(No Model.) 5 Sheets—Sheet 1.

C. P. HIGGINS.

MACHINE FOR FORMING POLYGONAL TUBES.

No. 606,213. Patented June 28, 1898.

Fig. 1

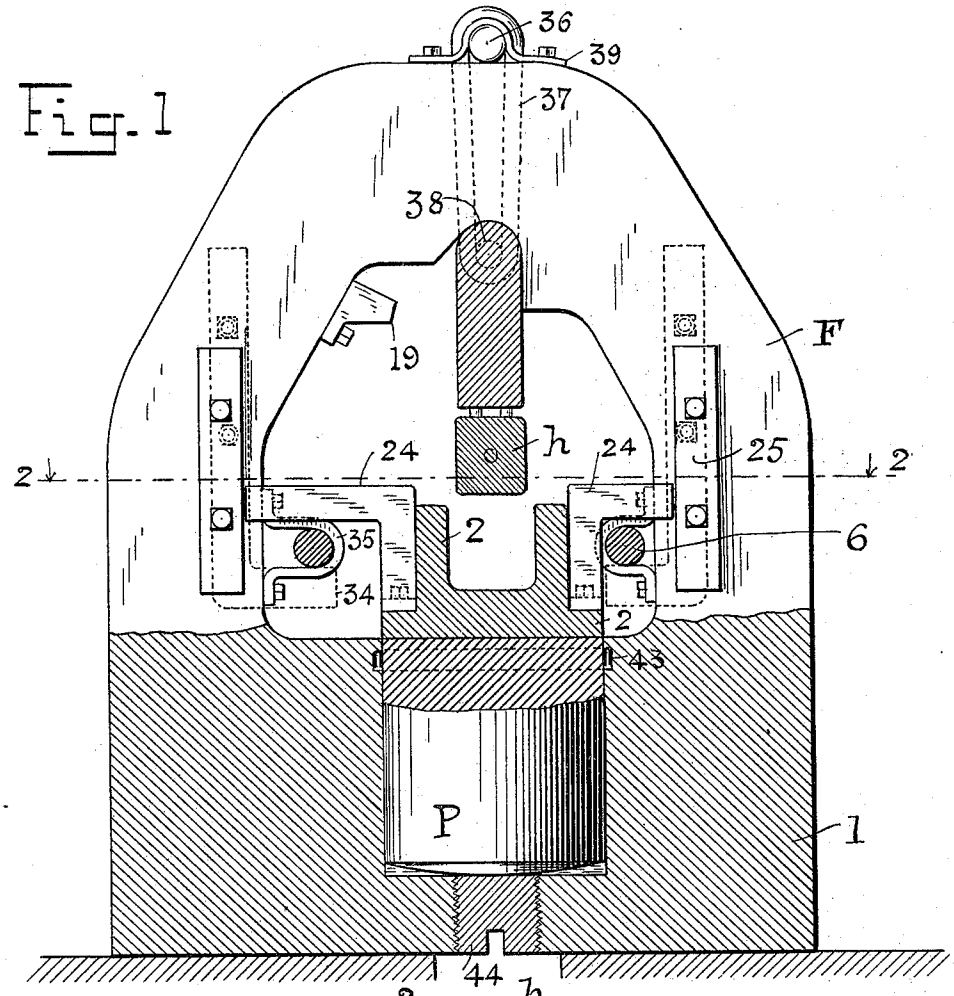
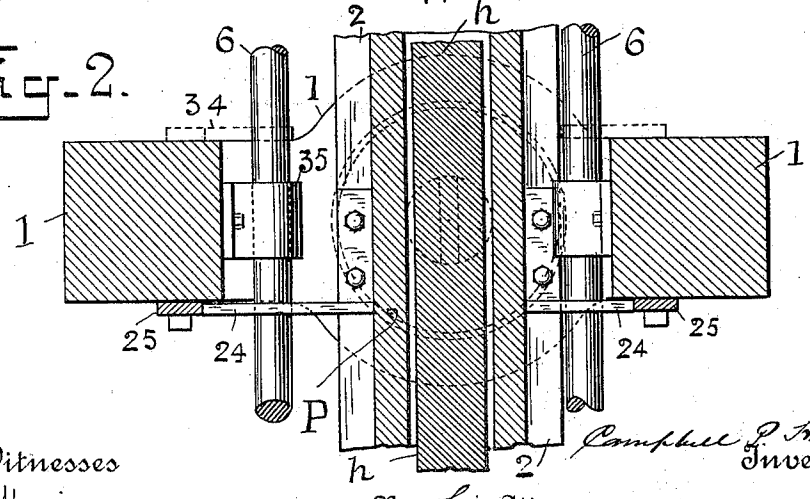


Fig. 2.



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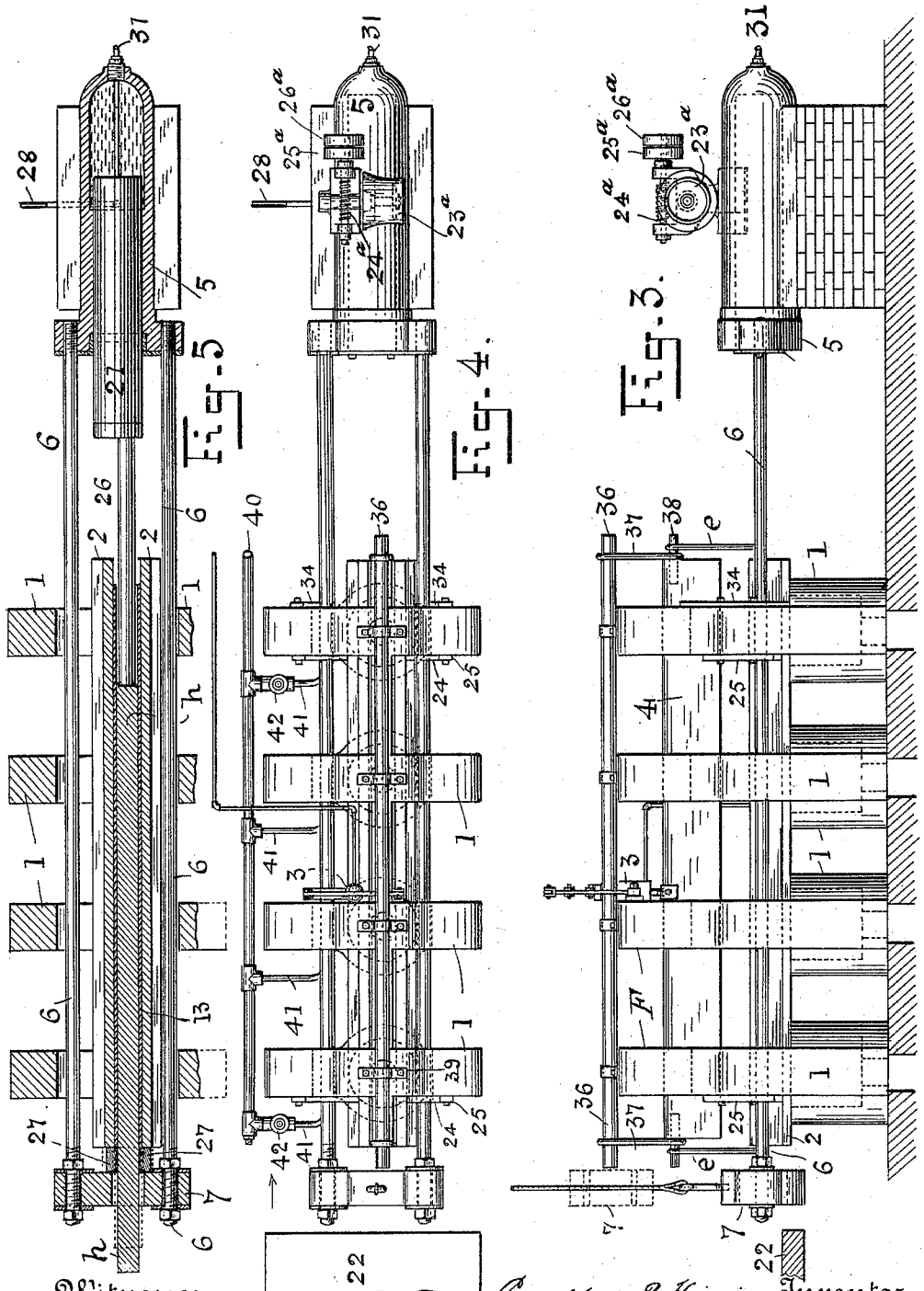


Fig. 5.

Fig. 4.

Fig. 3.

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MACHINE FOR FORMING POLYGONAL TUBES.

No. 606,213. Patented June 28, 1898.

Fig. 6.

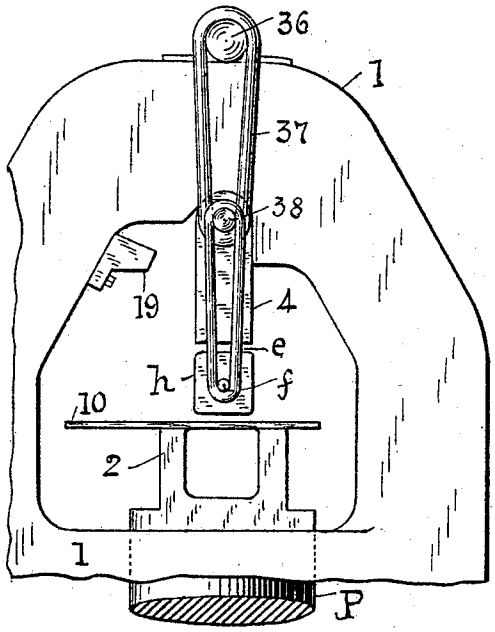


Fig. 7.

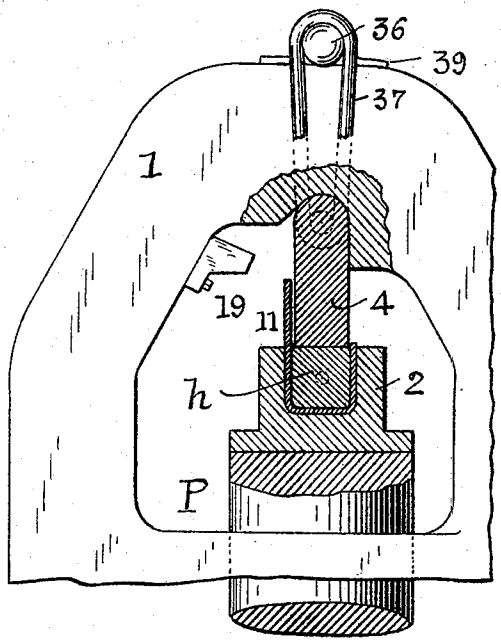


Fig. 8.

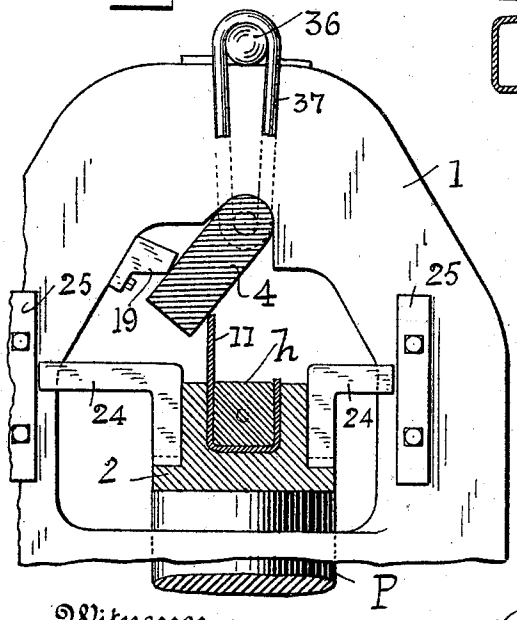


Fig. 10.

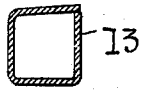


Fig. 9

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MACHINE FOR FORMING POLYGONAL TUBES.

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Fig. 11

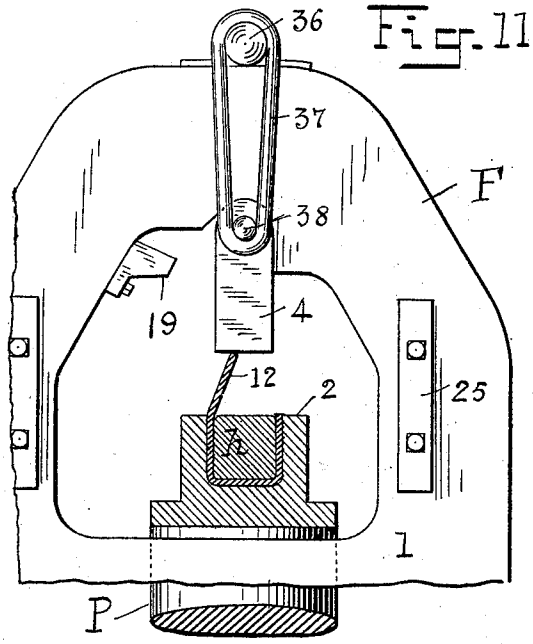
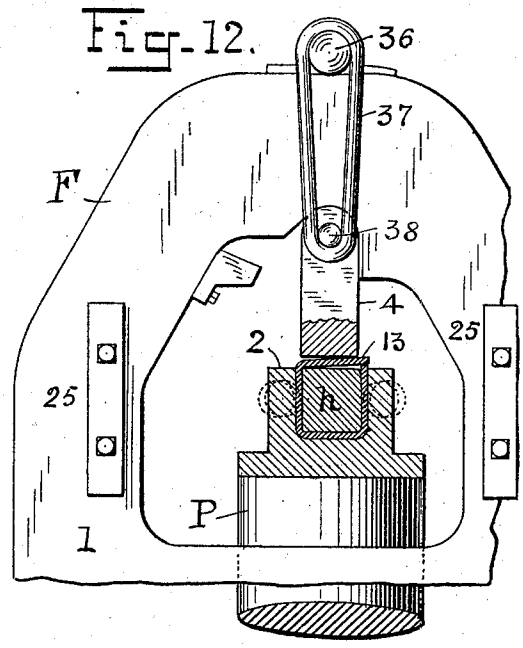


Fig. 12.



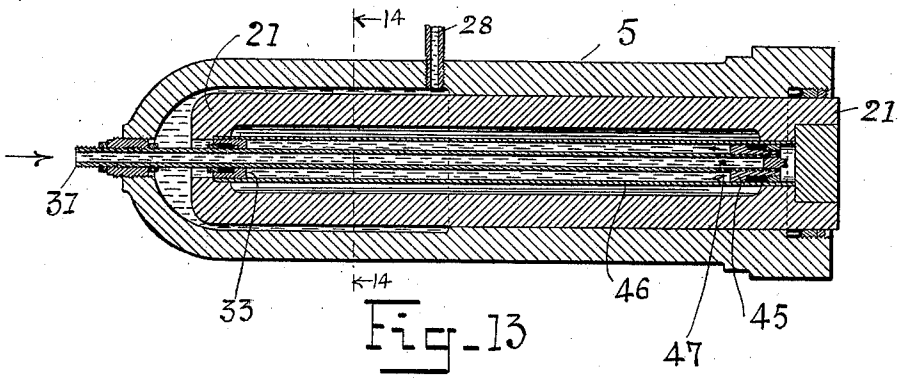


Fig. 13

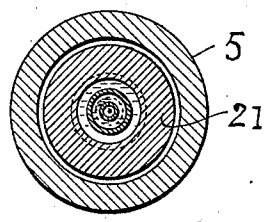


Fig. 14

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MACHINE FOR FORMING POLYGONAL TUBES.

No. 606,213. Patented June 28, 1898.

Fig. 16.

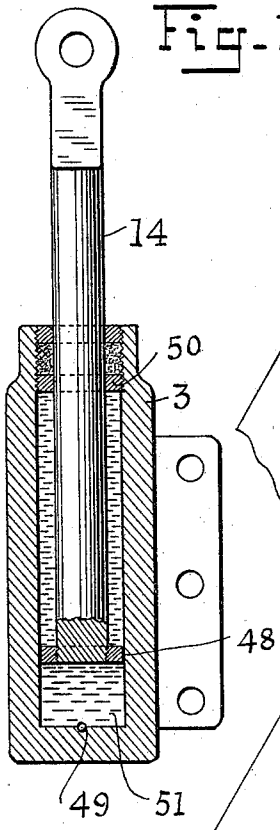


Fig. 15.

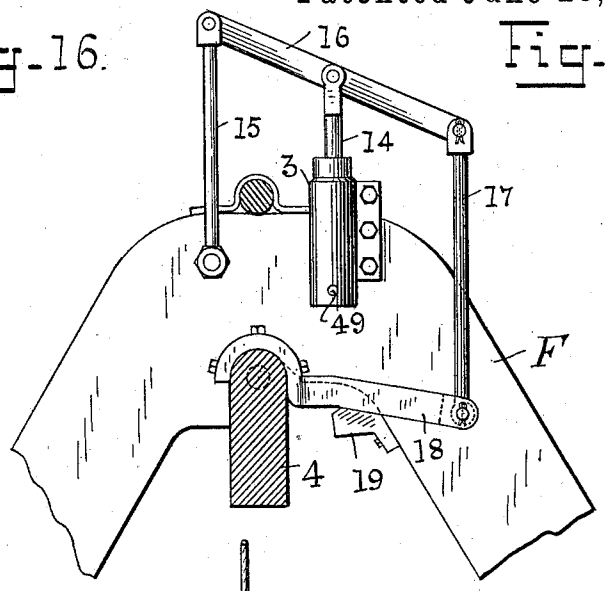
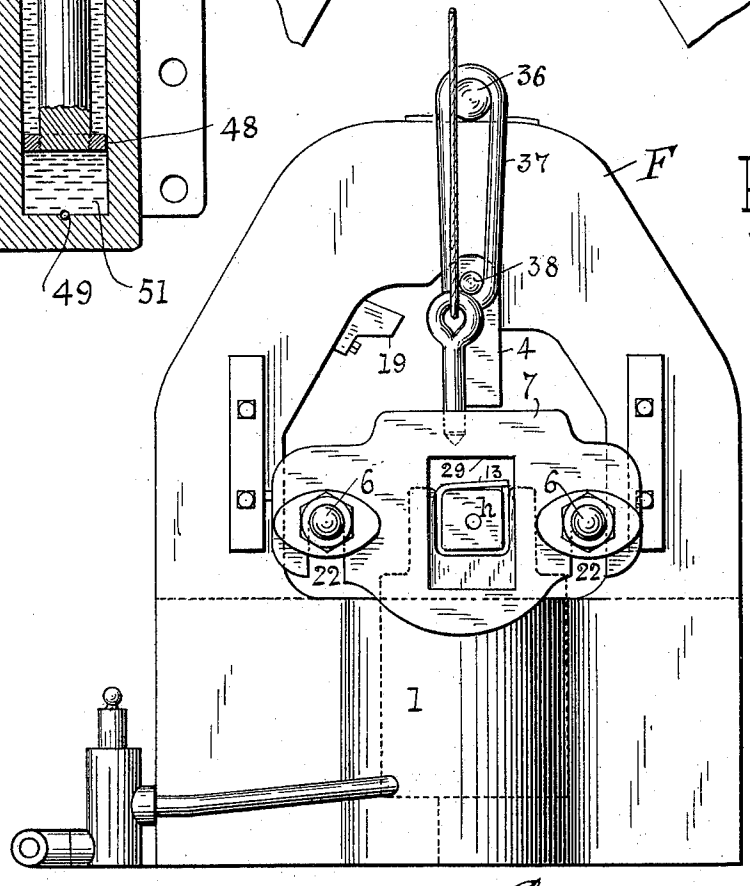


Fig. 17.



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UNITED STATES PATENT OFFICE.

CAMPBELL P. HIGGINS, OF ROSELLE, NEW JERSEY.

MACHINE FOR FORMING POLYGONAL TUBES.

SPECIFICATION forming part of Letters Patent No. 606,213, dated June 28, 1898.

Application filed March 13, 1897. Serial No. 627,398. (No model.)

To all whom it may concern:

Be it known that I, CAMPBELL P. HIGGINS, a citizen of the United States, residing at Roselle, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Machines for Forming Polygonal Tubes, of which the following is a specification, taken in connection with the accompanying drawings, in which—

Figure 1 is an end view, partly in section, of a bending-press embodying the invention; Fig. 2, a section of Fig. 1 on the line 2 2; Fig. 3, a side elevation of the press; Fig. 4, a top view of the same; Fig. 5, a horizontal longitudinal section showing the means for removing the mandrel. Figs. 6, 7, 8, 9, 11, and 12 are views, partly in section, showing the successive steps in the operation of the press; Fig. 10, a cross-section of the tube bent to shape; Fig. 13, a horizontal section of a hydraulic power-cylinder; Fig. 14, a cross-section of the same on the line 14 14 of Fig. 13; Fig. 15, a view illustrating in detail a hydraulic attachment for operating the bending device; Fig. 16, a section of the hydraulic cylinder 3, and Fig. 17 a front view of the press with the formed tube ready for removal.

The invention is designed for use in the manufacture of wrought-metal headers for sectional steam-generators, but is adapted to form polygonal tubes for other purposes, and in order that others may understand and use the same I will first proceed to describe the machine shown and embodying it and subsequently to point out in the claims its novel characteristics.

In the machine illustrated a series of vertical hydraulic cylinders 1 are arranged in line, as shown in Fig. 3, each having a piston or plunger P acting upon a die 2, conformed to the desired shape or size of the tube to be made. These cylinders 1 and the die 2 are mounted within heavy arched framework F, which also supports the other devices employed in the bending operations, consisting, essentially, of a mandrel *h*, bending-arm 4, and the auxiliary hydraulic cylinder and connections by which the bending-arm 4 is operated. In Figs. 3, 4, 5, 13, and 14 another hydraulic cylinder 5 is shown located at a convenient distance from and in line with the die 2, which is used to force the mandrel *h* out of the tube when formed and also to force the tube from the die 2.

A windlass 23^a, with worm-gear 24^a and tight and loose pulleys 25^a 26^a, is mounted upon this apparatus and used to draw the plate or blank 10, from which the tube is formed, from a table 22 to its position upon the die 2 by means of a chain or other suitable connection. (Not shown.) Also in connection with this hydraulic cylinder 5 are two parallel tie-rods 6, rigidly secured at one end to the head of the cylinder 5 and at their opposite ends to a cross-head 7, which bears through intervening devices upon the end of the die 2 and resists the force of the plunger 21 when applied to the tube in the operation of pushing the same from the die 2. This cross-head 7 is capable of being raised or lowered and is slotted from its lower edge, as shown in Fig. 17, so that it may be released from connection with the tie-rods 6 when raised, the object in raising the same being to make room for introducing the plate 10 onto the die 2.

In Fig. 17 a means for raising the cross-head 7 is shown, consisting of an eyebolt and rope or equivalent, which may connect to the windlass 23^a or to any other convenient means. The bending mechanism used in conjunction with the die 2 consists in the mandrel *h* and bending-arm 4, which is operated by means of the auxiliary hydraulic cylinder 3 and its connections. (Shown in Figs. 3 and 4 and more clearly in Fig. 15.)

The bending-arm 4 is suspended from its journals 38 by links 37 to a shaft 36, resting upon the top of the framework F, and its swinging movement effected by the arm 18, rods 17, 16, and 15, connected with the auxiliary hydraulic cylinder 3, a stop 19 being secured to the inside of the framework to limit its swinging movement.

Another feature in the supporting structure consists in the angular braces 24, which are secured to the die 2 and bear against and slide in guideways or plate 25, bolted to the main framework, (see Figs. 1 and 2,) the object of these braces being to prevent a shifting of the die laterally during the operation of bending the plate.

The means for removing the mandrel and tube after the bending operations are completed consist in alternately interposing bars 26, Fig. 5, of different lengths between the mandrel or tube and the plunger 21 of the hydraulic cylinder 5, blocks 27 being also placed at the opposite end of the die 2, be-

tween the same and the head 7, to hold the die in place during the operation of removing the mandrel or tube.

The object in using the bars 26 of different or increasing length and removing the mandrel or tube step by step is to conform to the short stroke of the plunger 21.

Having referred to the construction of the essential operative parts of the machine, I will now describe its operation and the method of manipulating the hydraulic apparatus, which will include a description of the details of the latter.

As shown in Fig. 3, the cross-head 7 is raised to the dotted position to allow the plate or blank 10 to be hauled from the adjacent table 22 upon the die 2 by means of a chain connected with the windlass 23. The blank or plate 10 is then in position to be acted upon, as shown in Fig. 6. The hydraulic plungers P, carrying the die 2 and plate 10, are forced upward against the mandrel *h* and depending arm 4 to the position shown in Fig. 7, thereby forcing the mandrel and plate into the die 2 and bending the plate to the form shown. The links *e* and pins *f*, by which the mandrel was suspended, are now removed to allow the mandrel to accompany the die in retracting the latter. The plungers P, carrying the die, mandrel, and partially-formed tube, are then lowered to allow the arm 4 to be swung laterally against the stop 19, this being effected by means of the auxiliary hydraulic apparatus shown in Fig. 15. The plungers P and die 2 are again raised to bring all the parts to the relative position shown in Fig. 8, the projecting side of the partially-formed tube being brought in contact with the inclined face of the arm 4, and by a continued upward movement of the die the plate is bent to the position shown in Fig. 9. The plungers P are now lowered and the swinging arm 4 brought back to a vertical position, as shown in Fig. 11. The following upward movement then completes the bending of the plate and the forming of the tube, as shown in Fig. 12. The die is then lowered and the cross-head 7 returned to its place in connection with the tie-rods 6, as shown in Fig. 17, which brings its central opening 29 in line with the tube and mandrel and through which each is removed. The bars 26 (see Fig. 5) and blocks 27 are now used to force the mandrel from the tube and the tube from the die out and through the opening 29 in the cross-head 7, a bar about equal in length to the stroke of the plunger 21 being first used and others of similar length subsequently placed behind in succession until step by step the mandrel or tube is forced out.

The cross-sectional form of the bars 26 or blocks 27 should conform to bear upon the end surface of the mandrel or of the tube in the act of removing either.

The hydraulic cylinder 5 (shown in detail in Figs. 13 and 14) to accomplish the operation of removing the mandrel and tube is not claimed herein, but will form the subject-matter of a separate application. In the construction of this cylinder shown in Figs. 13 and 14 a constant pressure from the pipe 31, acting through the opening 47 and space 33 under the annular piston 45, moves the plunger 21 into the cylinder. The connection 28 is then brought under its inlet-pressure and the plunger 21 performs its work in the outward movement.

The water connections for operating the plungers P of the hydraulic cylinder 1 are of the usual kind and are shown in Figs. 4 and 17, 40 representing the main supply and discharge pipe, 41 the branches, and 42 stop-valves attached to the outer branch pipes, whereby in making tubes of shorter lengths the outer cylinders of the series may be cut out or closed and the intermediate ones only employed.

What I claim, and desire to secure by Letters Patent, is—

1. A power-machine for forming tubes from plates or sheets comprising a movable die, a swinging bending-arm, a mandrel suspended between the die and arm, whereby the arm is adapted to serve as an abutment for the mandrel.

2. In a machine for forming tubes from plates or sheets embracing a die and mandrel, a power device for forcing the mandrel out of the tube consisting of a cross-head connected respectively with the framework of the machine and with the power device to hold the tube in place and a rod interposed between the power device and mandrel to force the latter out of the tube, substantially as described.

3. In a machine for forming tubes from plates or sheets, the combination with the die and tube of a power device having a removable connecting-rod arranged to bear upon the end of the mandrel or the tube and force the same from the die, substantially as described.

4. In a polygonal-tube-forming machine, the combination of a movable die, a suspended mandrel and an arm adapted to serve as a relative fixed abutment therefor.

5. In a polygonal-tube-forming machine and combination of a movable die, a mandrel and a movable arm adapted with one face to act as an abutment for the mandrel and with another to bend the metal being formed.

6. In a polygonal-tube-forming machine the combination of a movable die, a mandrel and a movable arm adapted with its one face to both abut the mandrel and bend the metal being formed thereon, and also in another position to bend the metal with another face.

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