Jan. 22, 1952 S. P. WYRFEL 2,583,404

TUBE BENDING APPARATUS

Filed Aug. 3, 1948 2 SHEETS—SHEET 1

Fig. 1.

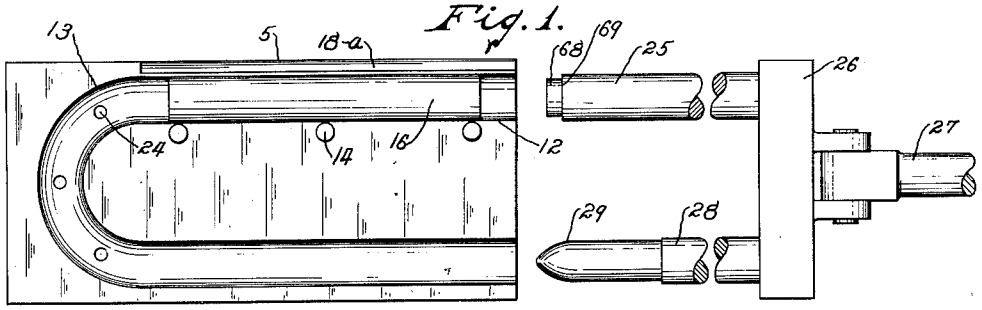


Fig. 2.

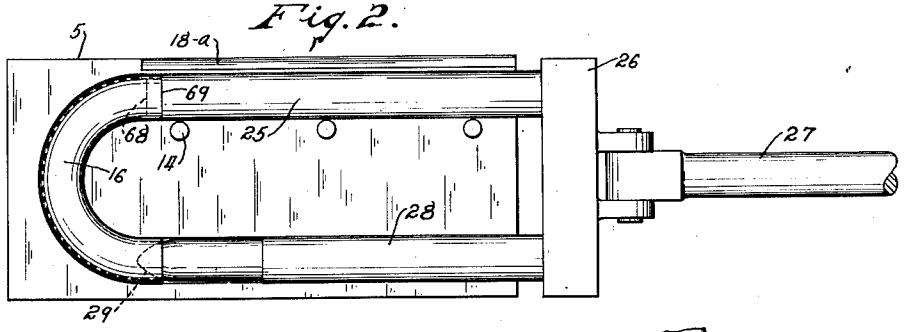


Fig. 3.

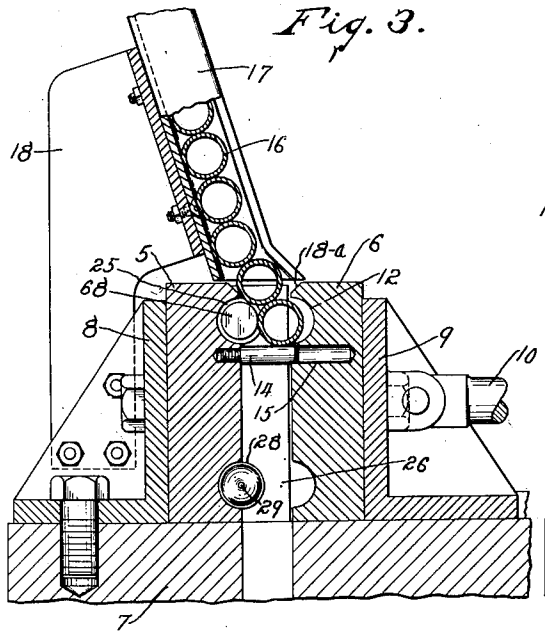
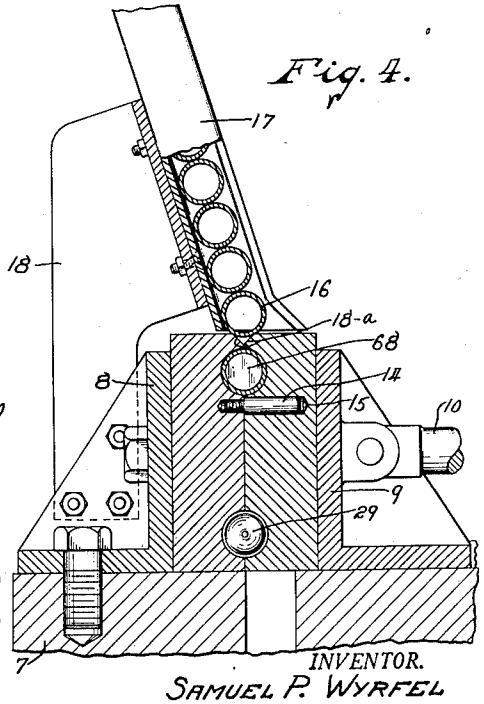


Fig. 4.



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TUBE BENDING APPARATUS

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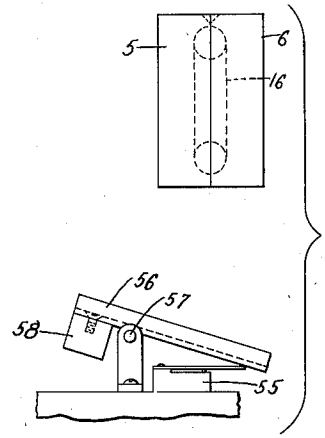


Fig. 5.

Fig. 6.

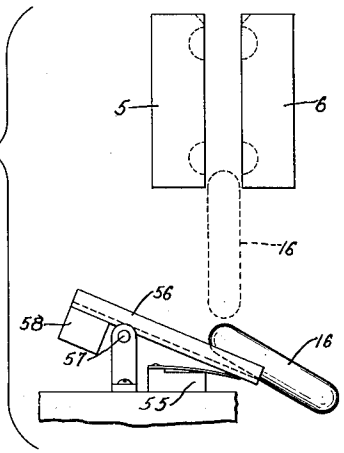
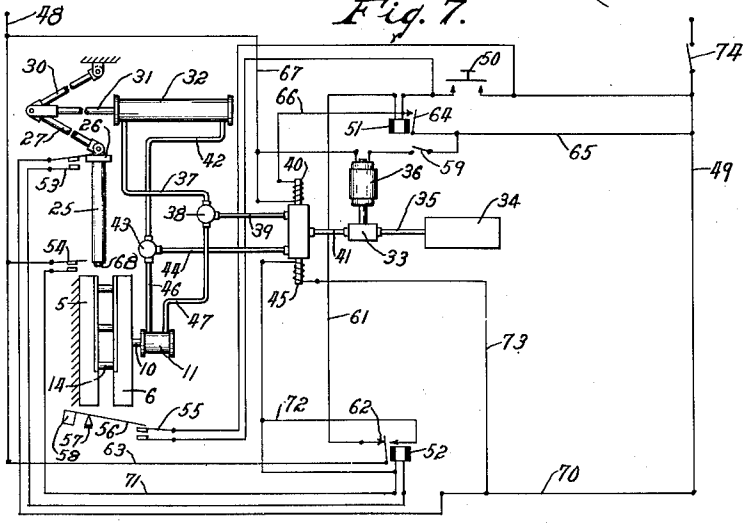


Fig. 7.



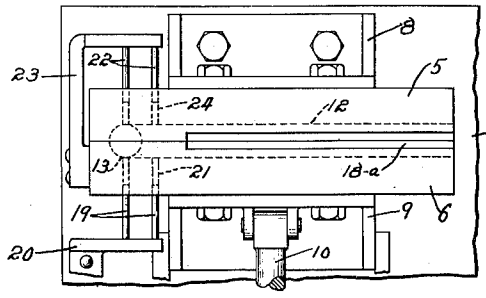


Fig. 8.

Fig. 9.

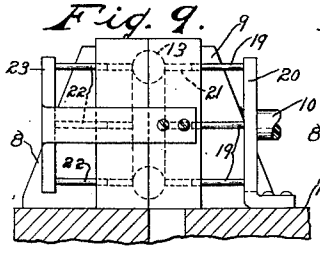
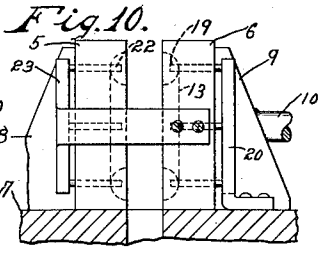


Fig. 10.



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UNITED STATES PATENT OFFICE

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TUBE BENDING APPARATUS

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Application August 3, 1948, Serial No. 42,253

12 Claims. (Cl. 153—32)

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This invention relates to a tube bending apparatus and more particularly to an apparatus for bending tubes into elbow shapes on a quantity production basis.

An object of this invention is to provide an apparatus which will rapidly bend tubes to a predetermined shape in a continuously operating apparatus into which the tubes are fed from a suitable magazine.

A further object of this invention is to provide a highly efficient and economical mechanism for accurately and uniformly bending tubes in large quantities.

Further objects and advantages of this invention will be more clearly understood from the following descriptions accompanying the drawings in which:

Fig. 1 is a front view showing one half of the tube bending die and the plunger embodying my invention.

Fig. 2 is a similar view illustrating the operation of said die and plunger.

Fig. 3 is an end view, in vertical section, showing a portion of the apparatus embodying my invention with the said die in open position.

Fig. 4 is a similar view but showing the die in closed position.

Fig. 5 is a diagrammatic view illustrating the operation of my improved means for controlling the operation of the apparatus.

Fig. 6 is a similar view illustrating the operation of the controlling means illustrated in Fig. 5.

Fig. 7 is a diagrammatic view of said apparatus and of the electrical circuit for controlling the same.

Fig. 8 is a plan view of the bending die and ejecting mechanism included in the said apparatus.

Fig. 9 is an end view thereof showing the die in closed position.

Fig. 10 is a similar view showing the die in open position.

It is commonly known by those skilled in the art that, in order to accurately bend tubes, it has heretofore been necessary to either fill the said tubes with a suitable material, so as to prevent the collapse of the tube during the bending thereof, or bend the tubes in matched rolls. Both of these processes have been found unsuitable for producing accurate, uniform and smooth bends economically on a quantity production basis.

My invention is therefore directed primarily to an apparatus in which a die is used for economically and efficiently, as well as accurately

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and uniformly, bending tubes in rapid succession by continuous operation of the apparatus or machine in which the said invention is embodied.

In the preferred embodiment illustrated, there is provided a suitable bending die consisting mainly of a stationary half 5 and a movable half 6. The stationary half is preferably supported on a table, or base, 7 by means of a backing member 8 which is secured to said table. The movable half 6 of said die is slidable on the table 7 and movable thereon by means of a backing plate 9 to which the said half is secured and which is operated by suitable means such as a rod or shaft 10 that is preferably moved by a piston contained within a pressure cylinder 11.

The said die is provided with matching recesses in the faces of the opposite members 5 and 6 to form a cavity therein having a tube receiving portion 12 and a tube bending portion 13 which is shaped in accordance with the bend that is desired in the tubes which are to be bent in said apparatus.

Between the said die halves 5 and 6, there is provided a plurality of supporting pins 14 which are mounted on one of said halves and extend into recesses 15 in the opposite half. The said pins receive the tube sections, indicated at 16, as they are inserted between the said halves, and support them in position to be received within the cavity when the said halves are closed to the position indicated in Fig. 4.

As shown in Figs. 3 and 4, there is preferably provided a magazine 17 which may be supported on a bracket 18, for containing a quantity of tube sections 16 and feeding them by gravity into the bending die, as clearly shown in the drawings. It will be noted that a portion of the upper edge of the face of each of the said die halves are chamfered, as illustrated at 18–a, so as to facilitate the entrance of the said tubes between the die halves and also to separate the tubes in the magazine from the tube die when the said die is closed as shown in Fig. 4.

In order to eject a tube after it has been formed into a bend between die halves, I provide a suitable number of stationary ejecting pins 19 which are mounted on a bracket 20, that is secured to the table 7, and project into openings 21 extending through the die half 6. I also provide a suitable number of ejector pins 22 which are carried on a bracket 23, that is secured to and travels with the movable die half 6, and project into openings 24 which extend through the stationary die half 5.

The tubes 16 are moved in the die cavity by means of a plunger 25 which is mounted on a head 26 that is operated by a suitable pitman or toggle member 27 which is included in a preferred toggle mechanism for operating said head as to be further described herein.

The head 26 also carries a shaping portion 28 having a point 29 thereon which is adapted to engage the leading end of the tube being bent for shaping the same against the inner walls of the die cavity during a tube bending operation.

In the form of apparatus illustrated in Fig. 7 of the drawings, the said head 26 is preferably operated by means of the toggle mechanism 30 which includes the member 27. This mechanism is operated by a plunger 31 having a piston thereon movable within a cylinder 32.

The cylinders 11 and 32 are connected to a suitable source of hydraulic pressure, which may consist of a conventional pump 33 that is connected to a liquid reservoir 34, through a pipe 35, and operated by means of an electric motor 36. One end of the cylinder 32 is connected to said pump through a pipe 37, a suitable sequence valve 38, a pipe 39, a suitable solenoid valve 40 and a pipe 41. The other end of said cylinder 32 is connected to said pump by means of a pipe 42, a suitable sequence valve 43, a pipe 44, an electric solenoid valve 45 and the pipe 41. The cylinder 11 is connected with said pump at one end through a pipe 46, the sequence valve 43, the pipe 44, the solenoid valve 45 and the pipe 41. The other end of the said cylinder 11 is connected with said pump through a pipe 47, the sequence valve 38, the pipe 39, the solenoid valve 40 and the pipe 41.

In order to control the operation of said hydraulic system, I provide an electric circuit between a pair of line conductors 48 and 49 which includes a manually operable switch 50, relays 51 and 52 for controlling the operation of the solenoids 40 and 45 respectively, and electric switches 53, 54 and 55 for controlling said circuit through the operation of the above described tube bending apparatus.

As illustrated in Figs. 5 and 6, the switch 55 is operated by means of a member 56 which is fulcrumed at 57 and balanced on said fulcrum by a counterweight 58. The said member 56 is located directly under the die members 5 and 6 so that, when the said die is operated to discharge a bent tube, as illustrated in Fig. 6, the said tube will drop upon the balanced member 56 and rock said member downwardly to cause the switch 55 to close the circuit and thereby initiate the operation of the apparatus for bending the succeeding tube blank which has already moved from the magazine 17 into position within the bending die.

The said switch 55 is provided merely for the purpose of preventing the operation of the bending apparatus in the event of a tube becoming jammed in the bending die or upon the supply of tube blanks becoming exhausted.

The operation of my improved tube bending apparatus above described is as follows:

The motor 36 is first started by closing the electric switch 59 to operate the pump 33 and thereby supply hydraulic pressure for the cylinders 11 and 32.

The tube blanks 16 are then placed within the magazine 17 and the lowermost tube will drop into position between the die halves 5 and 6, which are normally in open position, and rest upon the supporting pins 14 as shown in Fig. 3.

The operation of the apparatus may then be initiated by merely pressing the switch 50 into

closed position and then releasing it; whereupon the said switch will return to its normally open position. The said operation of momentarily closing the switch 50 will close an electric circuit through the conductor 61, the normally closed switch 62 of the relay 52, and the conductor 63, and energize the solenoid of the relay 51 to thereby close the normally open switch 64 thereof; whereupon the electric circuit will be closed through the conductor 65, the said switch 64, the conductor 66, the solenoid 40 and the conductor 67, and thereby energizing the solenoid of the valve 40 to open the said valve and cause hydraulic pressure to pass through the pipe 39, the sequence valve 38, and the pipe 47, into the cylinder 11. This will cause operation of the plunger 10 to move the die half 6 into the closed position illustrated in Fig. 4.

As the said die is closed, the increase of hydraulic pressure in the cylinder 11, caused by the resistance thereto from the closed die, which prevents further movement of the piston in said cylinder 11, will cause operation of the sequence valve 38 to transfer the application of the hydraulic pressure to the cylinder 32 through the pipe 37. This will cause the plunger 31 to be moved inwardly into said cylinder and thereby operate the toggle connection, including the members 27 and 30, to force the head 26 with the plunger 25 and 28 therein forwardly into the closed die; whereupon the reduced portion 68 on the plunger 25 will enter the end of the tube blank that is positioned within the die and the shoulder 69 on said plunger will engage the end of said tube blank and cause the blank to be forced forwardly within the bending cavity portion 13 and thereby cause movement of the said blank into the position clearly illustrated in Fig. 2 and bending of said tube blank into a semicircular shape which conforms with the shape of the cavity 13. The said tube blanks may be bent to any other shapes desired for which the cavity has been previously formed.

As the plunger 26 begins to move towards the bending die, for the operation above described, it will allow the normally open switch 53 to close and complete the connection between the conductor 49 and the solenoid of the relay 52, through the conductor 70.

As the forward, or tube bending, movement of the head 26 and the plunger 25 thereon is completed, the normally open switch 54 will be closed. This will cause closing of the circuit through the conductor 71 and thereby energizing the solenoid of the relay 52 which will then move the switch 62 into position to break the circuit to the solenoid of the relay 51, and thereby de-energize said solenoid 51 and cause opening of the switch 64 and de-energization of the solenoid of the valve 40 for closing said valve. The said operation of the switch 62, by the energization of the solenoid of the relay 52, will cause the switch 62 to move towards the opposite position wherein it will close the circuit through the said switch, the conductor 72, the solenoid of the valve 45 and the conductors 73 and 70, and thereby energize the said solenoid of the valve 45 and cause operation of said valve to its open position.

Hydraulic pressure will then flow through said valve 45 and the pipe 44 to the sequence valve 43, from which it will first flow through the pipe 42 into the cylinder 32 and cause the plunger 31 to be forced outwardly from said cylinder and thereby operate the members 27 and 30 to withdraw the plunger 25 from the bending die.

As the said plunger nears its rearmost position, the increase in pressure within the cylinder 32, which is caused by the resistance to the movement of the plunger 31, through the toggle mechanism, as the plunger 25 nears its rearmost position, will cause operation of the sequence valve 43. This will transfer the hydraulic pressure through the pipe 46 into the cylinder 11 and thereby operating the plunger 10 to move the die half 6 to the open position.

As the head 26 reaches its rearmost position, relatively to the bending die, it will operate the switch 53 to open position and thereby cause de-energization of the solenoid of the relay 52. This will cause movement of the switch 62 to its normal position whereby it will break the circuit through the solenoid of the valve 45 and thus cause the said valve to close and complete the cycle of operation of the apparatus.

The succeeding cycles of operation of the said apparatus are initiated by the momentary closing of either the manually operable switch 50, or by the switch 55 which is operated by the balanced member 56 as each completed bent tube is discharged from the bending die upon the opening thereof, as shown in Fig. 6.

It will be understood that, as long as tube blanks are delivered to the die from the magazine 17 the optration of the bending apparatus will be continuous since the discharge of each bent tube will initiate the bending operation for the succeeding tube. When the supply of blanks from the magazine 17 has been exhausted and the switch 55 is not closed, the apparatus will automatically come to a stop and may be restarted only by momentarily closing the manually operable switch 50. When it is desired to otherwise stop the operation of the apparatus, it may be rendered entirely inoperative by opening a manually operable switch 74 which will break the entire circuit.

It will also be understood that the chamfered portions 18 of the die halves 5 and 6 will operate as an escapement mechanism for the tube blanks in the magazine 17 by engaging the blank following the lowermost blank which is positioned upon the supports 14 and raising the said following blank, as shown in Fig. 4, as the die halves come to a closed position and the lowermost blank is moved into bending position.

I claim:

1. An apparatus of the character described for bending an elongated blank including a bending die comprising a pair of opposed halves having a bending cavity therebetween, each of said die halves having therein one half of said cavity, means for moving at least one of the said halves for opening and closing said die to permit the insertion of elongated blank members into the said cavity and the ejection of said members from said cavity after they have been bent therein, means for moving said members is said cavity for a bending operation, and means including supporting pins carried by one of said die halves and extending across the space between said die halves, when open, to support the said blank members substantially in alignment with the die cavity so as to permit the said members to be received in said cavity upon the closing of the die.

2. A bending apparatus of the character described comprising a bending die which includes a pair of opposed halves each having therein one half of a bending cavity provided in said die, means for moving at least one of said halves to open said die to receive an elongated blank in said

cavity, means for closing said die, means for moving said blank in said cavity for a bending operation, and a plurality of ejector pins carried by said movable die half and extending through the opposite half and into the cavity portion therein for ejecting a bent blank therefrom as the movable half of the die is moved to open position.

3. A bending apparatus of the character described comprising a bending die including a pair of opposed die halves each having therein one half of a bending cavity, means for moving at least one of said halves to open said die to permit the insertion of an elongated blank into said cavity, means for closing said die, a plunger for moving said blank in said cavity for a bending operation, and a plurality of stationary ejector pins extending into said movable die half and adapted to project into the half of the cavity therein when the said die half is moved to open position and thereby eject the bent blank therefrom.

4. A bending apparatus of the character described including a bending die comprising a pair of opposed halves having a bending cavity therebetween, means for opening said die to permit the insertion of an elongated blank into said cavity, means for moving said blank in said cavity for a bending operation, means for opening said die to eject a bent blank therefrom, and means including a magazine positioned above said die and operable by the opening of the die to feed a blank between the said halves and in position to be received within said cavity upon the closing of the die.

5. A bending apparatus including a bending die as set forth in claim 4, wherein the blanks in said magazine are supported by the die while in closed position during a bending operation on the blank in the bending cavity.

6. A tube bending apparatus of the character described including a bending die comprising a pair of opposed halves having a cavity therebetween, at least one of the said halves being movable for opening said die to receive an elongated members in said cavity and eject said member from the cavity after it has been bent therein and for closing said die, a plunger movable relatively to said die after it has closed for moving the member in the cavity for a bending operation, hydraulic pressure means operable for opening and closing said die and moving said plunger, and a toggle connection for operating said plunger; said pressure means including a cylinder having a piston therein operable for moving said die to open and closed positions, a separate cylinder having a piston therein for operating said toggle connection to move said plunger, a system of valves for controlling said pressure means to progressively cause closing of the die, movement of the plunger into said bending cavity, withdrawal of said plunger from said cavity and opening of the die.

7. A bending apparatus as set forth in claim 6 wherein the said pressure means is controlled by an electric circuit including a manually operable switch for momentarily closing said circuit, a first solenoid valve for causing closing of the die and movement of the plunger into the cavity, a first relay for energizing said solenoid valve upon the closing of the manually operable switch, a second solenoid valve for causing withdrawal of the plunger and opening of the die, a second relay operable upon the movement of the plunger into the die cavity to de-energize the first relay and energize the second solenoid valve

and, upon the withdrawal of the plunger from the die cavity, to de-energize the second solenoid valve and cause energization of the first relay.

8. A bending apparatus of the character described including a bending die comprising a pair of opposed halves having a cavity therebetween, means for opening said die to receive an elongated member in said cavity and eject said member from the cavity after it has been bent therein and for closing said die, a plunger movable in said cavity for moving the said member for a bending operation and hydraulic pressure means operable for opening and closing said die and moving said plunger; said pressure means being controlled by an electric circuit including a plurality of solenoid valves for controlling the opening and closing of said die, a normally open manually operable switch for closing said circuit to cause energization of said solenoid valves for causing a cycle of operation of said apparatus, and means including a normally open switch operable upon the ejection of a bent member from said die to close said circuit indepently of the said manually operable switch.

9. A bending apparatus as set forth in claim 8 where the said circuit closing means includes a pivoted member disposed under said die in position to receive and be moved by the bent member, as it is discharged from the die upon the opening thereof, and an electric switch operable by said pivoted member for closing the circuit independently of the manually operable switch.

10. A bending apparatus of the character described comprising a die which includes a pair of opposed halves with a bending cavity therebetween, means for opening said die to permit the insertion of an elongated blank into said cavity, means for moving said blank within said cavity for a bending operation when the die is in closed position, means for opening the die, and ejector means including a plurality of ejector pins in fixed position relatively to one of the said die halves and extending into the opposite die half

for ejecting the bent blank from the cavity upon the opening of the die.

11. A bending apparatus comprising a die which includes a pair of opposed halves having a bending cavity therebetween, each of said die halves having therein one-half of said cavity, means for moving at least one of the said halves for opening and closing said die to permit the insertion of a blank into the said cavity and the ejection of said blank from the said cavity after a bending operation, means including a magazine positioned over the die for feeding the blank into said cavity, and a plurality of supporting pins carried by one of said die halves and extending across the space between the said die halves, when open, to receive a blank from the magazine and support it substantially in alignment with the die cavity so as to permit the said blank to be received in said cavity upon the closing of the die.

12. A tube bending apparatus comprising a die including a pair of opposed halves having a bending cavity therebetween, means for moving at least one of said halves relatively to the other for opening and closing the said die, means including a magazine positioned over said die for delivering a blank between the die halves when open, and means between said die halves for stopping the said blanks in properly aligned position with the die-cavity forming portions of the die halves so that the blanks are enclosed within the die cavity upon closing of the die and means for moving said blank in the cavity for a bending operation.

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