Mandrel Apparatus for Tube Bending

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This invention relates to apparatus for feeding a mandrel into a machine for bending tubing.

One technique for bending tubing consists of clamping a linear portion of the tubing in a stationary position and either wiping the tubing about a form or clamping the tubing against the form and rotating the clamp and form about the axis of the form. Due to the tendency of the metal on the inside face of the bend to wrinkle or buckle and since such wrinkling depends on the ratio between pipe radius and wall thickness, the conventional method is limited as to the size and type of tubing which may be successfully bent. One method of preventing such wrinkling is to insert some type of support such as a mandrel within the interior of the tube. This mandrel may either take the form of a snake which assumes the shape of the pipe as it is bent, or a shoe which is disposed at the beginning of the bend and supports the wall of the pipe through the first few degrees of the bend, the portion in which collapse of the tube normally occurs. In accordance with prior practice, these snakes or shoes were placed on the end of long rods for insertion into the tubing. The rod was necessarily as long as the longest piece of tubing to be handled by the bending machine.

This invention contemplates a mandrel disposed on the end of a length of flexible cable having a radius smaller than that of the smallest pipe which can be accommodated in the machine. The cable is stored in a tube disposed parallel and adjacent to the supporting structure of the bending machine. The cable is passed into the storage tube through a 180 degree bend so that the storage tube may be placed under the machine proper. An alternative method contemplates winding the cable about a winch.

In either event, the forward end of the cable which carries the mandrel is normally disposed at a point on the axis of the tube beyond the extension of the longest workpiece which can be accommodated in the machine. The cable is moved by a pair of powered rubber wheels, which engage the cable on opposite sides. Alternately, if a winch is used as a storage means, the cable could be powered by rotating the winch. A series of movable blocks support the cable at spaced points along the cable as it moves in and out of the tubing.

It is therefore an object of the present invention to provide means, in a tube bending machine, for feeding a mandrel into the interior of the tubing, positioning the mandrel at the point where bending begins, and for retracting the mandrel after the bending operation.

It is another object of this invention to provide a flexible rod or extension for the mandrel, and suitable means for storing the rod while the tubing is being placed in the bending machine.

A further object of the present invention is to provide support means for the mandrel and flexible rod between the end of the tubing and the storage area.

Other objects and advantages of the present invention will be made apparent by the following detailed description wherein is disclosed a preferred embodiment of the present invention. The description makes reference to the accompanying drawings in which:

FIGURE 1 is a perspective view of a stretch bending machine incorporating the present invention.
If a shoe type mandrel 20 (FIGURE 5) is employed, the shoe 20 would be disposed with its end projecting just beyond the point at which bending begins.

A chuck 34, slidably disposed on a slide rod 56, is positioned along the slide rods 36 by a hydraulic motor 38. The chuck 34 has jaws 40 which may be opened or closed by a hydraulic cylinder 42 or revolved by a hydraulic motor 44 by means of gears (not shown) in a manner well known to the art. A stationary clamp 46, operated by a hydraulic cylinder 48 locks the pipe in place during the bending operation.

The bending apparatus consists of a column of annular bending forms 50 of varying diameter mounted on a screw 52, and an arm 54 fixed so as to rotatably move about the screw 52. As shown in FIGURE 2, each of the forms 50 permit a different radius of bend. A hydraulic motor 56 engages a gear (not shown) which is mounted on the screw 52 so that rotation of the motor 56 revolves the screw 52 and enables the desired bending form 50 to be moved vertically into position adjacent the pipe 16. A bending clamp 58, operated by a hydraulic cylinder 60, locks the workpiece firmly between the clamp 58 and the form 50. A hydraulic motor 62 rotates a pinion 64 which engages a gear 66 permanently affixed to both the forms 50 and the arm 54 in such a manner as to rotate the forms 50 and the arm 54 at the same time. The pinion 64 is located in a housing 68 which is permanently affixed to a slide block 70, slidably mounted in longitudinal ways 72. The entire assembly of forms 50, arm 54, slide block 70 and longitudinal ways 72, is slidably mounted in lateral ways 74 and may be moved in the lateral ways 74 by a hydraulic motor 76. The movement of the slide block along the longitudinal ways 72 is limited by a passive hydraulic cylinder 78 which is preset to prevent movement of the slide block 70 until the stress in the pipe 16 reaches a value in excess of the yield strength, but less than the ultimate strength, of the pipe material.

In operation, the arm 54 is swung to its open position perpendicular to the axis of the pipe 16, with the bending clamp 58 in an open position. The bending forms 50 are raised or lowered until the form having the desired radius of bend is at the same elevation as the pipe 16. The stationary assembly of forms 50, arm 54, slide block 70 and longitudinal ways 72 is moved laterally until the bending form 50 is immediately adjacent to the pipe 16. The cable 22 and snake 15 are retracted (to the left in FIGURE 1) and the stationary clamp 46 opened so as to allow the pipe 16 to be placed in the chuck 34. The hydraulic cylinder 42 and motor 48, 44 are activated, positioning the desired point on the pipe 16 between the bending clamp 58 and the forms 50. The stationary clamp 46 is closed and the cable 22 moved forward (to the right in FIGURE 1) until the snake 18 or shoe 20 is disposed at the point of bending. The bending clamp 58 is closed, locking the pipe 16 between the clamp 58 and the form 50. The hydraulic motor 62 is activated, rotating the arm 54 and forms 50, pulling the pipe 16 around the form 50.

Due to the resistance in the pipe length between the stationary clamp 46 and the forms 50, there is a tendency for the arm 54 and forms 50 to move or "walk" towards the stationary clamp 46 as the pipe 16 is pulled around the forms 50. The hydraulic cylinder 78 resists such movement with the result that the pipe 16 is stretched between the bending clamp 58 and the stationary clamp 46. The stress on the pipe 16, and hence the force on the slide block 70, reaches a predetermined value in excess of the yield stress but less than the ultimate strength of the pipe material, the resistance of the cylinder 78 is overcome and the arm 54, forms 50, and slide block 70 move towards the stationary clamp 46. The pipe 16 is thus uniformly bent and stretched past its yield limit but below its ultimate limit.

After the arm 54 and forms 50 have rotated through the desired arc distance, the bending clamp 58 is opened and the chuck assembly 34, 40 actuated to rotate the pipe 16 and move it forward (to the right in FIGURE 1) along its axis to its new desired position adjacent the forms 50. The bending operation is then repeated.

If the shoe mandrel 20 (FIGURE 5) is utilized, means must be provided to retract the mandrel 20 at the same rate that the forms 50 and the arm 54 walk back towards the clamp 46. This may be accomplished by connecting the hydraulic motor 28 to the fluid relief valve in the hydraulic cylinder 78 in such manner that the wheels 26 will retract the cable 22 and mandrel 20 when fluid is forced out of the hydraulic cylinder 78. If the snake mandrel 18 (FIGURE 6) is employed, such retracting means are not necessary since the snake 18 may be bent with the pipe 16 around the form 50.

Although the above embodiment illustrates the present invention incorporated in an automatic stretch bending machine, the invention may also be successfully employed in machines of the non-automatic variety and in machines which employ different bending techniques. This invention may be embodied in other forms or carried out in other ways without departing from the spirit or essential characteristics thereof. The present embodiment of the invention is therefore to be considered as in all respects illustrative and the right of the invention being indicated by the appended claims, and all changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.

Having thus described my invention, I claim:

1. In a machine for bending tubing having means for maintaining a portion of said tubing in a stationary position during bending, the improvement for feeding a mandrel into the interior of said tubing to support the interior walls of said tubing at the point of bending, comprising: a flexible elongated member disposed and movable along the axis of said portion of said tubing, said member having an outer diameter smaller than the inside diameter of said tubing; a mandrel fixed at one end of said member; power means for retracting said member to a position exterior of said tubing, and for extending said member to a point along the interior of said tubing where bending is to begin; and means receiving the other end of said member for storing said member alongside of the axis of said portion of said tubing.

2. In a machine for bending tubing having means for maintaining a portion of said tubing in a stationary position during bending, the improvement for feeding a mandrel into the interior of said tubing to support the interior walls of said tubing at the point of bending, comprising: a flexible elongated member disposed and movable along the axis of said portion of said tubing, said member having an outer diameter smaller than the inside diameter of said tubing; a mandrel fixed at one end of said member; power means for retracting said member to a first point exterior of said tubing, and for extending said member to a second point in the interior of said tubing where bending is to begin; track means for guiding said member between said first and said second positions; and a storage tube disposed parallel to and displaced from the axis of said portion of said tubing, said storage tube being adapted to maintain that portion of said member which extends beyond said track means on the opposite side of said track means from said tubing, in return relation with respect to the remaining portion of said member.

3. In a machine for bending tubing having means for maintaining a portion of said tubing in a stationary position during bending, the improvement for feeding a mandrel into the interior of said tubing to support the interior walls of said tubing at the point of bending, comprising: a flexible elongated member disposed and movable along the axis of said portion of said tubing, said member having an outer diameter smaller than the inside
diameter of said tubing; a mandrel fixed at one end of said member; power means for retracting said member to a point along the interior of said tubing where bending is to begin; and storing means for storing at least a major portion of said member when said member is not in use and for causing at least a portion of said member to bend into a storage position wherein at least a major portion of said member is offset with respect to said axis.

6. In a machine for bending tubing wherein said tubing is initially placed in position along a first axis and subsequently bent into a desired configuration, the improvement for feeding a mandrel into the interior of said tubing to support the interior walls of said tubing at the point of bending, comprising: a flexible elongated member disposed movably along said first axis, said member having an outer diameter smaller than the interior diameter of said tubing; a mandrel fixed at one end of said member; power means for retracting said member along said first axis to a position exterior of said tubing, and for extending said member along said axis to a point along the interior of said tubing where bending is to begin; and a storage receptacle displaced from said axis, said receptacle being adapted to maintain a portion of said member at the end thereof opposite to said mandrel in bent position with respect to the remaining portion of said member.

7. In a machine for bending tubing wherein said tubing is initially placed in position along a first axis and subsequently bent into a desired configuration, the improvement for feeding a mandrel into the interior of said tubing to support the interior walls of said tubing at the point of bending, comprising: a flexible elongated member disposed movably along said first axis, said member having an outer diameter smaller than the interior diameter of said tubing; a mandrel fixed at one end of said member; power means for retracting said member along said first axis to a position exterior of said tubing, and for extending said member along said axis to a point along the interior of said tubing where bending is to begin; and a storage receptacle displaced parallel to and from said axis, said receptacle being adapted to maintain a portion of said member at the end thereof opposite to said mandrel in return relation with respect to the remaining portion of said member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,119,875 Carl ------------------ June 7, 1938
2,306,223 Parker et al. ------------ Dec. 22, 1942
2,382,745 Powers ---------------- Aug. 14, 1945
2,777,500 Ekholm et al. -------- Jan. 15, 1957