June 18, 1968 V. IGNOFFO 3,388,574

ATTACHMENT FOR A TUBING BENDER FOR CONTROLLING THE DEPTH OF BEND OF TUBING

Filed March 3 1966 2 Sheets-Sheet 1

FIG. 2.

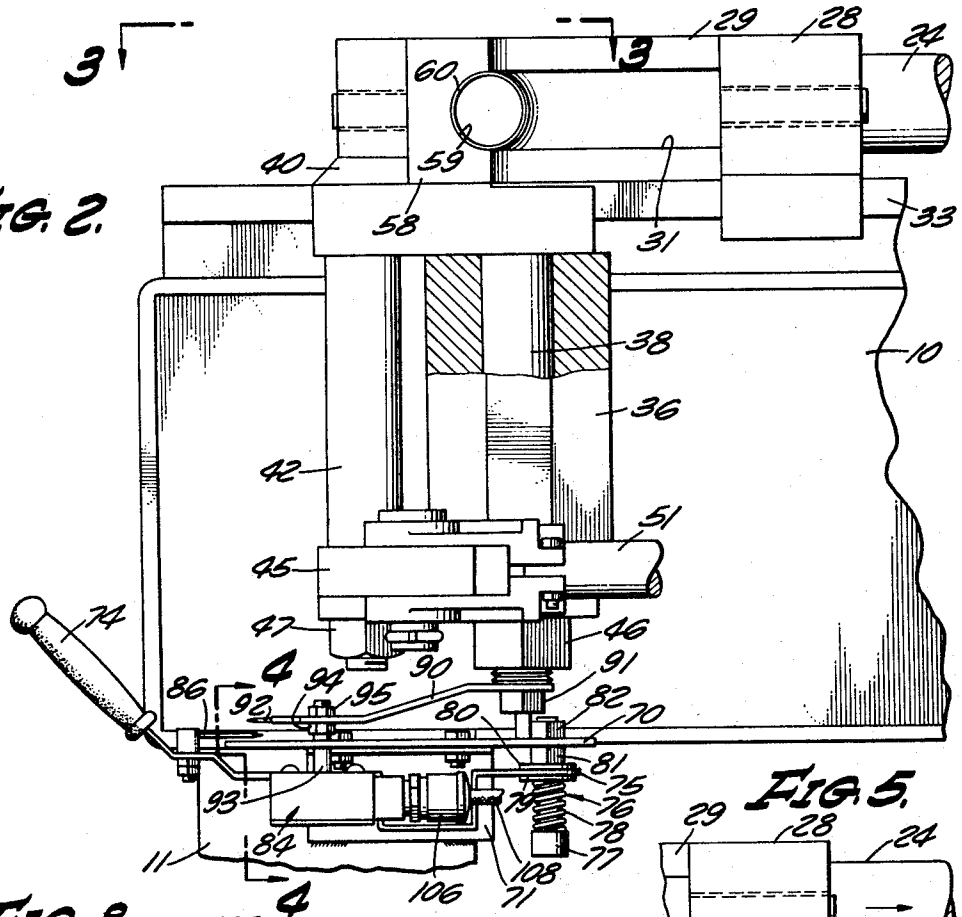


FIG. 5.

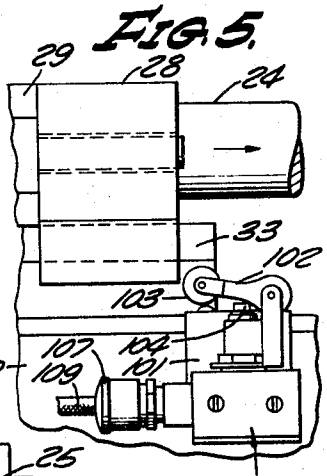


FIG. 8.

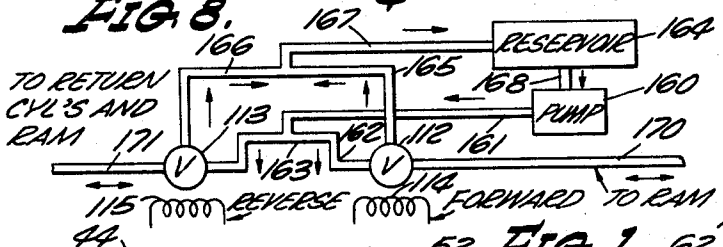
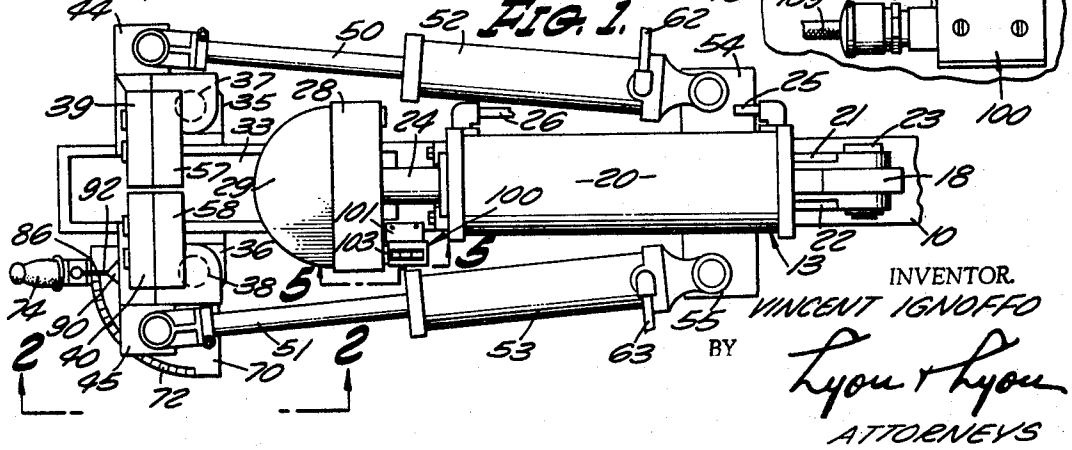


FIG. 1.

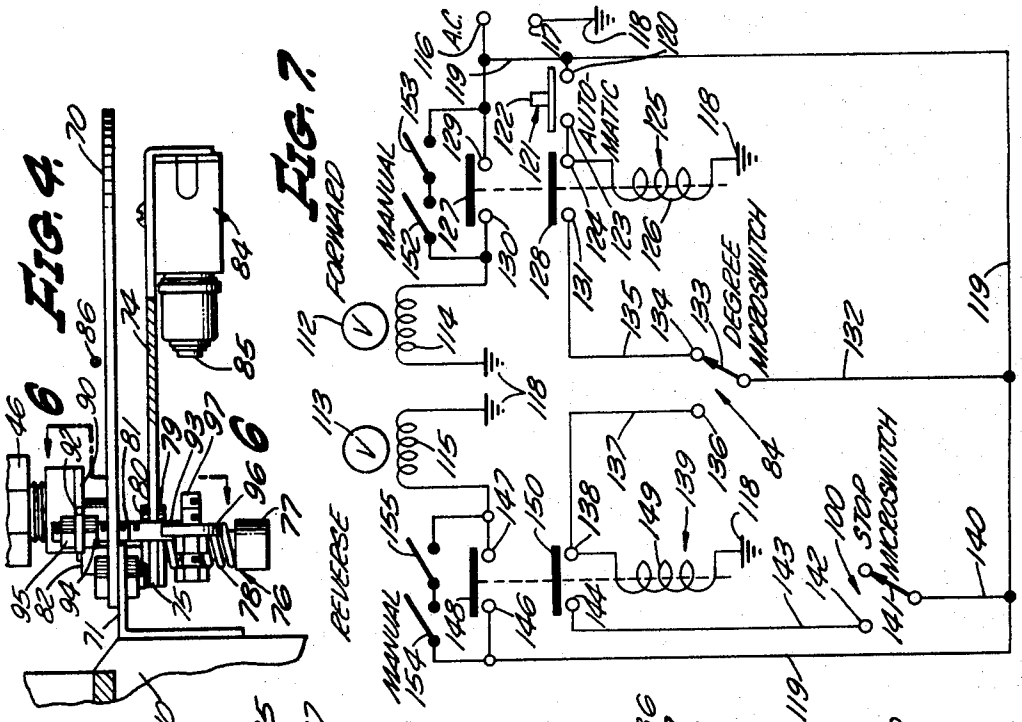


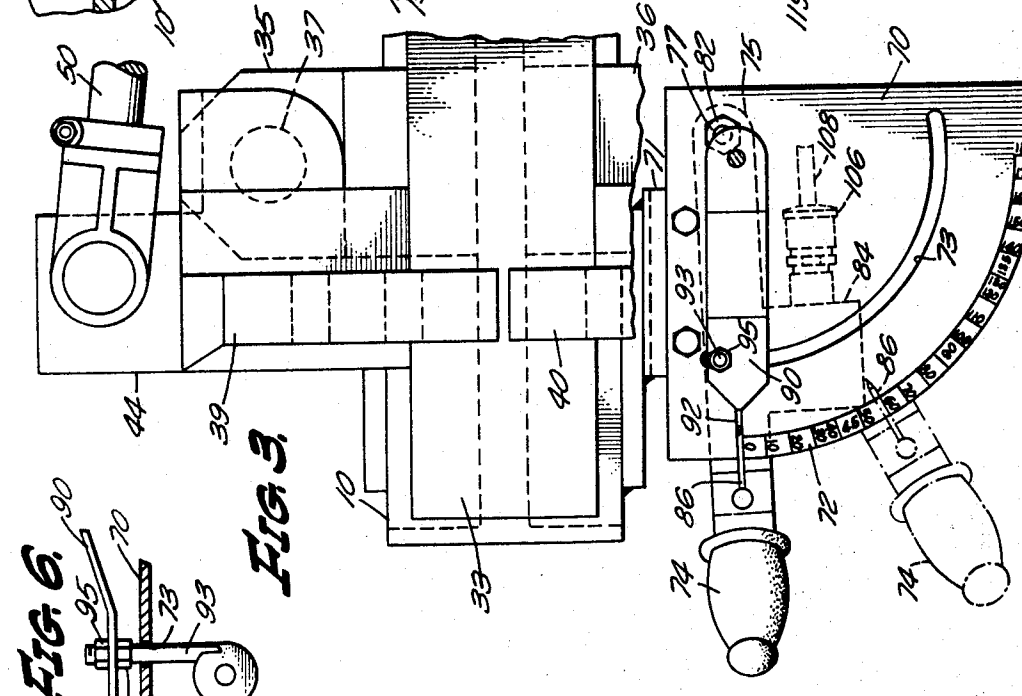
INVENTOR.
VINCENT IGNOFFO
BY
Lyon & Lyon
ATTORNEYS

June 18, 1968 V. IGNOFFO 3,388,574

ATTACHMENT FOR A TUBING BENDER FOR CONTROLLING THE DEPTH OF BEND OF TUBING

Filed March 3, 1966 2 Sheets-Sheet 2





INVENTOR.
VINCENT IGNOFFO
BY Lyon & Lyon
ATTORNEYS

United States Patent Office 3,388,574 Patented June 18, 1968

3,388,574
ATTACHMENT FOR A TUBING BENDER FOR CONTROLLING THE DEPTH OF BEND OF TUBING

Vincent Ignoffo, 6336 W. Belmont Ave., Chicago, Ill. 60634

Filed Mar. 3, 1966, Ser. No. 531,524
9 Claims. (Cl. 72—22)

This invention relates to a device or attachment for use with a tubing bender for controlling the depth or degree of bend of tubing.

In the tube bending art, various apparatus and machines have been devised for bending tubing. One principle use for such machines is for bending tubing such as automobile exhaust and tailpipes. In applications of this nature, frequently a number of various bends are required thereby necessitating careful operation and control of the machine to provide accurate bends. In many cases, this requires considerable skill, and is unduly time consuming. Some machines have been devised for controlling the bend imparted to a material but these machines have been relatively complex in structure and in operation.

Accordingly, it is an object of the present invention to provide means for use with tubing benders for automatically controlling the degree or depth of bend of tubing.

It is another object of this invention to provide control means coupled with a tubing bender which may be preset to a desired depth of bend, and which automatically causes the bending operation to cease when the preset depth of bend of tubing is accomplished.

It is a further object of this invention to provide a simple and reliable control means for use with a tubing bender to control the depth of bend of tubing, and to return the machine to a deactivated or normal state automatically after the desired degree of bend has been accomplished.

These and other objects of this invention will become more apparent upon a consideration of the following description taken in conjunction with the drawings in which:

FIGURE 1 is a partial plan view of a tubing bender incorporating the concepts of the present invention;

FIGURE 2 is a partial side elevational view as seen along a line 2—2 of FIGURE 1;

FIGURE 3 is an enlarged partial plan view as seen along a line 3—3 of FIGURE 2;

FIGURE 4 is a partial front end view taken along a line 4—4 of FIGURE 2;

FIGURE 5 is a fragmentary side elevational view as seen along a line 5—5 of FIGURE 1;

FIGURE 6 is a fragmentary elevational view taken along a line 6—6 of FIGURE 4;

FIGURE 7 is a circuit diagram of a control circuit according to the invention; and

FIGURE 8 is a hydraulic schematic diagram.

Referring now to the drawings, and particularly to FIGURES 1 through 3, a tube bending machine or apparatus includes an I beam 10 which is supported at its ends by a pair of legs affixed thereto, only forward leg 11 (FIGURE 2) being partially shown for simplicity of illustration. A hydraulic ram 13 (FIGURE 1) and a pair of pivotally mounted shoes are mounted on the upper leg of the I beam as hereinafter will be described in greater detail.

A bracket 18 is secured near one end of the I beam 10. The hydraulic ram 13 includes a cylinder 20 having a pair of brackets 21 and 22 extending from an end thereof which are coupled by a pin 23 to the bracket 18. A piston rod 24 extends from the opposite end of the cylinder 20. Suitable couplings and hydraulic lines

25 and 26 are coupled to the ends of the cylinder 20 so that fluid under pressure may be applied to either side of a piston (not shown) on the piston rod 24 within the cylinder 20.

The piston rod 24 carries a die bracket 28 at its forward extremity. A curved bending die 29 has dowels extending from the back face thereof which are coupled with apertures in the die bracket 28. Thus, the die bracket 28 supports the die 29, with the die being readily removable from the bracket. The front face of the die 29 has a radius of curvature which determines the radius of bend to be applied to tubing. This curved face of the die 29 is grooved, as at 31 as shown in FIGURE 2, the radius of curvature of groove being the same as the diameter of the tubing to be bent.

Mounted on the upper leg of the I beam 10 is a T bar 33, the cross of which supports the die bracket 28. The bottom of the bracket 28 extends under the cross of the T bar 33 forming a gib which engages the underside of the cross of the T bar 33 thereby guiding the bracket 28 during extension or retraction of the piston rod 24.

Bearing blocks 35 and 36 are affixed on each side of the I beam 10 for receiving respective shafts 37 and 38 which provide pivotal supports for a pair of shoe brackets 39 and 40 which are secured to the respective shafts 37 and 38. A spacer bar, such as a bar 42 illustrated in FIGURE 2, is affixed to and extends downwardly from each of the shoe brackets 39 and 40. A rocker arm 44 is affixed to the lower ends of the shaft 37 and the spacer bar for the bracket 39, and a rocker arm 45 (note FIGURE 2) is affixed to the lower ends of the shaft 38 and spacer 42. Preferably, the rocker arms 44 and 45 are secured by means of nuts, such as nuts 46 and 47 shown in FIGURE 2 on the lower threaded ends of the shaft and spacer, respectively. Piston rods 50 and 51 are pivotally coupled with respective rocker arms 44 and 45. Each of the piston rods 50 and 51 carries a piston (not shown) thereon within respective compression cylinders 52 and 53 (FIGURE 1). The opposite ends of the cylinders 52 and 53 are pivotally coupled with respective brackets 54 and 55 affixed to the sides of the I beam 10.

The shoe brackets 39 and 40 support respective shoes 57 and 58. Each shoe has a pair of dowels extending from the back face thereof which engage apertures within a shoe bracket. The front face of each shoe includes a groove, such as a groove 59 shown in FIGURE 2, having a radius of curvature the same as the diameter of the pipe to be bent.

Tubing 60 is positioned between the die 29 and the shoes 57 and 58 as shown in FIGURE 2, and upon extension of the piston rod 24 the tubing 60 is bent. The ram 13 and the compression cylinders 52 and 53 are operated by a hydraulic system which will be explained in greater detail subsequently. Briefly, fluid pressure applied to the tube 25 coupled to the back end of the ram cylinder 20 causes the piston rod 24 to extend to the left as shown in FIGURES 1 and 2. As the piston rod 24 moves, the tubing 60 is bent and the shoes 57 and 58 and shoe brackets 39 and 40 pivot. As the shoes and brackets pivot, the piston within each of the compression cylinders 52 and 53 resists the pivoting action because of hydraulic fluid within the cylinders. Typically, the resistance is fixed by adjusting a suitable needle valve or valves, with fluid then being expelled from the cylinders at a predetermined rate. After the tubing 60 is bent, fluid under pressure is delivered through tubes 62 and 63 to the respective cylinders 52 and 53 thereby causing their respective piston rods 50 and 51 to extend. At the same time, fluid is delivered through the tube 26 to the cylinder 20 at the forward end thereof to cause the piston rod 24 to retract to its initial or normal position as shown in FIGURE 1.

According to an embodiment of the present invention, means are provided, which operate in conjunction with the movement of one of the shoe brackets 39 or 40 and a presettable means, for controlling the degree of depth of bend applied to the tubing 60. Additionally, means are provided which cooperate with the movement of the die bracket 28 to allow automatic return of the die bracket 28 and die 29, and the shoes to a normal or deactivated position. A dial plate 70 is affixed to the I beam 10 by means of a bracket 71, or the like, secured to the beam. the dial plate 70 includes markings 72 thereon for indicating degree of bend. An arcuate aperture 73 is provided in the plate 70 for purposes which will be explained subsequently.

A movable handle arm 74 is pivotally coupled at one end 75 by means of a spring loaded coupling 76 to the plate 70 as shown in FIGURE 2. The spring loaded coupling 76 may essentially comprise a bolt 77, or the like, a spring 78, and washer 79 and 80, with the one of the bolt 77 being secured to the plate 70 by means of nuts 81 and 82. The arm 74 has a microswitch 84 secured thereto, the switch being operated by means of an actuator 85 (FIGURE 4) and a pointer 86 is secured toward the outer end of the arm 74 as shown in FIGURES 2 and 3. The arm 74 may be positioned along the dial plate 70 as shown by phantom lines in FIGURE 2 with the pointer 86 indicating a desired degree of bend.

A control arm 90 is secured to the lower end of the shaft 38 by means of a nut 91. The control arm 90 carries a pointer 92. A rod 93 having an upper threaded end is secured to the control arm 90 by means of nuts 94 and 95. The lower end of the rod 93 carries a plate 96 into which a bolt 97 is adjustably threaded as shown in FIGURE 4. As will appear subsequently, the handle arm 74 is moved to a position indicating the desired degree of bend, and as the tubing 60 is bent the shoe bracket 40 pivots thereby causing the control arm 90 to pivot. As the control arm 90 pivots, the end of the bolt 97 which serves a switch control finger ultimately contacts the actuator 85 of the switch 84 which will cause the bending operation to cease at the desired degree of bend by terminating the application of fluid pressure to the ram 13 as will appear subsequently.

A microswitch 100 is secured to the I beam 10 by means of a bracket 101 as shown in FIGURES 1 and 5. A roller arm 102 carrying a roller 103 is pivotally secured to the switch 100 for contacting the actuator 104 of the switch 100 when the die bracket 28 is returned to the normal position as shown in FIGURE 1. In this position, the switch 100 is open. As the die bracket 28 is moved forward by the piston rod 24 the roller arm 102 is allowed to pivot clockwise as seen in FIGURE 5 thereby allowing the switch 100 to close an electrical circuit. Each of the switches 84 and 100 has a respective electrical connector 106 and 107 coupled therewith for connecting electrical lines 108 and 109, respectively, thereto.

FIGURE 7 illustrates the manner in which the switches 84 and 100 operate solenoid controlled valves in the hydraulic system shown in FIGURE 8. A pair of valves 112 and 113, which may be a single valve serving the same purpose, are operated by respective control windings 114 and 115. As will appear subsequently, when the winding 114 is energized the valve 112 causes the hydraulic ram piston 24 to move forward or extend; whereas when the winding 115 is energized the valve 113 causes the piston rods 50 and 51 to extend and the piston rod 24 to retract. A pair of terminals 116 and 117 are adapted to be connected to an A.C. source, such as a 120 volt source. The terminal 117 is connected to ground 118. The terminal 116 is connected through a line 119 to a terminal 120 of a push-button switch 121 which serves to initiate automatic operation. The push-button switch 121 includes a push-button actuator 122 adapted to couple the contact 120 to a contact 123. The contact 123 is connected to a contact 124 of a relay 125, the contact 124 being connected through a winding 126 of the relay to ground. The relay 125 includes a pair of contactors 127 and 128 which, when the winding 126 is energized, respectively connect contacts 129, 130, and contacts 124 and 131. The contact 130 is connected in series with the control winding 114 to ground.

The line 119 coupled to the power supply terminal 116 is connected through a line 132 to a movable contact 133 of the degree control microswitch 84. A fixed contact 134 of the switch 84 is connected through a line 135 of the contact 131 of the relay 125. A second fixed contact 136 is connected through a line 137 to a contact 138 of a relay 139. The line 119 is connected through a line 140 to a movable contact 141 of the stop control microswitch 100. A fixed contact 142 of the switch 100 is connected through a line 143 to a contact 144 of the relay 139. The line 119 also is connected to a contact 146 which is adapted to be connected to a contact 147 by a contactor 148 when a winding 149 of the relay 139 is energized. The winding 149 is connected between the contact 138 and ground, and the contact 147 is connected in series with the winding 115 to ground. The relay 139 also includes a contactor 150 which connects the contacts 138 and 144 when the winding 149 is energized. Although the terminal 117 and the various windings are not shown and described as being connected to ground 118, this is for simplicity of illustration. It is to be understood that ground 118 is a common terminal and preferably not actually grounded to the tubing bender.

The parallel manual control circuit is connected across the contacts 129 and 130 of the relay 125 and includes a pair of series connected switches 152 and 153. A similar circuit is connected across the contacts 146 and 147 of the relay 139 and includes a pair of series connected switches 154 and 155. One of the series switches of each relay, such as the switches 152 and 154, is a manually operated on-off selector switch which, when closed allows manual control of operation by means of the second series switches 153 and 155 which are preferably normally open foot pedal switches.

Turning to FIGURE 8, the valves 112 and 113, whether they be separate valves or a single two way type valve, receive hydraulic fluid from a pump 160 through lines 161, 162 and 163. The fluid may be returned to a reservoir 164 through lines 165, 166 and 167. The reservoir 164 is connected through a line 168 to the pump 160. The valve 112 has an outlet line 170 which is connected to the tube 25 coupled to the rear of the cylinder 20 of the hydraulic ram 13. The valve 113 has an outlet line 171 which is connected to tubes 62 and 63 of the respective compression cylinders 52 and 53, and to the tube 26 coupled to the forward end of the cylinder 20 of the ram 13. When the valves 112 and 113 are deactivated or in a neutral position, that is with the winding 114 and 115 deenergized, fluid is allowed to return from the cylinders through the lines 170 and 171, the valve 112 and 113, and the lines 165, 166 and 167 to the reservoir 164. When the winding 114 is energized, fluid is supplied from the pump 160 through the valve 112 and the line 170 to the back of the cylinder 20 of the ram 13. When the winding 115 is energized, fluid is supplied from the pump 160 through the valve 113 and the line 171 to the cylinders 52 and 53 and to the forward end of the cylinder 20 of the ram 13.

In order to impart a desired degree of depth of bend to the tubing 60 (FIGURE 2) according to the invention, the tubing 60 is placed between the die 29, and the shoes 57 and 58 as shown in FIGURE 2, and the movable arm 74 is positioned with the pointer 86 thereof adjacent the marking 72 indicating the desired degree of bend. The push-button actuator 122 of the automatic control switch 121 is operated to connect the contacts 120 and 123 thereby energizing the relay winding 126. This causes the contactors 127 and 128 to interconnect their respective contacts thereby energizing the control winding 114, and

providing a holding circuit for the relay **125**. That is, a circuit is completed through the contact **129**, the contactor **127**, and the contact **130** to energize the control winding **114**. A circuit is completed by the contactor **128** and the contacts **124** and **131** through the line **135**, contact **134**, movable contact **133** of the switch **84**, the line **132** and the line **119** to maintain the winding **126** of the relay **125** energized. Hydraulic fluid is then supplied through the valve **112** and the tube **25** to the cylinder **20** of the ram **13** causing the piston rod **24** thereof to extend or move forward to thereby bend the tubing **60**. As the tubing **60** is bent, the control arm **90** pivots, ultimately causing the switch control finger **97** to contact the switch actuator **85** of the switch **84**. When this occurs, the movable contact **133** of the switch **84** as shown in FIGURE 7 moves to the fixed contact **136**, thereby deenergizing the winding **126** of the relay **125**. When the winding **126** is deenergized, the control winding **114** of the valve **112** becomes deenergized thereby terminating the application of fluid pressure through the line **170** and the tube **125** to the back of the ram cylinder **20**.

When the piston rod **24** started moving forward upon the initial energization of the control winding **114** of the valve **112**, the bottom of the die bracket **28** moved away from the roller **103** of the stop control microswitch **100** thereby causing the movable contact **141** thereof (FIGURE 7) to engage the fixed contact **142**. When the desired degree of bend occurs and the arm **133** of the microswitch **84** engages the contact **136** thereof, the winding **149** of the relay **139** is energized thereby causing the control winding **115** of the valve **113** to be energized through the contactor **148**. A holding circuit is completed by the contactor **150** when the winding **149** is energized through the line **143**, contact **142**, movable contact **141** of the switch **100**, and the line **140** to the line **119**. This holding circuit is necessary inasmuch as the movable contact **133** of the degree microswitch **84** disengages the fixed contact **136** and engages the fixed contact **134** as soon as the finger **97** moves away from the switch **84** as the piston rod **24** commences to retract and the piston rods **50, 51** commence to extend. When the shoes **57** and **58**, and the die **29** return to a normal position as shown in FIGURE 1, the die bracket **28** again contacts the roller **103** causing the movable contact **141** of the stop control microswitch **100** to disengage the fixed contact **142**. When this occurs, the winding **149** of the relay **139** becomes deenergized thereby deenergizing the control winding **115** of the valve **113**. The bending operation is thus completed, with a desired degree of bend being imparted to the tubing **60**, and the apparatus being returned to a normal condition.

The parallel circuits including the switches **152, 153**, and the switches **154, 155**, across the respective contacts **129, 130**, and **146, 147**, enable manual control of the tubing bender when desired. Semi-automatic operation may be provided by dispensing with the relay **139** and the stop control microswitch **100**. In this case, actuation of the switch **121** causes the control winding **114** to be energized until the movable contact **133** of the degree microswitch **84** disengages the fixed contact **134** thereof upon occurrence of the desired degree of bend. The apparatus, that is the die, shoes and piston rods may then be returned to a normal position by operation of a switch in series with the control winding **115** of the valve **113**, or this valve may be operated manually if desired.

The present embodiments of the invention are to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims therefore are intended to be embraced therein.

What is claimed is:

1. In an apparatus having die means and shoe means for bending tubing, hydraulic ram means operable for advancing said die means from a normal position to engage and bend said tubing and for returning said die means to said normal position, hydraulic control means coupled with said shoe means for restricting the movement thereof during bending of said tubing and for returning said shoe means to a normal position, depth of bend control means comprising

control means coupled to said shoe means for movement therewith as said tubing is bent upon operation of said hydraulic ram means,

depth of bend indicator means,

manually movable depth of bend setting means mounted for movement with respect to said indicator means for selecting a desired degree of bend of said tubing,

first switch means mounted on one of said control means and said setting means, said first switch means being actuated upon engagement with the other of said control means and setting means in response to movement of said shoe means to a position corresponding to said selected degree of bend, and

circuit means coupled with said first switch means and including start switch means for activating valve means operatively associated with said hydraulic ram means to operate said ram means and advance said die means into bending engagement with said tubing, said circuit means being responsive to actuation of said first switch means for deactivating said valve means to terminate the die means-advancing operation of said hydraulic ram means.

2. Depth of bend control means as in claim **1** wherein said depth of bend setting means comprises manually movable arm means pivotally mounted for movement relative to said indicator means.

3. Depth of bend control means as in claim **1** including

second valve means operable in response to actuation of said first switch means for applying fluid pressure to said hydraulic ram means and said hydraulic control means to return said die means and said shoe means to said normal position after a desired degree of bend is imparted to said tubing.

4. Depth of bend control means as in claim **2** wherein said manually movable arm means is pivotally mounted by a spring loaded coupling, and

said first switch means is mounted on said manually movable arm means and is actuated upon engagement with said control means.

5. Depth of bend control means as in claim **3** including second switch means coupled with said circuit means, said second switch means being actuated upon advancing movement of said die means by said ram means as a bending operation is started.

6. Depth of bend control means as in claim **5** wherein said circuit means includes

first and second relay means each having contacts,

said valve means each include winding means which activate the respective valve means upon energization of said winding means,

said start switch means is coupled with said first relay means for energizing said first relay means and for completing through the contacts thereof a circuit to energize the winding means of said first mentioned valve means, and

further circuitry wherein said first switch means maintains said first relay means energized until said first switch means is actuated whereupon said first relay means is deenergized and said second relay means is energized respectively to deenergize the winding means of said first mentioned valve means and energize the winding means of said second valve means to cause said die means and said shoe means to return to said normal position, said second switch

means deenergizing said second winding means upon return of said die means to said normal position.

7. Depth of bend control means as in claim 6 including first and second manually operable switch means respectively coupled with respective winding means of said valve means for enabling manual control of energization of the respective winding means of said valve means.

8. Apparatus having die means and shoe means for bending tubing, hydraulic ram means operable for advancing said die means from a normal position to engage and bend said tubing and for returning said die means to said normal position, hydraulic control means coupled with said shoe means for restricting the movement thereof during bending of said tubing and for returning said shoe means to a normal position, support means for supporting said die means, said shoe means, said ram means and said control means, the improvement comprising

control means coupled to said shoe means and movable with said shoe means as said tubing is bent,

depth of bend indicator means mounted on said support means,

manually movable depth of bend setting means mounted for movement with respect to said indicator means to select a desired degree of bend for said tubing,

switch means mounted on one of said control means and said setting means, said switch means being actuated by said control means upon movement thereof with said shoe means when the selected degree of bend has been imparted to said tubing,

first valve means coupled with said hydraulic ram means for causing said ram means to extend and bend said tubing,

second valve means coupled with said ram means for causing said ram means to retract to said normal position, said second valve means being coupled with said hydraulic control means for causing said shoe means to return to said normal position,

second switch means mounted on said support means, said second switch means being actuated in response to movement of said die means from said normal position, and

circuit means coupling said first and second switch means and adapted to be coupled with a power supply for operating said first and second valve means, said circuit means including third switch means for

initiating operation of said apparatus whereby said first valve means causes said hydraulic ram means to move said die means to bend said tubing, said first switch means is actuated when the selected degree of bend is imparted to said tubing thereby deactivating said first valve means and activating said second valve means to cause said die means and said shoe means to return to a normal position whereupon said second switch means causes said second valve means to be deactivated.

9. Apparatus as in claim 8 wherein

said shoe means includes a pair of pivotally mounted shoes,

said control means comprises control arm means coupled to one of said shoes for rotation therewith as said tubing is bent,

said manually movable setting means comprises manually movable arm means mounted for manual movement relative to said indicator means,

said circuit means includes first and second relay means for respectively operating said first and second valve means, and

said first switch means is a microswitch connected in said circuit means by circuitry normally causing said first relay means to be energized to operate said first valve means for causing said ram means to extend and bend said tubing until the selected degree of bend is imparted thereto until said microswitch is actuated whereupon said first relay means is deenergized and said second relay means is energized respectively to deactivate said first valve means and activate said second valve means for causing said ram means and said shoe means to return to said normal position.

References Cited

UNITED STATES PATENTS

2,056,155	10/1936	Brinkman	72—22
2,306,223	12/1942	Parker	72—22
2,357,873	9/1944	Bower	72—22
2,456,675	12/1948	Chaille	72—22
2,525,403	10/1950	De Witt	72—382

CHARLES W. LANHAM, *Primary Examiner.*

K. C. DECKER, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,388,574 June 18, 1968

Vincent Ignoffo

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 11, "the" should read -- The --; line 19, "one" should read -- end --. Column 4, line 26, cancel "not"; line 54, "winding" should read -- windings --.

Signed and sealed this 14th day of October 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents