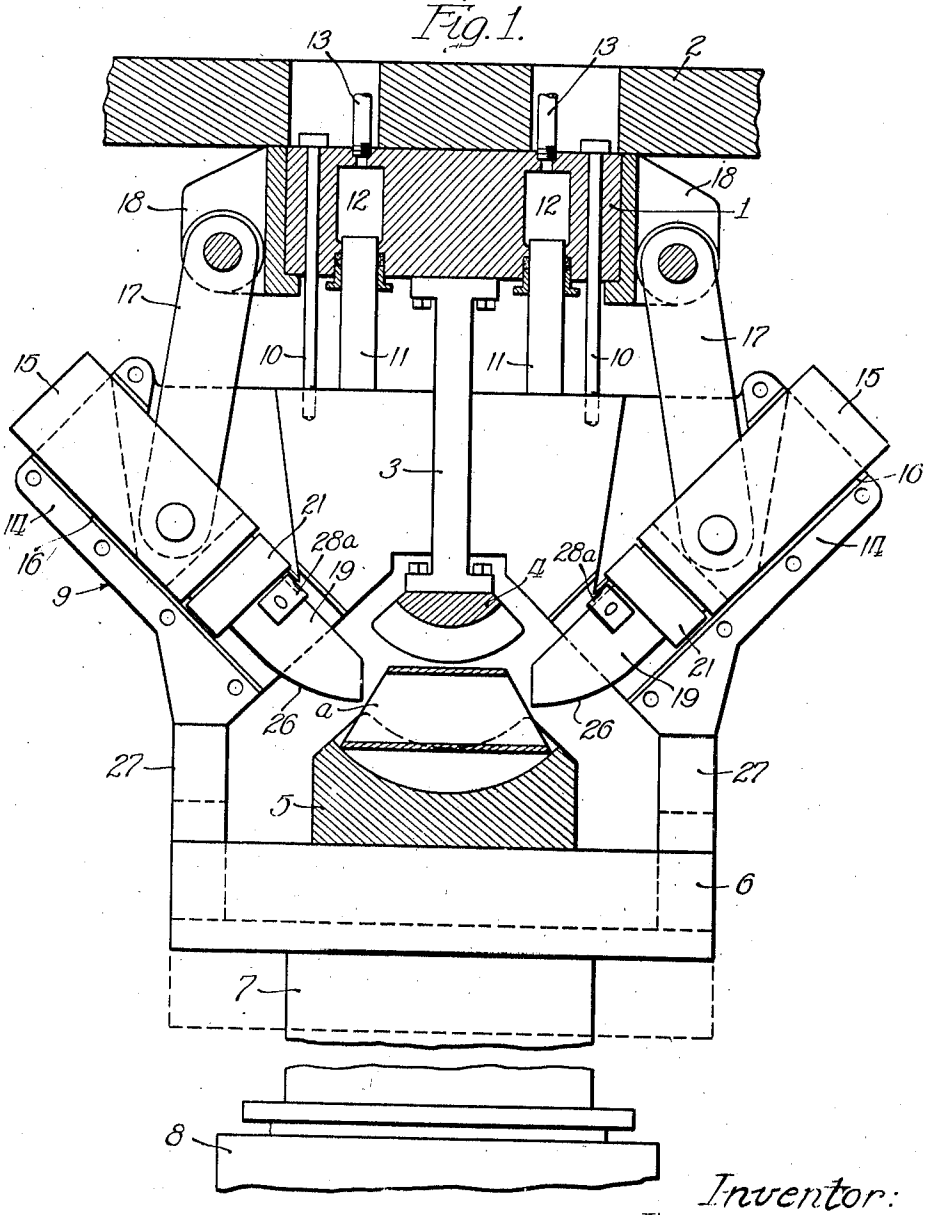
Aug. 22, 1933. J. MAROTO 1,923,272

METHOD AND MEANS FOR FORMING PIPE ELBOWS

Filed Nov. 19, 1930 5 Sheets-Sheet 1

Fig. 1.



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METHOD AND MEANS FOR FORMING PIPE ELBOWS

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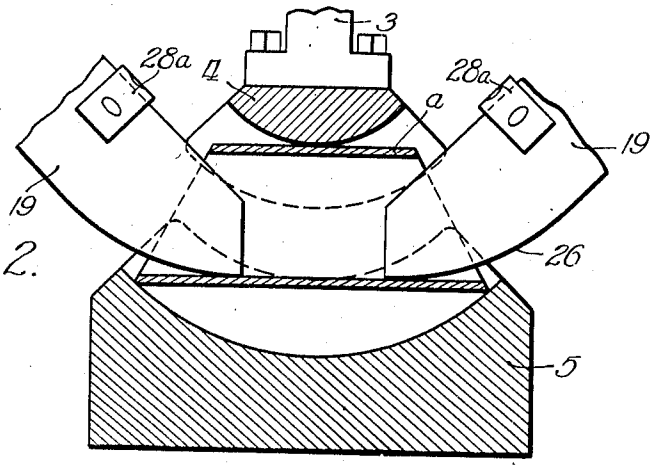


Fig. 2.

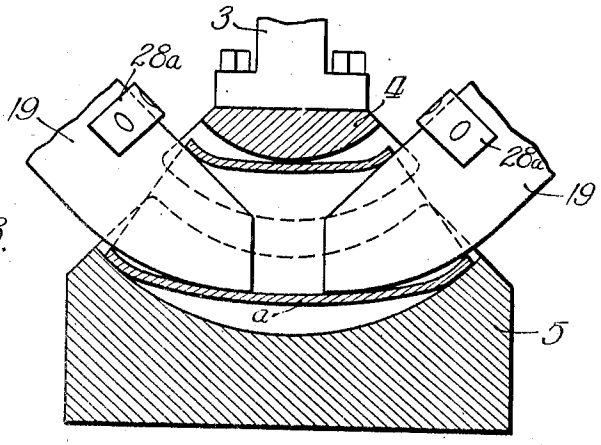


Fig. 3.

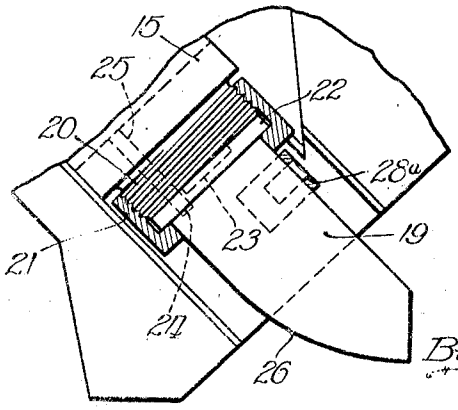


Fig. 5.

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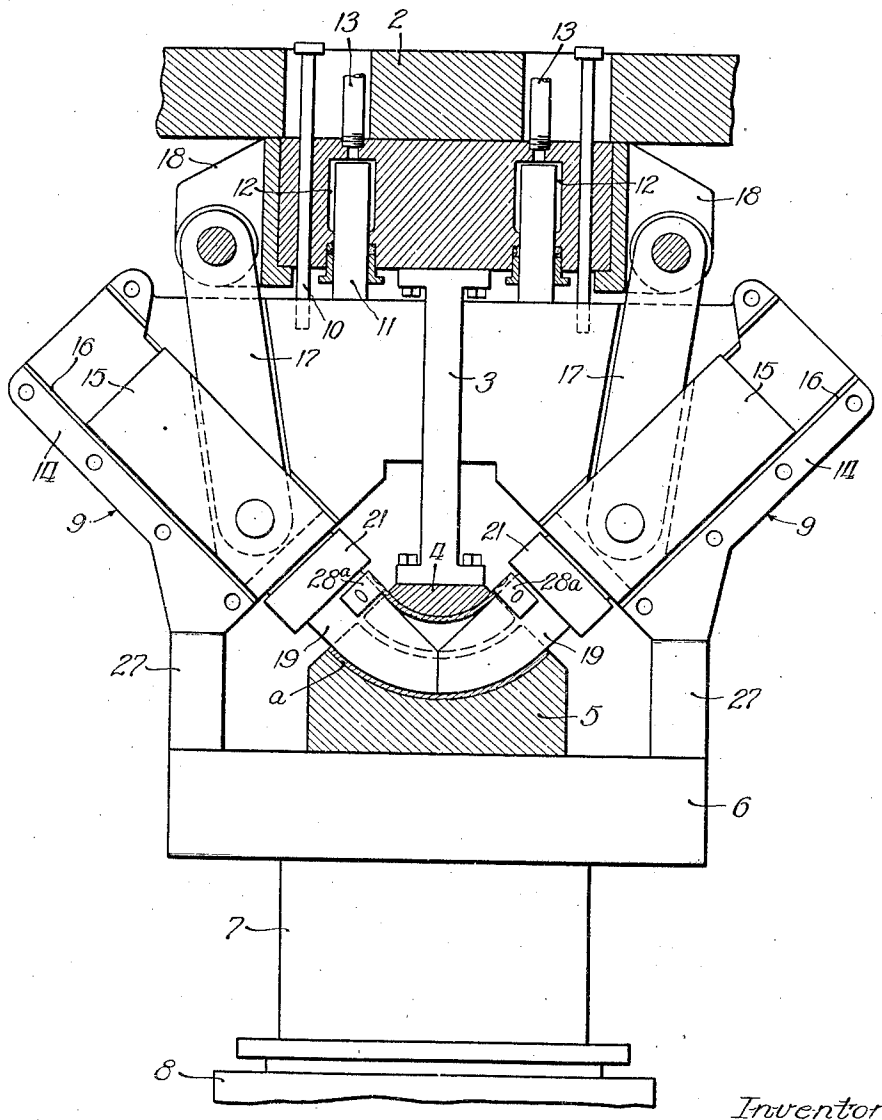
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METHOD AND MEANS FOR FORMING PIPE ELBOWS

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Fig. 4.



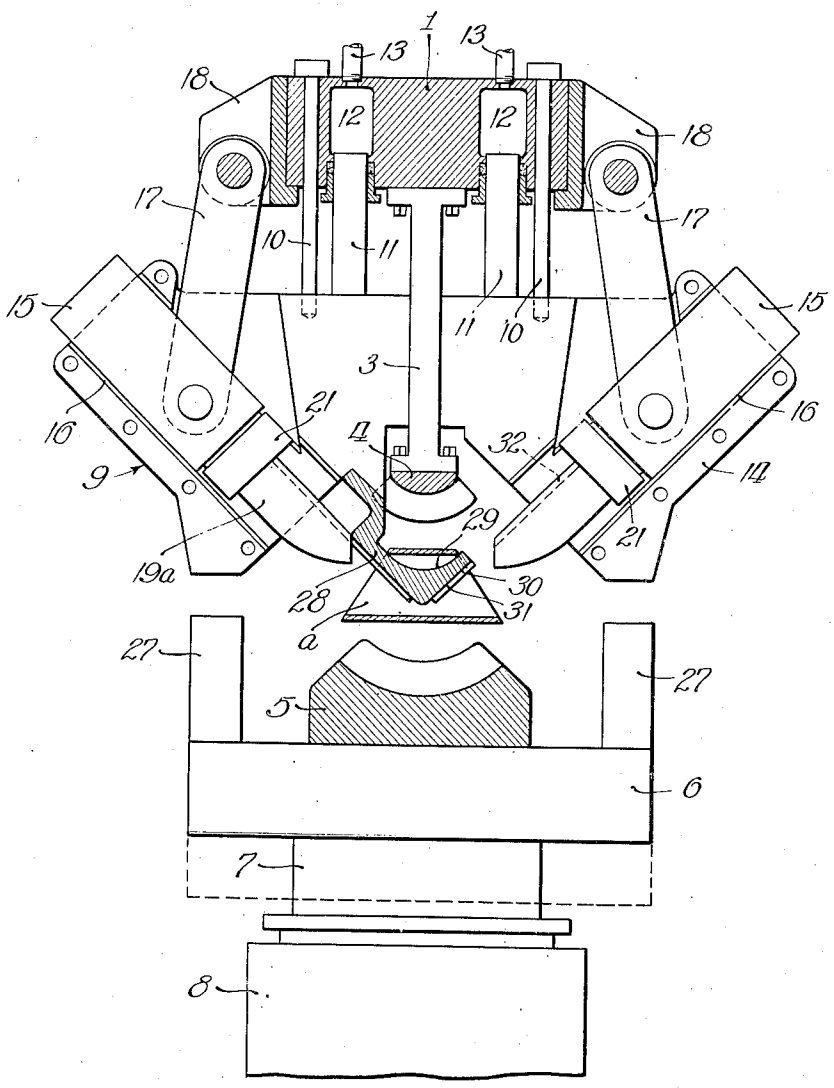
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METHOD AND MEANS FOR FORMING PIPE ELBOWS

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Fig. 6.



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METHOD AND MEANS FOR FORMING PIPE ELBOWS

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Fig. 7.

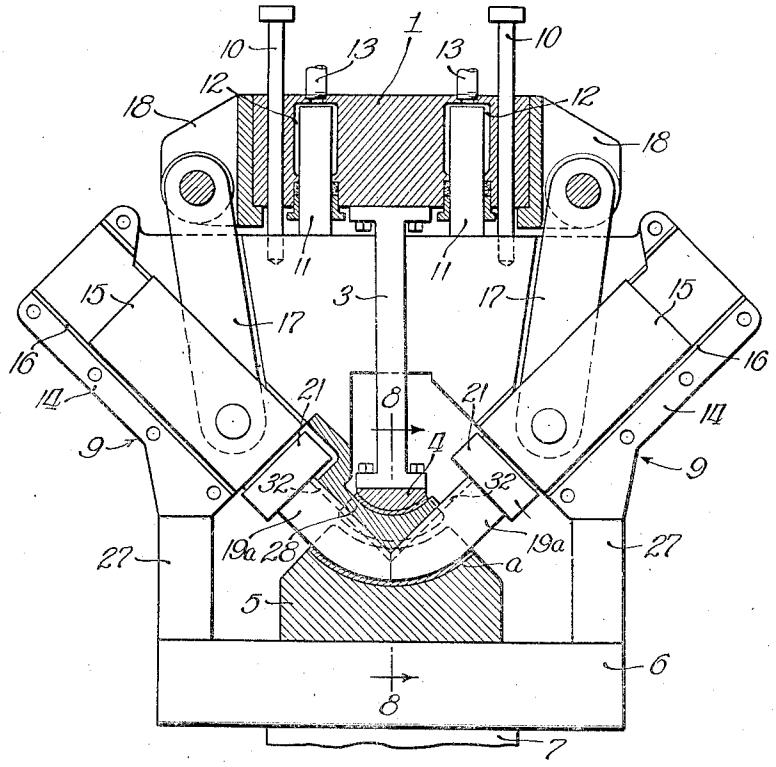
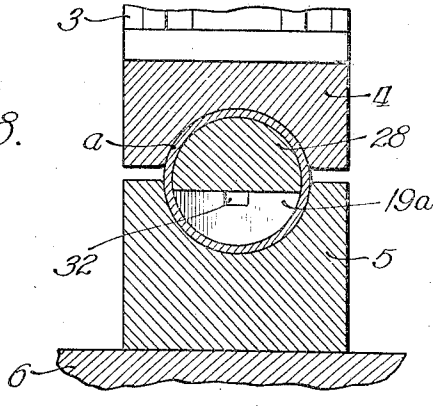


Fig. 8.



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Patented Aug. 22, 1933 1,923,272

UNITED STATES PATENT OFFICE

1,923,272

METHOD AND MEANS FOR FORMING PIPE ELBOWS

Jorge Maroto, Chicago, Ill., assignor to Taylor Forge and Pipe Works, Chicago, Ill., a Corporation of Illinois

Application November 19, 1930
Serial No. 496,615

21 Claims. (Cl. 153—33)

This invention relates to the manufacture of pipe elbows from wrought metal, and has to do more particularly with a method of and means for bending suitable lengths of tubing into desired final curvature to form therefrom the elbows.

One of the main objects of my invention is to provide an improved method whereby a length of tubing can be bent quickly into desired curvature so as to form an elbow without undesirable thinning of the tubing at the end portions, particularly at the inner side, thereof. A further object is to provide improved means for bending the tubing, this means employing dies having rectilineal movement and so related and operated that the bending of the tubing is accomplished in a relatively short period of time, thus facilitating speed of operation with consequent reduction in cost. Further objects and advantages of my invention will appear from the detail description.

In the drawings:

Figure 1 is a sectional view of the dies and associated parts, parts being shown in elevation, showing a length of tubing in position in the lower exterior die, this view illustrating the first step in the method of my invention;

Figure 2 is a sectional view through the two exterior dies and the length of tubing, illustrating the second step of my method, the two horn dies being shown in elevation;

Figure 3 is a view similar to Figure 2, illustrating the third step of my method;

Figure 4 is a view similar to Figure 1, but with the two exterior dies in full closed position, this view illustrating the fourth and final step of my method;

Figure 5 is a detail view, partly in section, illustrating the mounting of one of the horn dies upon its associated plunger;

Figure 6 is a view similar to Figure 1 but on a slightly reduced scale and illustrating a modification of the die structure for bending the tubing;

Figure 7 is a view similar to Figure 6 but illustrating the final step in the bending of the tubing by the die structure of Figure 6;

Figure 8 is a sectional view taken substantially on line 8—8 of Figure 7;

In manufacturing elbows in accordance with my invention, I provide suitable lengths of tubing of proper diameter and of wrought metal, each length having its ends cut on converging diagonal planes. Such a length of tubing constitutes a blank, designated *a*, from which an elbow is formed. The shorter side of this tubing forms the inner side or shorter bend of the elbow, and is accordingly termed the inner side of the tubing for purposes of description. The longer side of the tubing forms the outer or longer bend of the elbow and, accordingly, is termed the outer side of the tubing.

I shall first consider the means or apparatus illustrated in Figures 1 to 5, inclusive. A head structure 1 is suitably secured to the underface of a fixed platen 2, and a rigid supporting member or column 3 is suitably secured to the underface of head 1 and depends therefrom. An exterior die 4 is secured to the lower end of column 3, this die being provided with a troughlike depression defining a forming surface, this depression being of approximately semi-circular cross section and being curved lengthwise to conform to the desired final curvature of the inner side of the elbow. Since this die is employed to form the inner side of the elbow, I term it the inner exterior die.

An outer exterior die 5 is disposed beneath and in alignment with die 4. This outer die is provided in its upper face with a recess curved lengthwise thereof, such recess being also of approximately semi-circular cross section and defining a forming surface for shaping the outer bend of the elbow. This die 5 I term the outer exterior die. Die 5 is suitably mounted upon a bed 6 secured upon the upper end of a hydraulic piston or ram 7 operating in a cylinder 8. In its lowermost position, bed 6 occupies the dotted line position of Figure 1. Die 5 thus has rectilineal movement toward and away from die 4, these two dies cooperating with each other and with internal dies, presently to be described, for imparting the desired final curvature to the blank *a* for producing the elbow.

A frame 9 is disposed beneath and adjacent head 1. This frame is conveniently formed of two complementary sections, one of which is omitted for clearness of illustration. Downward movement of the frame relative to head 1 is positively limited by suspension bolts 10 slidable through the head and having their lower ends screwing into the upper end of frame 9. The frame 9 is yieldingly urged downwardly away from head 1 by two pistons 11 which bear upon the upper face of the head, these pistons being disposed at opposite sides of and equidistant from column 3 which is disposed at the transverse center of the head. Pistons 11 operate in cylinders 12 formed in head 1, liquid under pressure being supplied to these cylinders by means of pipes 13. Preferably the head is subjected to a constant pressure, by means of an intensifier, or equivalent means, known in the art.

The head is provided, at each side thereof, with

a sleeve 14 which is inclined downwardly and inwardly toward die 5. Plungers 15 are slidably mounted in the sleeves 14 which, preferably, are provided with suitable bushings 16. Each of these plungers is connected by a link 17 to bracket 18 suitably secured to head 1. The head and the plungers are suitably recessed to accommodate the links 17 and movement thereof in accordance with movement of the plungers.

A horn die 19 is suitably secured to the inner end of each of the plungers 15. Referring more particularly to Figure 5, it will be noted that each of the plungers is provided, at the inner end thereof, with a reduced threaded neck 20 upon which screws a clamping nut 21. This nut engages over a flange 22 at the base of die 19 so as to hold the die securely against endwise movement relative to the plunger. A stud 23, disposed centrally of the inner end of plunger 15, engages snugly into a corresponding recess in the base of the die, so as to hold the latter in centered relation to the plunger. A pin 24, secured through flange 22, engages into a bore 25 extending from the inner end of the plunger, and serves to hold the die against turning movement relative to the plunger and in proper operative relation thereto. The die 19 is of circular cross section and tapers towards its inner end, the outer side of this die being curved lengthwise at 26 and the inner side of this die being straight or uncurved lengthwise. The inner end of die 19 is flat and disposed parallel to the direction of movement of the outer exterior die 5. Due to the inclination of the plungers 15 and the linkage connection between the same and head 1, when frame 9 is moved upwardly toward head 1 the plungers 15 are moved downwardly and inwardly of the frame 9 so as to impart rectilineal motion to the horn dies 19 toward each other and, upon movement of frame 9 away from head 1 the plungers 15 are moved outwardly so as to retract the dies 19.

Bed 6 is provided, at each side thereof, with upwardly projecting elements 27 disposed to contact the lower face of frame 9 in the upward movement of the bed. With bed 6 in its lowermost position, indicated by dotted lines in Figure 1, the blank *a* is placed in the recess of die 5 in symmetrical relation thereto, with the shorter or inner side of the blank uppermost, as in Figure 1. The bed is then raised, moving the outer exterior die 5 toward the inner exterior die 4. In the initial upward movement of bed 6, elements 27 contact the lower end of frame 9, at which time the blank *a* is disposed between the horn dies 19 and in spaced relation to the inner exterior die 4, as shown in Figure 1. Continued upward movement of bed 6 results in raising frame 9 toward head 1 so as to project the horn dies into the ends of the blank, with the curved outer sides 26 of these dies in contact with the inner face of the outer side of the blank, the blank being raised to within a short distance of the rounded forming surface of die 4, as in Figure 2. Continued upward movement of bed 6 causes the dies 19 to be projected still further into the blank and, since these dies converge downwardly and contact the inner face of the outer side of the blank, this movement of the dies into the blank causes bending of the outer side thereof lengthwise at a plurality of points successively, due to the fact that the outer side of the blank is supported by the die 5. Furthermore, as the dies 19 enter the ends of the blank the straight inner sides of the dies contact the inner side of the blank at the end portions thereof so as to cause bending of the inner side as well as the outer side of the blank. In this manner, the blank as a whole is bent lengthwise by entry of the horn dies into the same, this bending movement at the outer side of the blank being supplemented by the action of the die 5 which shapes the outer side of the blank smoothly about the curved surfaces 26 of the dies 19. Also, the straight inner sides of dies 19 have tight frictional contact with the ends of the inner side of the blank and, since these dies move inwardly of the blank, exert an upsetting effect which is highly efficient in preventing undesirable thinning of the ends of the blank in the bending thereof. As die 5 is moved into its uppermost position, the outer side of the blank is curved smoothly and uniformly about the curved outer sides of the horn dies 19, and the inner side of the blank is shaped smoothly and accurately about the curve forming surface of the inner exterior die 4. This operation is clearly illustrated in Figures 3 and 4. It is particularly pointed out that in shaping the blank to the desired final curvature, it is bent successively from each end thereof by the action of the horn dies cooperating with the exterior dies and an upsetting effect is exerted by the horn dies at the ends of the inner sides of the blank. This is advantageous as avoiding objectionable thinning of the ends of the elbow, particularly at the inner side thereof, such as occurs where a length of tubing is curved by drawing the same about a curved surface instead of successively bending the tubing from each end thereof as above described. As a further assurance against thinning of the ends of the elbow, at the inner side thereof, I preferably provide upsetting members, in the form of arcuate strips 28^a of suitable thickness secured about the inner sides of dies 19 in a suitable manner. These upsetting members are so disposed as to contact the ends of the elbow, at the inner side thereof, as the dies 19 reach substantially fully projected position with their inner ends in contact and the die 5 reaches substantially its full closed position, shown in Figure 4. The members 28^a exert a slight upsetting effect upon the ends of the elbow in the final closing of the dies and provide an additional safeguard against thinning of the elbow at these portions. It is particularly pointed out that the dies and associated movable parts have rectilineal movement, which is advantageous as contributing to rapidity of operation with resulting saving in time and reducton in cost.

In the modified form illustrated in Figure 6, I provide an interior die 28 suitably secured to the lower end of frame 9 for movement therewith toward and away from the inner exterior die 4. Die 28 is provided, in the upper or inner side thereof, with a recess 29 curved lengthwise thereof, the inner side of this die being rounded and providing, with the recess, a forming surface conforming in curvature to the desired final curvature of the inner side of the elbow, such forming surface cooperating with the inner exterior die 4 for shaping the inner side of the elbow. The outer side of die 28 is provided with two outwardly converging and flat or plane surfaces 30, at the center portion of each of which is provided an outwardly projecting rib or tongue 31. This interior die cooperates with horn dies 19^a. The inner side of each of these horn dies is flat or plane to seat upon the cooperating face 30 of die 28, and is provided with a groove 32 extending lengthwise thereof and adapted to

snugly receive tongue 31. The interior die 28 has its inner forming surface accurately aligned with the forming surface of die 4, and is adapted to receive the blank *a* placed thereon with its inner or shorter side uppermost.

With die 5 in its lowered or open position, blank *a* is placed upon the interior die 28 in symmetrical relation to the inner forming face thereof, as in Figure 6. Die 5 is then moved upwardly into closed position, and during such upward movement contacts the blank *a* at the ends of the outer side thereof. At the same time that die 5 contacts the blank, elements 27 contact the lower end of frame 9 so as to cause upward movement thereof and project the horn dies 19*a* into the ends of the tubing. Tongues 31 enter grooves 32 of dies 19*a* as they enter the tubing or blank, and serve to hold the horn dies and the interior die 28 in proper relation to form a rigid internal die structure. After the horn dies have entered the blank, they contact the outer side thereof, and die 5 imparts a preliminary lengthwise bend to the blank, this bending of the outer side of the blank also causing lengthwise bending of the inner side of the blank. As the horn dies 19*a* approach fully projected position they form, with the interior die 28, an internal die structure the outer side of which is of the desired final curvature of the tubing, the inner side of such structure being of the desired final curvature of the inner side of the blank. In its final closing movement, the die 5 cooperates with the die 4 to accurately shape the tubing about the internal die structure so as to impart to such tubing the desired final curvature at both the inner and the outer sides thereof, thus producing the elbow, as in Figure 7. Since the blank is shaped about forming surfaces having the desired curvatures, the curvatures of the inner and the outer sides of the elbow produced are quite accurate.

As above indicated, and as will be obvious to those skilled in the art, changes in my method, as well as in the means for performing the same, may be resorted to without departing from the field and scope of my invention. I intend, therefore, to include in my invention all such variations as fall within the scope of the appended claims, the preferred forms only of my invention being disclosed herein.

What I claim is:

1. In combination, two opposed and cooperating exterior dies having relative rectilineal movement, two opposed and cooperating horn dies operating between the exterior dies and having rectilineal movement toward and away from each other and substantially transversely of the relative movement between said exterior dies, and means controlled by relative movement of the exterior dies toward and away from each other for moving the horn dies toward and away from each other.

2. In combination, a fixed exterior die, a movable exterior die having rectilineal movement toward and away from the fixed die and cooperating therewith, oppositely inclined horn dies disposed at opposite sides of and operating between the exterior dies, said horn dies having rectilineal movement toward and away from each other, and means actuated by movement of said movable exterior die for moving the horn dies toward each other in the movement of the movable die toward the fixed die.

3. In combination, a fixed exterior die, a movable exterior die having rectilineal movement toward and away from the fixed die and cooperating therewith, oppositely inclined horn dies disposed at opposite sides of and operating between the exterior dies, said horn dies having rectilineal movement toward and away from each other, and means controlled by movement of said movable die for moving the horn dies toward and away from each other in accordance with movement of the movable die toward and away from the fixed die.

4. In combination, a fixed head, an exterior die fixedly supported from said head, a frame having limited movement toward and away from the head, an exterior die opposed to and having rectilineal movement toward and away from the fixed die, oppositely inclined horn dies slidably mounted on the frame at opposite sides of and operating between the exterior dies, linkage means connecting the horn die to the head and acting to cause movement of said horn dies toward and away from each other in accordance with movement of the frame toward and away from the head, and means for moving said frame toward and away from the head and the movable exterior die toward and away from the fixed die.

5. In combination, a fixed head, an exterior die fixedly supported from the head, a frame having limited movement toward and away from the head, an exterior die opposed to and having rectilineal movement toward and away from the fixed die, horn dies slidably mounted on the frame at opposite sides of and operating between the exterior dies, connections between the head and the horn dies for moving the latter toward and away from each other in accordance with movement of the frame toward and away from said head, and means for moving said frame toward and away from the head and the movable exterior die toward and away from the fixed die.

6. In combination, a fixed head, an exterior die fixedly supported from the head, a frame movable toward and away from the head, means continually yieldingly urging the frame away from the head, means limiting movement of the frame away from the head, an exterior die opposed to and having rectilineal movement toward and away from the fixed die, horn dies slidably mounted on the frame at opposite sides of and operating between the exterior dies, connections between the head and the horn dies for moving the latter toward and away from each other in accordance with movement of the frame toward and away from said head, and means for moving said frame toward and away from the head and the movable exterior die toward and away from the fixed die.

7. In combination, a fixed head, an inner exterior die fixedly supported from the head, a frame movable toward and away from the head, means continually yieldingly urging the frame away from the head, means limiting movement of the frame away from the head, an outer exterior die opposed to and having rectilineal movement toward and away from the fixed die, oppositely inclined horn dies slidably mounted on the frame at opposite sides of and operating between the exterior dies, said horn dies converging toward the movable exterior die and having their outer sides curved lengthwise, connections between the head and the horn dies for moving the latter toward and away from each other in accordance with movement of the frame toward and away from said head, and means for moving said frame toward and away from the head and the movable exterior die toward and away from the fixed die,

8. In combination, a fixed head, an inner ex-

terior die fixedly supported from the head, a frame movable toward and away from the head, means continually yieldingly urging the frame away from the head, means limiting movement of the frame away from the head, an outer exterior die opposed to and having rectilineal movement toward and away from the fixed die, oppositely inclined horn dies slidably mounted on the frame at opposite sides of and operating between the exterior dies, said horn dies converging toward the movable exterior die and having their outer sides curved lengthwise, connections between the head and the horn dies for moving the latter toward and away from each other in accordance with movement of the frame toward and away from said head, and means for moving said frame toward and away from the head and the movable exterior die toward and away from the fixed die, the horn dies being provided at their inner sides with upsetting elements.

9. In means for curving a length of tubing, in combination, an inner exterior die and an opposed outer exterior die, said dies having relative rectilineal movement toward and away from each other, oppositely inclined horn dies at opposite sides of and operating between the exterior dies, said horn dies having rectilineal movement toward and away from each other and converging toward the outer die, the horn dies having their outer sides curved lengthwise and being adapted for insertion into a length of tubing disposed between the exterior dies and through the ends of the tubing, and an interior die provided in its inner side with a recess conforming to the forming surface of the inner exterior die, said interior dies being disposed to form with the horn dies when the latter are fully projected into the tubing a die structure having its inner and outer sides curved to conform to the desired final curvature of the tubing.

10. In means for curving a length of tubing, in combination, a fixed inner exterior die, an opposed interior die having a forming surface aligned with the forming surface of the fixed die, the interior die being adapted for insertion into the length of tubing and having rectilineal movement toward and away from the fixed die, said interior die being provided at its outer side with two flat and outwardly converging surfaces, an outer exterior die having rectilineal movement toward and away from the fixed die, and two opposed and outwardly converging horn dies having rectilineal movement toward and away from each other and operating between the interior die and the outer exterior die, the horn dies also having movement toward and away from the fixed die, said horn dies having their outer sides curved lengthwise and their inner sides flat and seating upon the flat surfaces of the interior die when the horn dies are extended into the tubing.

11. In means for curving a length of tubing, in combination, an inner exterior die, an opposed interior die adapted to receive the length of tubing, opposed horn dies movable into the tubing from the ends thereof and forming with said interior die a die structure curved at its inner side and its outer side to conform to the desired final curvature of the inner side and the outer side of the tubing, and an outer exterior die cooperating with said inner die to shape the tubing about said die structure.

12. In means for curving a length of tubing, in combination, an inner exterior die, an opposed interior die adapted to receive the length of tubing, opposed horn dies having rectilineal movement into the tubing from the ends thereof and forming with said interior die a die structure curved at its inner side and its outer side to conform to the desired final curvature of the inner side and the outer side of the tubing, and an outer exterior die cooperating with said inner die to shape the tubing about said die structure, the two exterior dies having relative rectilineal movement toward and away from each other.

13. In means for curving a length of tubing, in combination, a fixed inner exterior die, an opposed interior die having rectilineal movement toward and away from the fixed die and adapted to receive the length of tubing, opposed horn dies having rectilineal movement into the tubing from the ends thereof and forming with said interior die a die structure curved at its inner side and its outer side to conform to the desired final curvature of the tubing, the horn dies having rectilineal movement with the interior die toward and away from the fixed die, and an outer exterior die having rectilineal movement toward and away from the fixed die, and cooperating therewith to shape the tubing to final curvature about said die structure.

14. The method of curving a length of tubing which comprises supporting the tubing at its ends and at one side thereof in a concave external die, and bending the wall at said side of said tubing toward the concaved wall of the die by applying pressure against the inner surface of said wall toward said die and progressively in direction from the ends toward the middle of said length of tubing.

15. The method of curving a length of tubing which comprises supporting the tubing at its ends and at one side thereof in a concave external die, bending the wall at said side of said tubing toward the concaved wall of the die by applying pressure against the inner surface of said wall toward said die and progressively in direction from the ends toward the middle of said length of tubing, and bending the wall at the opposite side of said tubing by engaging the same externally and transversely of the tubing, and applying pressure internally of the tubing against the end portion of said last-named wall in direction intersecting the direction of said external engagement.

16. The method of curving a length of tubing which comprises supporting the tubing at its ends and at one side thereof in a concave external die, bending the wall at said side of said tubing toward the concaved wall of the die by applying pressure against the inner surface of said wall toward said die and progressively in direction from the ends toward the middle of said length of tubing, and bending the wall at the opposite side of said tubing by engaging it with a convex external die moving toward said concave external die and simultaneously applying pressure internally of the tubing against said last named wall at the end thereof in direction toward the middle of said length of tubing.

17. The method of curving a straight length of tubing with oblique converging ends which comprises bending the wall at one side of said tubing against a longitudinally concave die of trough-shaped cross section by applying pressure internally of the tubing against said wall toward said die and progressively from each end toward the middle of said length of tubing.

18. The method of curving a straight length of tubing with oblique converging ends which comprises bending the wall at one side of said tub-

ing against a longitudinally concave die of trough-shaped cross section by applying pressure internally of the tubing against said wall toward said die and progressively from each end toward the middle of said length of tubing, and bending the wall at the opposite side of said tubing against a longitudinally convex die of trough-shaped cross section by applying pressure internally of the tubing against said last-named wall at each end thereof in direction toward said last-named die and toward the middle of said length of tubing.

19. In a machine for bending a length of tubing, a longitudinally concave external die and a complementary longitudinally convex die having relative movement toward and away from each other, a pair of horn dies mounted to converge toward each other and to enter between said external dies from opposite sides thereof, said horn dies having curved surfaces together corresponding to and cooperating with the curved surface of said first-named external die and surfaces cooperating with said last-named external die, and means for simultaneously moving said external dies toward each other and said horn dies toward each other.

20. The method of curving a length of tubing, which comprises subjecting the tubing to internal pressure applied adjacent both ends thereof and inclined inwardly of the tubing toward one side thereof, with the lines of pressure converging from both ends of the tubing toward said side thereof, thereby imparting to the tubing a preliminary bend toward the other side thereof, and shaping the tubing to final curvature by subjecting it to transverse pressure between forming surfaces.

21. The method of curving a length of tubing, which comprises subjecting the tubing to internal pressure applied adjacent both ends thereof and inclined inwardly of the tubing toward one side thereof, with the lines of pressure converging from both ends of the tubing toward said side thereof, progressively advancing the points of application of said internal pressure from the ends of the tubing toward the center thereof and thereby imparting to the tubing a preliminary bend extending substantially the full length and toward the other side thereof, and shaping the tubing to final curvature by subjecting it to transverse pressure between forming surfaces.

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