated thickness, and the channels therein of graduated depth, to determine the limiting spacing of the die blocks; such spacing can be varied by placing spacer members on one or both sides of the plates to position them depthwise in the channels.

The apertured offset ends of the die plates extend into the central tube-receiving passage through the blocks, and form a helical corrugating edge for engaging the outside wall of ductile tubing passing through the die. Preferably, sufficient clearance is provided between the ends of the plates and the walls of said passage through the blocks so that the plates can flex radially to a limited extent. Moreover, the unsupported ends of the plates in said passage are free to flex slightly in axial direction to accommodate variations in the tubing. However, if desired, spacer means can be included to fix the spacing of the ends of the last or smallest die plate, so as to control more accurately the pitch of the helical convolutions formed in the pipe.

Guide means are preferably provided for centering the tubing as it enters the die, such means comprising for example a chuck-engaging block to which the die blocks are secured, having a

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cylindrical aperture therein, concentric with the die aperture and conforming slidably to the outside diameter of the pipe to be corrugated.

In using the die, it is rotated about the axis of the spiral helix formed by the die plates, and a length of ductile straight-walled tubing, restrained against rotation, is passed through the guide means and the die which progressively forms helical convolution therein. The tubing can be started through the die by reducing its leading end so that the latter can extend through the die, and can be pulled therethrough as the die begins to operate on the undeformed wall of the tubing. The radial passages formed by the channels in the die blocks provide convenient openings for introducing lubricants to the die edges or surfaces.

My invention will be more fully understood from the following description of a preferred embodiment thereof taken in conjunction with the accompanying drawings, wherein:

Figure 1 is an axial cross-section of a die in accordance with my invention, fully assembled, and in process of forming convolutions in ductile straight-walled tubing;

Fig. 2 is a transverse cross-section of the die of Fig. 1 along the line 2—2;

Figs. 3 and 4 are respectively front and side elevations of a die plate included in the assembly of Fig. 1;

Fig. 5 is an axial cross-section of one of the die blocks of Fig. 1, which support the die plates; and

Fig. 6 is a fragmentary end elevation of the die of Fig. 1, showing spacer means for the terminal die plate.

Referring to the drawings, the die of my invention comprises a circular mounting block 10 having a rotary chuck-engaging boss 11 on its rear surface, and a central cylindrical passage 12 therethrough conforming to the outside diameter of a piece of straight-wall tubing 13, which is to be corrugated by the die, said passage serving as a guide in centering the tubing.

A plurality of die blocks 14, 15 and 16 are secured to the mounting block 10 in face-to-face relation, for example, by a number of bolts 17, distributed around the axis of the die. The die blocks are preferably of graduated thickness, block 14 next to the mounting block 10 being the thickest, and block 16 at the opposite outer end of the die being the narrowest.

Die blocks 14, 15 and 16 each have a central aperture forming a passage 18 extending through the assembly, said passage being of larger diameter than the guide passage 12 through the mounting block 10. Each of the die blocks 14, 15 and 16 has a radial channel 19 in the face thereof, of approximately the same width as the diameter of the passage 18, or preferably slightly narrower, and extending from said aperture across the face of the block to the periphery thereof. Advantageously, one of the bolts 17 extends through the channels 19 in the die blocks. The channels 19 are preferably of graduated depth corresponding to the thickness of the die blocks.

When the die blocks 14, 15 and 16 are assembled, as shown in Fig. 1, the channels 19 in each of the plates are parallel and all face the mounting block 10 forming radial passages in the assembly, communicating with the central passage 18 through the die blocks.

A plurality of die plates 20, 21 and 22, one for each of the blocks 14, 15 and 16, of relatively thin metal, are positioned in the channels 19 and are

clamped therein by spacing collars 23 carried by the bolt 17 which intercepts the channels 19. In the assembly shown in Fig. 1, they are clamped between said collars 23 and the bottom wall of the respective channels 19. The die plates are advantageously of the same width as channels 19 so that when mounted in said channels, they are held by the side walls against lateral displacement. The opposite or lower ends of the aforesaid die plates extend through the channels into the central passage 18 through the die blocks 14, 15 and 16.

In accordance with my invention, die plates 20, 21 and 22 are shaped as shown in Figs. 3 and 4. Thus, their width preferably conforms to the width of the channels 19 in the die blocks, and the lower end of each die plate, being adapted to extend into the cylindrical passage 18 of the corresponding die block is shaped to conform substantially to the contour of the wall of said passage, e. g. by forming the lower end of the plate of arcuate shape. Said lower end of each die plate includes an aperture 25 therein, concentric with the arcuate end portion, and having a shape corresponding to a revolution of a spiral, the apertures 25 of the successive die plates 20, 21 and 22 forming consecutive revolutions or segments of the same spiral as best shown in Fig. 2. The termini of the spiral revolutions or segments of each aperture are preferably at the lower end of each plate, and the plates are split along a radius 26 passing through said termini.

The two curved ends or arms 27 and 28 surrounding the aperture 25 are offset or bent outward from the plane of the plate as shown in Fig. 4 so that the inner edge of the aperture 25 forms substantially a portion of a spiral helix. The two ends 27 and 28 of intermediate plate 21, when mounted in the manner shown in Fig. 1, coincide substantially with the adjacent ends 28 and 27 of plates 20 and 22 on either side thereof respectively so that the ends of the three plates extending into passage 18 form a substantially continuous helix of spiral or conical shape, having its smaller end at the outer end of the die and formed by plate 22, while its wider end is formed by plate 20 adjacent the mounting block 10.

The radius of the widest portion of the helix formed by plate 20 is preferably the same as the radius of the pipe 13 to be deformed thereby. Since the plates are spaced progressively closer together, the pitch of the helix as well as the radius, decreases in approaching the outer end thereof formed by plate 22. If desired, an arcuate spacer 29 can be inserted between the ends 27 and 28 of the final plate 22 to maintain the constant spacing during operation of the die, said spacer 29 being held in place by a clip 30, clamped against the spacer by one of the bolts 17.

In order to use the die of my invention in the manufacture of corrugated flexible metal hose, the die is first assembled as shown in Fig. 1, and mounted for rotation in a rotary chuck which engages boss 11 on the mounting plate 10. Tubing 13, preferably having its leading end reduced so that it can extend through the spiral helical die formed by the plates 20, 21 and 22 is inserted through the guide passage 12 of the mounting block 10, and through the helix forming die plate aperture. The die is rotated and the tube is started forward through the die by tension applied to the reduced end projecting from the outer end of the die. Once formation of helical convolutions begins, the tube 13 continues to feed through the die as the latter is rotated relative

thereto, and the helical edge formed by the die plates progressively forms helical convolutions in the tubing as shown in Fig. 1.

During the corrugating operation, the split ends adjacent the plates flex sufficiently to bring them into alignment with the corresponding offset end of the adjacent plate, if they are not already in such alignment. Moreover, the plates are sufficiently flexible in axial direction to accommodate variations in the rigidity or thickness of the tubing, thereby minimizing the wear of the dies, and substantially eliminating the possibility of collapsing, weakening or mutilating the tubing. Lubricant can be introduced through the passages formed by channels 19 to the tube-deforming die surfaces during the corrugating operation. Slight clearance is preferably allowed between the arcuate circumference of the ends of the die plates 20, 21 and 22 and the walls of the passage 18 in the blocks 14, 15 and 16 so that the ends of the plates can also flex outward radially to a limited extent when excessive strain is produced by variations in the character of the tubing.

An advantage in forming die plates in the manner hereinbefore described moreover resides in the fact that the direction of the helix and hence of the helical convolutions formed thereby can be changed from right to left-hand, by reversing the direction of offset of the ends 27 and 28 of each plate with reference to the plane of the plate.

Variations can be made in the die of my invention without departing from the scope thereof. Thus, the die plates can be supported by the walls of the cylindrical passage 18 against any radial expansion, but it has been found preferable to allow a slight clearance for such expansion. It is likewise possible to provide additional spacer elements between the ends of the dies in addition to spacer 29, such spacer elements, like spacer 29, lying outside the circumference of the corrugated pipe within passage 18. However, provision of additional spacing means is generally unnecessary and may be undesirable if substantial variation occurs in the character of the tubing.

Other variations can be made within the scope of my invention and portions thereof can be used without others.

I claim:

1. In a die for forming helical convolutions in straight-walled ductile tubing, a series of die plates mounted in spaced parallel relation, having coaxial apertures therein corresponding to consecutive segments of a spiral, said series of plates being spaced progressively closer together from the larger to the smaller apertured plate, and the portions of said plates forming the opposite sides of the apertures being offset in opposite directions from the planes of the plates to cooperate with an offset portion of an adjacent plate and form a substantially continuous spiral helix through series of plates of progressively reduced pitch and radius.

2. In a die for forming helical convolutions in straight-walled ductile tubing, a series of flexible die plates having apertures therein, the portions of said plates forming opposite sides of the apertures being shaped to form a spiral helix, said plates being mounted in parallel spaced relation and supported at one side only of said helix to permit flexing of said spiral forming portions.

3. A die as defined in claim 2, including means for preventing forward flexure of at least one of said die plates at the smaller end of said helix.

4. In a die for forming helical convolutions in

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straight-walled ductile tubing, a series of die plates mounted in spaced parallel relation, said plates having coaxial apertures formed to provide successive revolutions of a single spiral, each plate being split from said aperture to its outer periphery at the termini of the spiral forming the outline of its aperture, the portions of each plate adjacent the split portion being offset in opposite directions from the plane of the plate to cooperate with an offset end of an adjacent plate, thereby forming an internal progressively reduced helical die surface.

5. A die for forming helical convolutions in straight-walled ductile tubing, comprising a plurality of flat blocks demountably secured together in face-to-face relation, having a central passage extending therethrough, a channel in the face of each of said blocks extending from said passage to the periphery thereof, a plurality of relatively thin die plates respectively extending from within each of said channels into said central passage and secured in spaced parallel relation at only one end thereof within said channels, the end portions of said plates extending into said passage having apertures therein corresponding to successive revolutions of a spiral, each plate being split from its inner edge to its outer periphery opposite said channel and at the termini of the spiral outlining said aperture, the sides of said plate within said passage and on opposite sides of the split therein being offset from the plane of the plate to coincide with an opposite end of an adjacent plate so as to form an internal spiral helix.

6. A die as defined in claim 5, including spacing means positioned in each channel for clamping the end of each plate in predetermined parallel spaced relation with the other plates.

7. A die as defined in claim 5 comprising means associated with said blocks, for mounting the die for rotation about the axis of said spiral helix and for centering straight-walled tubing passing into the aperture of said helical die plates to be corrugated thereby.

8. A die as defined in claim 5 wherein said plates are flexible and the offset portions of said plates within said passage are free to flex in axial direction therein.

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9. A die as defined in claim 5 wherein said plates are flexible and have slight clearance from the walls of said passage so as to be free to flex in radial, as well as axial direction, in the passage.

10. A die as defined in claim 5 wherein said blocks are of graduated thickness to position the plates mounted in the channels thereof in progressively closed relation toward the smaller end of the spiral helix.

11. A die as defined in claim 5 including a mounting block to which said die blocks are attached, said mounting block having a central aperture for guiding and centering tubing when fed toward the helix of said die plates, said mounting block having a chuck-engaging portion for mounting the die for rotation relative to said tube.

12. In a die for forming helical convolutions in straight-walled ductile tubing, a series of substantially flat die plates mounted in spaced parallel relation and having coaxial apertures formed by a pair of recessed arms on each plate, the arms on each plate being offset in opposite directions from the plane of the plate sufficiently for the offset arms of successive plates to provide a substantially continuous groove-forming helix through the die.

13. A die as defined in claim 12 wherein said plates are mounted in fixed parallel relation at one side only of said apertures opposite the offset ends thereof to provide a flexible mounting for the groove forming helix.

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Certificate of Correction

February 7, 1950

Patent No. 2,496,790

STEPHEN GUARNASCHELLI

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 3, line 18, for the words "on opposite" read *in opposite*; column 8, line 9, for "closed" read *closer*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of May, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.