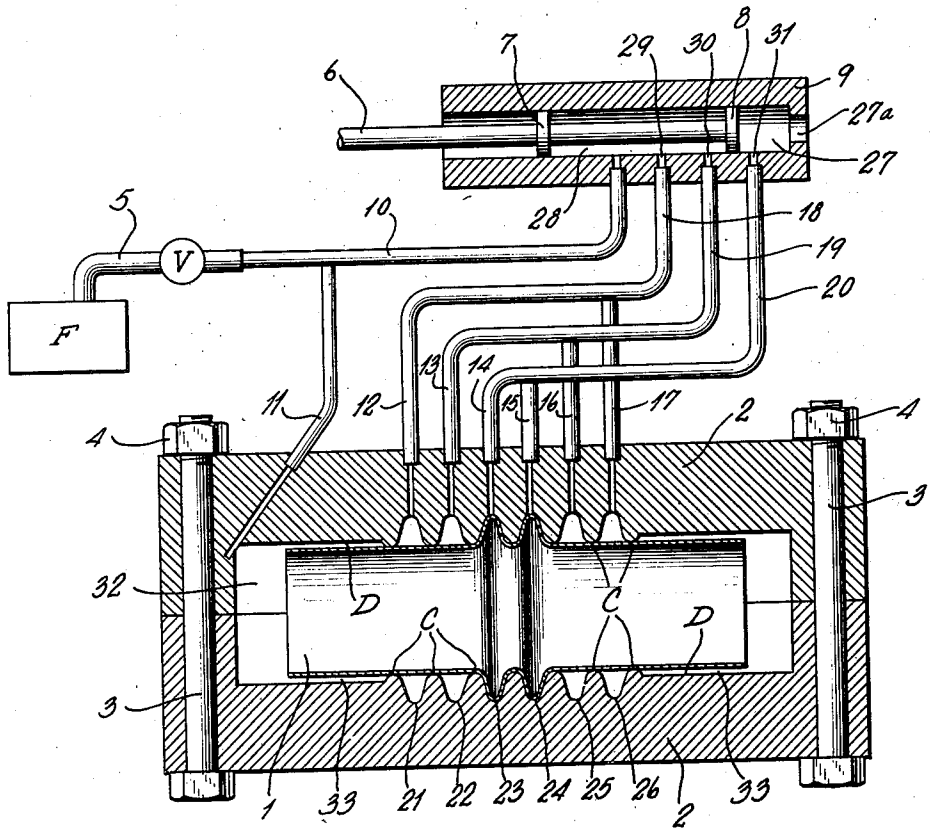
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APPARATUS FOR PRODUCING CORRUGATED TUBING

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APPARATUS FOR PRODUCING CORRUGATED TUBING

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12 Claims. (Cl. 153—73)

This invention relates to improvements in equipment for forming shaped tubing such as metallic bellows or the like by fluid pressure, and has for an object the provision of a simple, rigid-forming die for such purpose, which cannot bend or distort.

Another object of the invention is the provision of forming equipment whereby the inside and outside diameter and shape of corrugation of the formed bellows are held uniform.

Another object of the invention is the provision of forming equipment in which there is no axial drag on the unformed portion of the tube as each pair of corrugations is formed; so that the tube shortens freely and no axial stretching takes place.

Another object of the invention is the provision of forming equipment which is relatively inexpensive so that special shapes and sizes can be economically produced even in comparatively small quantities.

Another object of the invention is the provision of a simple valve which successively shuts off the pressure to each corrugation of the die and then reduces that pressure to atmospheric at a rate which is controlled by the shape of the port in the valve and the speed of the valve piston, thus controlling the speed of forming of each individual corrugation to the ideal rate at each stage.

One of the major features of this invention is that elaborate mechanisms to prevent undue stretching of the tubing wall during formation of the corrugations are eliminated. This is accomplished by providing fluid pressure on both sides of the tubing wall except in the particular corrugation recess into which the metal is actually forming, and by decreasing and/or removing the fluid pressure from the corrugation recesses of the die chamber consecutively so that there is no resistance to movement of the unformed wall of the tubing.

Other objects and advantages of the invention will be apparent to those skilled in the art from the following description and the drawing accompanying this application.

Referring to the drawing:

The sole figure of the drawing is a sectional elevation of the forming die with a bellows shown partly formed, and a sectional elevation of the fluid control valve together with connecting pipes.

Referring now to the drawing, a tube blank 1 is placed within the two halves of the split die 2 and the bolts 3 are pushed through close-fitting holes to dowel the two halves of the die accurately in relative position, and the nuts 4 screwed down tight to clamp the two halves of the die together in a leakproof manner.

The die 2 is provided with annular grooves 21, 22, 23, 24, 25 and 26, corresponding to the number of corrugations wanted in the bellows, or more. These annular grooves are connected through drilled holes with pipes 12, 13, 14, 15, 16 and 17 respectively. Pipes 14 and 15 are joined and connected with pipe 20. Pipes 13 and 16 are joined and connected with pipe 19. Pipes 17 and 12 are joined and connected with pipe 18. Pipes 18, 19 and 20 connect with ports 29, 30, 31 respectively. Pipe 11 connects generally with the interior of the die and tube through a drilled hole. Pipe 5 is from a source of fluid F under suitable pressure with means such as valve V to shut off. Pipe 10 connects pipe 11 and pipe 5 with annular space 28 between valve pistons 7 and 8 in valve body 9. Space 27 beyond piston 8 is open to atmosphere through opening 27a. Piston rod 6 is arranged to be moved at suitable speed from stop position at extreme right, far enough to the left to open ports 31, 30, 29 successively to atmosphere. These ports may be specially shaped to provide a predetermined rate of increase or decrease of fluid pressure relative to piston movement.

After the tube is placed in the die and the die bolted or otherwise held together, the source of fluid pressure is turned on and through pipe 5 and pipes 10 and 11 fills space 28, the interior or chamber 32 of the die 2 and tube 1 and the space 33 between die and tube beyond the annular grooves. From space 28 (with piston rod 6 all the way to the right) fluid pressure enters tubes 18, 19, 20 through ports 29, 30, 31 and fills annular grooves 21, 22, 23, 24, 25 and 26 through pipes 12, 13, 14, 15, 16, 17 and drilled holes in die. The pressure is now in contact with all surface area of the tube 1, inside and outside.

Piston rod 6 is now moved to the left until piston 8 passes to the left of port 31. This shuts off the pressure from port 31 and then opens it to atmosphere. Pressure therefore drops to atmospheric in annular grooves 23 and 24 at a rate determined by the shape of port 31 and speed of piston rod 6. The tube 1 shortens and the metal of the wall flows into the annular grooves 23 and 24; from the left into groove 23; and from the right into groove 24 under the unopposed internal pressure.

There is no resistance to the longitudinal movement of the tube because the pressure is still equal inside and outside at all points except where the tube is actually forming into the annular groove.

Piston rod 6 is now moved further to the left

and uncovers port 30 to atmosphere. This repeats the previous action but in annular grooves 22 and 25. Finally, piston rod 6 is moved further to the left and uncovers port 29 to atmosphere. This forms up the last two corrugations in annular grooves 21 and 26. Of course, this process may be extended to any number of corrugations.

It is to be noted that the inner crests C of the die wall adjacent the corrugations 21, 22, 23, 24, 25, 26 project inwardly of the uncorrugated surface portion D of the die wall to an extent sufficient to support and space the blank portions of the tube from the uncorrugated wall portion D. The spaces 33 resulting permit access of the fluid pressure in the interior 32 of the die both to the inside and outside walls of the tube blank. Thus, there is no tendency for pressure deformation of the tube except in the desired successive zones, namely, the recesses 21, 22, 23, 24, 25, 26 as these are successively opened to atmosphere by manipulation of the valve piston rod 6.

It will be understood that the blank tubes are thoroughly annealed and are, therefore, dead soft. The tolerance of the tube diameters is such that the actual clearance between the crests (or interior diameters) of the webs, defining the annular grooves, is very small. Since the pressure is maintained inside the tube blank and also outside of it, in the areas defined by the grooves, this pressure is balanced. Now, when the piston rod 6 is moving to the left, as above described, until the piston 8 passes to the left of port 31, the pressure in the grooves 23 and 24 drops to atmospheric pressure and the internal pressure causes the wall of the tube blank to be deformed into the annular grooves 23 and 24 and, during the initial phase of this deformation, if there is any clearance between the outer wall of the blank and the crests of the grooves, the tube blank being deformable, is forced into contact with the crests and, thereby, prevents any leakage of fluid from the grooves 22 and 25 into grooves 23 and 24.

As the walls of the blank are deformed into the grooves 23 and 24, the blank shortens lengthwise, as described above, and as the piston rod 6 is moved to the left in steps to successively uncover the ports 30 and then 29, corrugations are formed in the grooves 22, 25, and then in the grooves 21, 26, following which the hydraulic pressure may be reduced, the die opened and the finished metallic bellows removed therefrom.

Where tubing of small diameter is to be shaped, it may be advisable to provide means associated with the die 2 to apply some force to the end or ends of the tube blank so that the internal pressure forming the tubing into the annular recesses is assisted in shaping of the tube to conform to the shape of the recesses by the forcing of the end or ends of the tube toward the shaping regions. Any suitable arrangement for such purposes can be employed.

The embodiment of the invention as described and shown in the drawing is primarily to convey as simply as possible the true spirit of the invention. It is to be understood that different combinations and arrangements of the essential elements may be made without departing from this spirit. Also, the process is applicable to the shaping of other than corrugated tubes as can be readily seen by those skilled in the art. There is no intention of limitation to the exact details shown and described.

What is claimed is:

1. Apparatus for preparing shaped tubing from blank tubing comprising, a sealable chamber for the reception of said blank tubing, said chamber having portions of its wall shaped to predetermined forms and adapted to so support said tubing blank that fluid pressure supplied to said chamber will be applied both the interior and at least a portion of the exterior of the tubing walls, means to supply fluid pressure to said chamber, means to supply fluid pressure individually to each of the shaped chamber portions externally of the blank suported in said chamber, and means to progressively eliminate the fluid pressure from said shaped portions, whereby the fluid pressure on the interior of the blank will cause the blank tubing to conform to said shaped portions in the same order as the fluid pressure has been eliminated therefrom while the tubing blank shortens freely.

2. In apparatus for preparing corrugated tubing from blank tubing, means including a sealable chamber for reception of said blank tubing, said chamber having portions of its wall shaped to corrugated form and adapted to so support the tubing blank that fluid pressure supplied to said chamber will be applied both internally and externally of the tubing walls, means to supply fluid pressure to said chamber, means to supply fluid pressure individually in each of said corrugated portions externally of the tubing bank supported in said chamber, and means to decrease fluid pressure in individual of said corrugated portions in predetermined order whereby unbalanced fluid pressures will conform the tubing blank to the corrugated portions from which fluid pressure has been eliminated while the tubing blank shortens freely.

3. In apparatus for preparing corrugated tubing from blank tubing, a sealable chamber for reception of said blank tubing, said chamber having a series of annular cavities formed therein and adapted to support the tubing blank, means to supply fluid pressure to said chamber and thereby subject the interior wall and at least a portion of the exterior wall of said blank to said pressure means to individually supply fluid pressure to each of said annular cavities, thereby subjecting the portions of the tubing blank embraced by said annular cavities to said pressure, and means to progressively eliminate the fluid pressure in said cavities and thereby permit the fluid pressure in the interior of said blank to cause the wall of said blank to conform to said annular cavities, said tubing blank being freely adapted to shorten as the work progresses.

4. In apparatus for preparing shaped tubing from blank tubing, a suitable chamber for the reception of said blank tubing, said chamber having portions of its wall formed with pre-shaped cavities therein, means for subjecting the interior wall of said blank to fluid pressure, means for individually subjecting at least those portions of the exterior wall of said blank spanned by said cavities to fluid pressure, thereby subjecting the interior and exterior walls of said blank to a substantially balanced pressure condition, and means to successively relieve the fluid pressure in said cavities, whereby the internal fluid pressure may successively cause said blank to conform to each cavity as the fluid pressure is relieved, said blank being freely adapted to shorten as the work progresses.

5. The invention according to claim 4, in which a common source of fluid pressure supply for

both said fluid pressure supply means is provided.

6. The invention according to claim 4, in which said means to individually relieve fluid pressure in said cavities comprises a valve adapted to cut off fluid pressure supply at a controlled rate and to release pressure fluid to atmosphere in those portions from which pressure fluid supply has been cut off.

7. The invention according to claim 1, in which said means to eliminate fluid pressure from individual of said shaped portions comprises a valve adapted to successively cut off fluid pressure supply to said shaped portions and to release to the atmosphere the fluid pressure in the portions from which pressure fluid supply has been cut off.

8. Apparatus for preparing shaped tubing from blank tubing comprising a die having a sealable recess into which said blank tubing may be inserted, said recess having shaped portions in its wall for defining the final shape of said blank tubing, means for impressing fluid pressure on the interior of said recess and for separately subjecting the said shaped portions to said fluid pressure, and means for progressively eliminating fluid pressure from the shaped portions, whereby the unbalanced pressure in said recess opposite the shaped portions from which pressure has been eliminated will force the corresponding tubing portions to conform in shape with that of said shaped portions from which pressure has been eliminated.

9. In apparatus for preparing corrugated tubing from blank tubing, a sealable chamber for the reception of said blank tubing, said chamber having portions of its wall shaped to corrugated form, means for supplying fluid pressure separately to said corrugated portions and to the balance of said chamber, and means to progressively eliminate fluid pressure supply from the corrugated portions in predetermined order, thereby permitting the fluid pressure in the interior of said chamber to conform the portion of said tubing embraced by the corrugated portion from which the fluid pressure is eliminated to conform to the shape of said last corrugated portion.

10. Apparatus for producing bellows comprising a die with a recess adapted to be opened to receive the blank tube, and having a plurality of annular corrugations, means of closing said die over said tube to contain fluid pressure, means of supplying fluid pressure to the interior of said die and to each of said annular corrugations, means of decreasing said fluid pressure in said annular corrugations successively whereby the tube is formed into each corrugation successively and the remaining blank tube freely shortens.

11. In apparatus for preparing corrugated tubing from blank tubing, a die having a series of recesses formed therein for defining the shape of the corrugations, means for supplying a balanced fluid pressure to both the inner and the outer surfaces of said blank tubing, the pressure upon the external wall being impressed via said recesses, and means for successively reducing the fluid pressure in said recesses in steps, whereby during each step the pressure of said fluid inside the blank forces the material of said blank into conformation with the recess in which said pressure is reduced, the blank shortening the while as the operation progresses.

12. In apparatus for producing tubular bellows, a die having a plurality of annular corrugations formed therein, said die being adapted to be opened to receive a blank tube, means for sealing said die after the same is closed over said tube, means for supplying fluid pressure both to the interior of said die and to each of said annular corrugations thereby subjecting both the inner and outer walls of said tube to the balanced pressure of said fluid, means for successively decreasing the fluid pressure in said annular corrugations in steps thereby unbalancing said pressure in zones defined by the corrugations, thereby causing the material of said tube in said zones to successively conform to the shape of said corrugations, said tube shortening as the conforming progresses.

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