UNIVERSAL AND ADJUSTABLE MOUNTING FOR A CLAMP DIE IN A TUBE BENDING MACHINE

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This invention relates to a tube bending machine and is particularly directed to a machine for obtaining a plurality of bends and having novel self-adjusting clamp die mechanism therein.

In the bending of tubing by the usual method, as shown and described in detail in my Patent No. 2,357,873, dated September 12, 1944, the advancing end of the tubing is clamped within and against the grooved, curved face of a rotatable bending die. The radius of the curve of the face of the die is the radius of the desired bend. A back-up die presses the tube snugly against the bending die. As the bending die is rotated, the tube is drawn along with it and the back-up die, moving in a straight line, accomplishes the actual bending of the tube against the approaching surface of the bending die. In this and other tube bending machines, but one bend is accomplished during one cycle of the tube bending mechanism. Additional bends as desired are accomplished after which the bent tubing is removed. Pairs of clamping and novely constructed self-aligning forming dies operate automatically in a predetermined sequence, it being necessary for the operator only to insert and remove the tubing at the start and end of the bending cycle. The forming dies are constructed in a manner to compensate for any irregularities in the tubing being worked.

It is therefore an object of the invention to provide a tube bending machine with novely constructed clamp dies and novel mounting means for said dies to permit adjustment of one relative to the other to compensate for irregularities in the tubes being bent thereby.

Another object is to provide a novel universal and adjustable mounting for a clamp die.

A further object of the invention is to provide a tube bending machine in which, during the course of one cycle of operation, there is accomplished either a single bend or a pair of spaced bends having the same or different radii, the same or different arc lengths, and lying in the same or different planes.

Another and still further object of the invention is to provide a tube bending machine which will simultaneously produce spaced bends in a tubing.

Still another object of the invention is to provide a tube bending machine which is easily and quickly adjusted, loaded and unloaded by an inexperienced operator.

A still further object of the invention is to provide a tube bending machine which is simple in design, rugged in construction, economical to manufacture, and highly efficient in use.

Other objects and advantages of the invention will become apparent during the course of the following description and from the accompanying drawings, in which:

Figure 1 is a plan view of a tube bending machine embodying principles of my invention;

Figure 2 is an end view of the machine, as seen from the right in Figure 1, but showing the bending mechanism tilted from the horizontal position shown in Figure 1, to an inclined position;

Figure 3 is an enlarged side view showing details of construction of the tube bending mechanism as seen in Figure 2, but in a horizontal position and without the support;

Figure 4 is a fragmentary view, similar to Figure 3, showing details of construction of the opposite side of the bending mechanism;

Figure 5 is a plan view in elevation of a toggle joint and bell crank arrangement for swinging the bending form shown in tubing clamping position.

Figure 6 is an enlarged plan view of the tube bending mechanism showing the operative relation of dies with the tubing clamped in position ready for the bending cycle;

Figure 7 is an enlarged isometric view of a self-aligning clamp die construction;

Figure 8 is an enlarged vertical cross-sectional view, with parts in elevation, as seen when taken substantially along planes indicated by the lines 8—8 of Figures 7 and 9.

Figure 9 is a reduced top plan view of the self-aligning clamp die construction shown in Figures 7 and 8.

Referring now in detail to the drawings, the tube bending machine shown therein includes a base construction having end supports 30 and 31 and spaced parallel mounting rods 32 and 33. A tube bending assembly 34 is mounted on the mounting rods adjacent the support 30. Similarly, a tube bending assembly 35 is mounted on the mounting rods adjacent the support 31. If desired, tubes may be used in place of the rods described. As will be more apparent hereinafter, the assemblies are constructed to operate in opposite directions.

In the present embodiment, a machine having two bending mechanisms is shown to effect, in one length of tubing, a pair of spaced bends. Both bending assemblies are so mounted on the rods as to be adjustably slidable therealong. The mounting rod 32 spans the space between and connects the supports 30 and 31 while the mounting rod 33 extends between and through the bending assemblies but is not connected to the end supports. By this arrangement, the bending assemblies are swingable together in the same plane on the mounting rod 32. As partially shown in Figures 1 and 2, the bending assemblies may be tilted through a wide range from horizontal position. This feature is provided in order that the bending assemblies be available for use in the most accessible position.

Between the mounting rods is located an adjusting screw preferably of one-piece construction having a threaded length 36 provided with left-hand threads and connected to bending assembly 34 and another length 37 provided with right-hand threads and connected to bending assembly 35. A centrally located bearing 38 has laterally extending bearing arms 39 and 40 which, respectively, embrace the mounting rods 32 and 33. As the adjusting screw is rotated, by the hand or wrench gripping portions 36a or 37a, the bending assemblies are slidable on the mounting rods either toward or away from each other depending on the direction of rotation.
As both of the bending assemblies 34 and 35 are of similar construction, except for such changes as are necessary because a tubing at one end is to be bent in a clockwise direction and at the other end in a counterclockwise direction, only one will be described in detail. As best shown in Figures 2 and 4, the bending assembly 35 is mounted on a frame 41. The frame includes a base plate 42, having on the upper surface thereof a dove-tail tongue 43, and, depending from the lower surface, a pair of spaced plates 44, 44, only one of which is shown. Adjacent to the left end of the plates is a split bearing, a half portion 45 of which is integral with the plates. A half round cap 46 mates with the bearing portion 45 to receive therethrough the mounting rod or tube 32. Studs 47 and 48 thread through muted ears to hold the bearing halves in assembly. As thus assembled, the tube bending assembly is locked on the mounting rod against rotation or movement lengthwise thereof. Movement of the tube bending assembly relative to the mounting member requires loosening of the studs. Intermediately of the ends of the plates 44 is a fixed bearing nut 49 having an internally threaded opening 50 for receiving therethrough the adjusting screw portion 37. At the ends of the plates 44, 44, opposite the bearing for mounting rod 32, is a fixed bearing 51 for slidably receiving therethrough the mounting rod or tube 33.

A base plate 52 has a morrise or groove 53 opening through the bottom surface thereof for complementally and slidably receiving the dove-tail tongue 43. By this arrangement the base plate 52 is slidably adjustable lengthwise of the base plate 42. A hanger 54 depends from the forward end of the bottom wall 62 of the main frame 60 and is provided with a bearing 55 at the lower end thereof. A nut 56 is connected to and between the plates 44, 44, for receiving therethrough an adjusting screw 57 which extends through the bearing 55 and terminates in an operating handle 58. A stop 59 is provided on the screw to limit relative movement of the base plates 42 and 52, since plate 52 is fixed to said bottom wall 62.

Fixedly mounted on the base plate 52 is the tube bending mechanism. Details of construction are shown in Figures 3, 4 and 6. The main frame 60 is generally of U-shape having a top wall 61, a bottom wall 62, and a side wall 63. A short intermediate web 64 provides added support for the offset leg 61a of the top wall 61.

As best shown in Figures 4 and 6, a toggle cylinder 65 is swiveled and mounted on a pivot pin 66 having ends journaled in the top and bottom walls of the main frame 60. A piston 67 within the cylinder has extending from the front end thereof a shaft 68 terminating in a vertically apertured block 69 (Figure 4). A pin 70 extends through the block and has journaled therein upper and lower toggle links 71 and 72 (Fig. 5). A second pair of toggle links, upper link 73 and lower link 74, are also journaled on the pin 70 above and below, respectively, the first pair of links. This link and pivot construction forms a toggle joint.

A pivot 75 vertically extends between and with the ends thereof journaled in the top wall 61 and the bottom wall 62 of the frame, and it carries a die carrying member 79, the downwardly extending boss portion of which is embraced by a split clamp member 80 secured thereto by studs 71 and 82. The opposite end of the clamp member is apertured therethrough a pivot pin 83. The die carrying member 79 and the split clamp member 80 together form the lever arms 79, 80 of a bell crank swingable on the pivot 75. Journaled on the pivot are the upper and lower toggle links 73 and 74 operatively connecting the pivots 70 and 83.

An arm 84 mounted rigidly between top wall 61 and bottom wall 62 has a reduced end through which extends a pin 87 for connecting the arm swingably to the pivot 75.
Once the manual adjustment in a vertical direction is made with screw 120, automatic adjustment of the groove 115 relative to the tubing to be received, to compensate for irregularities in the tubing, wear in the clamp die or the misalignment of parts making up the assembly, is obtained in both horizontal and vertical planes. This construction is the equivalent of a ball and socket arrangement by which automatic alignment is effected between the tube receiving grooves of the clamp and bending die. The major adjustment of the clamp die, as described above, is limited to the slot 98 and the associated opening 106. In order to effect an adjustment of the clamp die to desired position and to provide the necessary backing for the clamp die support, a support mechanism is provided. A support body 122 with a bottom guide not shown but similar to guide 96, adapted to slide in the groove 97, has a vertical opening to receive a locking stud 123 which threads into one of the openings 108. On either side of the stud are horizontally, forwardly extending and internally threaded openings to receive a, adjusting screws 124 and 125. These screws abut against the rear face of the clamp die support 95 and serve to forwardly adjust the die support to a desired position. The adjusting screws are then locked in position by the lock nuts 126 and 127.

As best shown in Figure 6, when the piston 67 in the toggle cylinder 65 is fully retracted, moving piston 76 rearwardly of the pivots 83 and 87, the lever arm 89 is rotated on pivot 75 and the movable pivot 83 is swung toward the stationary pivot 87. This movement of lever arm 80 also swings the die carrying member 79 and the bending form 89 carried thereby to a fully released position relative to the tubing. It is in this position of parts that the tubing is inserted or removed from the bending mechanism. It will be noted that the corner 128 of the bending form is beveled to provide necessary clearance for insertion or removal of tubing between the clamping members.

With the tubing 88 inserted in the machine within the groove 115 of the clamp die 113, the piston of the toggle cylinder 65 is actuated to a fully extended position as shown in Figure 6. The lever arm 80 is rotated on pivot 75 which, in turn, through the die carrying member 79, swings the bending form 89 to a position clamping the tubing in the mated and adapted bending mechanism. As also shown in Figure 6, the bending form 89 is fixed pivot 75, the groove 94 moves in a fixed plane. Accordingly, any variation in the tubing wear, on the clamping dies or misalignment of parts is automatically provided for by the self-adjusting clamp die 113. The lever 89 is laterally, longitudinally and along the groove 97 no further mechanical adjustment is necessary provided tubing sections of approximately the same diameter are inserted for bending.

Two adjustments are provided in actuating the bending form 89 through the lever arm 80. The die carrying member 79 is adjustable on pivot 75 relative to the lever arm 80 by means of the split clamp end secured in adjusted position by the studs 81 and 82. In addition, the extension of piston 67 within toggle cylinder 65 is adjusted by limiting the swinging of the cylinder on its pivot 66. This is accomplished by providing a bracket 129 on the end of the toggle cylinder 65. An actuator arm 130, adjustable in a direction normal to the bracket 129, is moved therewith through an opening in the side wall 63 into and out of bearing with the actuating lever 64, as shown in Figures 1 and 2. The design construction is not shown as it is a standard electric fixture forming no independent part of this invention. The limit switch is designed, by connection with an actuating valve, to limit swinging of the toggle cylinder 65 on its pivot 66.

A bending cylinder 131 is mounted, adjacent the rear end thereof, by a pivot pin 132 spanning and having its ends anchored in an offset 61 of the top wall 61 and bottom wall 62 of the main frame 60. An actuating piston 133 is connected by a piston rod or shaft 134 to a vertically apertured block 135 (Figures 3 and 4). A pivot pin 136 extends vertically through the block and is anchored thereto. The block is mounted between the reinforced upper plate 138 and the lower plate 139 of a secondary frame 140. The plates are maintained in spaced relation by a web 141. On the lower side of plate 138 is another plate 142 which co-operates with upper plate 139 to rotateably mount the ends of the pivot pin 136 (Fig. 3).

As best shown in Figure 6, the upper plate 138 of the secondary frame 140 extends rearwardly and terminates in spaced relation to the offset end 61a of the top wall 61 of the main frame 60. A skirt 148 depends partially lengthwise from the outside edge of plate 138 and performs no other function than to screen the cylinder. Similar to the grooved top wall 61, a groove 149 in the upper surface of plate 138 extends lengthwise thereof. This groove receives a wiper die construction 150. The die construction is similar to the self-adjusting clamp die construction previously described. Included therein is a wiper die 151 having a longitudinally extending groove 152 in the front face thereof. The groove 152 complements the groove 94 of the bending form whereby to gather they circumferentially embrace a section of length of an inserted tubing.

As best shown in Figures 3 and 6, a wiper die support 153, a pivot pin 154 with securing cap screw 154a, plate 155, securing cap screws 156 and 157, vertical adjusting screw set 158, and adjustable clamp stud 159 are of the same construction, respectively, as like parts 95, 96, 104, 110, 116, 118, 129, 130, and 99, of the self-adjusting universal joint clamp die mechanism previously described. The only difference in construction is the elimination of any spacing between the wiper die 151 and wiper die support 153. While this prevents any relative movement of the wiper die and wiper die support in a horizontal plane, the said wiper die 151 is self-adjustable in a vertical plane. Similar parts are used to promote interchangeability.

Similarly, the adjustable supporting construction 160 has a support body 161 with a bottom guide seated in the groove 149, a vertically extending locking stud 162 for engagement in one of a row of internally threaded openings 163, 165 in the upper plate 138, and horizontal adjusting screws 164 and 165 with lock nuts thereon all of which are similar, respectively, to like parts 122, 123, 124, 126, 128, 129, 130, 132 and 125. Again, similar parts are used to promote interchangeability.

The wiper die 151 is adjusted with respect to the bending form 89 whereby the grooved portions mate. In this position, the wiper die is ready for actuation in a tubing bending operation.

The bending cylinder 131, through the piston 133, rod 134, block 135, and pivot pin 136, rotates the secondary frame 140 around the stationary pivot 145. As the piston is actuated forwardly, the secondary frame carrying the wiper die mechanism rotates from the position shown in Figure 7 to the position shown in Figure 1 (right hand end) thereby effecting a bend in the tubing. Subsequently, the wiper die mechanism is returned, as the piston retracts in the cylinder, to its original position as shown in Figure 7 and, upon the return, the bending form 89 is swung about the pivot 75 to a position in which the bent tubing is free for removal from the machine.

While the invention has been described herein as a machine for bending tubes, it is equally applicable for bending solid bars, rods and other elongated objects either of circular or other cross sectional shape so characterized structurally that they may be bent by a machine construction in accordance with this invention. Also, the words "tubes" and "tubing" as used herein include pipes and other hollow elongated bendable objects whether of circular or other cross sectional shape. It will, of course, be understood that various details
of construction may be varied through a wide range without departing from the principles of this invention and it is, therefore, not the purpose to limit the patent grant hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. In a tube bending machine having a swingable bending form, a self-adjusting clamp die mechanism toward which said bending form is swung, comprising a tubing to be bent, comprising a clamp die having a tube receiving groove in one face thereof and another groove in the face opposite said one face, said grooves being substantially at right angles to each other, a clamp die support having a socket in a face thereof, a pivot pin having a half round body terminating in a full round head, a boss on the flat face of said half round body to seat in said socket and located to position the round head beyond an adjacent surface of the clamp die support, a stud within and extending through the half round body to connect said pivot pin on the clamp die support, and a plate having an opening for receiving the round head of the pivot.

2. In a tube bending machine, a self-adjusting clamp die mechanism comprising a clamp die having grooves on opposite faces thereof, said grooves being substantially at right angles to each other, a clamp die support having a socket in one face thereof, one of the grooved faces of the clamp die and the socket face of the die support being arranged to co-operate in closely spaced relation, a pivot pin having a full head and a shank of reduced section between said clamp die support and clamp die, a boss on one surface of the reduced section to seat in said socket, said reduced section being seated in said one groove of the clamp die and against the socket face of the clamp die support, means connecting said pin and clamp die support, and a plate connected to said clamp die and having an opening therein for pivotally receiving the full head of the pivot pin.

3. In a tube bending machine, a clamp die support, a pivot pin member, means securing said pivot pin member to the support between its end for limited rotational movement about an axis normal to its longitudinal axis, a clamp die seated on said pin member and secured to said end thereof so that it has a limited rotational movement about the longitudinal axis of the pivot pin member and has common movement therewith about the axis normal to the longitudinal axis of the pivot pin member.

4. In a tube bending machine, a clamp die support, a pivot pin member, means securing said pivot pin member between its ends to the support for limited rotational movement about an axis normal to its longitudinal axis, a clamp die and means securing said clamp die to one end of the pivot pin member so that it has a limited rotational movement about the longitudinal axis of the pivot pin member and is fixed thereto for common movement therewith about the axis normal to the longitudinal axis of the pivot pin member, and means for securing said clamp die relative to the pivot pin member.

5. In a tube bending machine, a self-adjusting clamp die mechanism comprising a clamp die having grooves on opposite faces thereof, said grooves being substantially at right angles to each other, a clamp die support, one of the grooved faces of the clamp die and one face of the clamp die support being arranged in closely spaced relation, a pivot pin having a head and a shank arranged with the shank between said clamp die support and clamp die, said shank being seated in one groove of the clamp die, pivot means securing the shank between its ends to the related face of the clamp die support, and means pivotally connecting the clamp die to the head of said pivot pin.

6. In a tube bending machine having a bending form provided with tube engaging means, a self-adjusting clamp die mechanism comprising a clamp die having a first surface provided with a tube engaging groove cooperable with the tube engaging means of the bending form in clampingly holding a tube to be bent, said clamp die having a second surface cooperable with the first surface, a semi-cylindrical groove in said second surface substantially at right angles to the first named groove, a clamp die support, an elongated member pivotally secured between its ends to said clamp die support and extending beyond one end of said support, said member having a complementary curved surface seated in said semi-cylindrical groove, a socket member carried by said clamp die and engageable with the extended end of said elongated member, said elongated member and socket member connecting the clamp die to said support in a manner to permit the clamp die to move universally relative to the bending form whereby to compensate for irregularities or variations in tubes and wear and misalignment.

7. In a tube bending machine having a bending form provided with tube engaging means, a self-adjusting clamp die mechanism comprising a clamp die having a surface provided with a tube engaging groove cooperable with the tube engaging means of the bending form in clampingly holding a tube to be bent, said clamp die having a surface substantially opposed to the first surface, a semi-cylindrical groove in said second surface substantially at right angles to the first named groove, a clamp die support, an elongated member pivotally secured between its ends to said clamp die support and extending beyond one end of said support, said member having a complementary curved surface seated in said semi-cylindrical groove, a socket member carried by said clamp die and engageable with the extended end of said elongated member, said elongated member and socket member connecting the clamp die to said support in a manner to permit the clamp die to move universally relative to the bending form whereby to compensate for irregularities or variations in tubes and wear and misalignment.

8. In a tube bending machine having a bending form provided with tube engaging means, a self-adjusting clamp die mechanism comprising a clamp die having a surface provided with a tube engaging groove cooperable with the tube engaging means of the bending form in clampingly holding a tube to be bent, said clamp die having a surface substantially opposed to the first surface, a semi-cylindrical groove in said second surface substantially at right angles to the first named groove, a clamp die support, an elongated member pivotally secured between its ends to said clamp die support and extending beyond one end of said support, said member having a complementary curved surface seated in said semi-cylindrical groove, a socket member carried by said clamp die and engageable with the extended end of said elongated member, said elongated member and socket member connecting the clamp die to said support in a manner to permit the clamp die to move universally relative to the bending form whereby to compensate for irregularities or variations in tubes and wear and misalignment.

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