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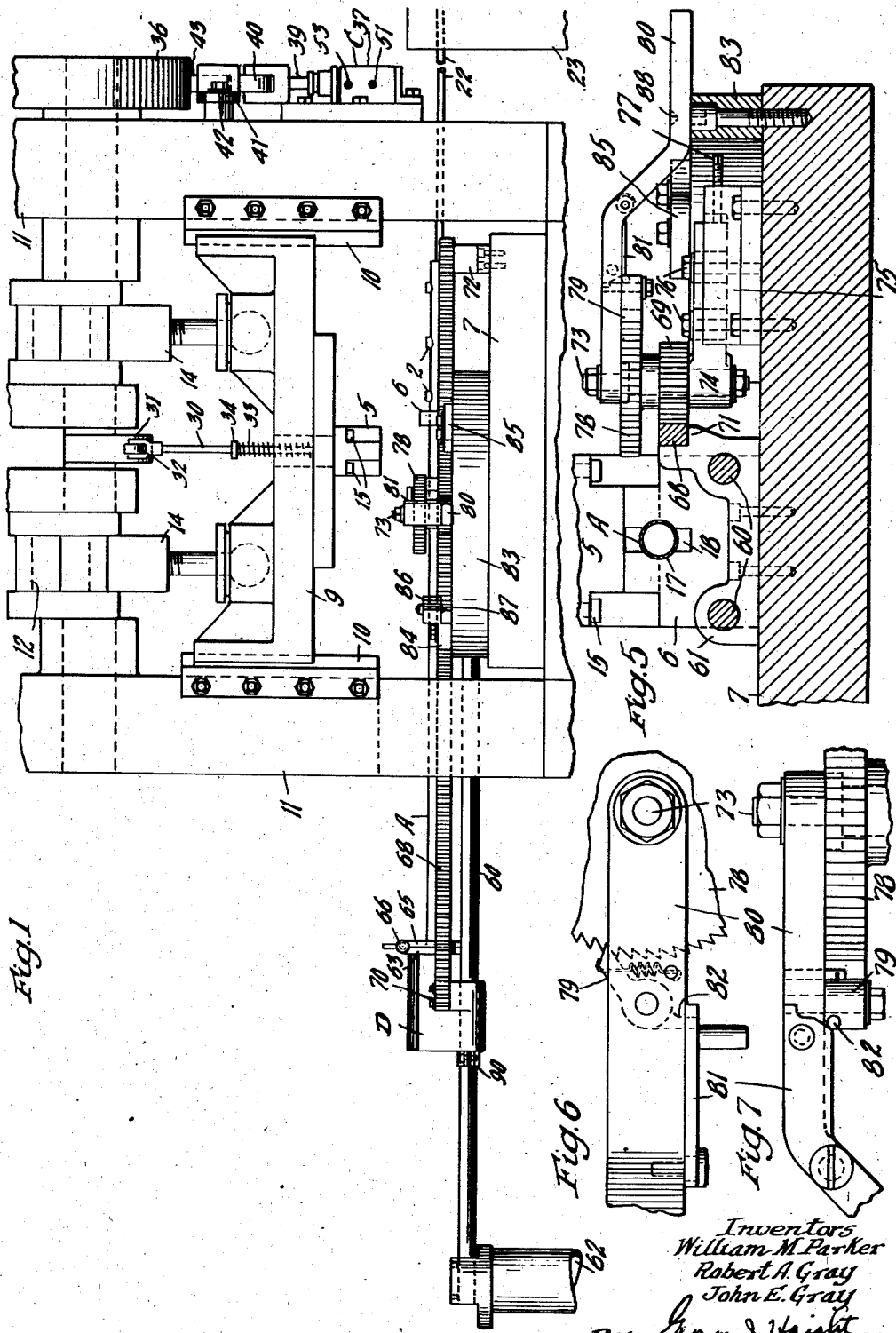
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2,280,255

APPARATUS FOR MAKING HEADERS

Filed Aug. 12, 1940

5 Sheets-Sheet 1



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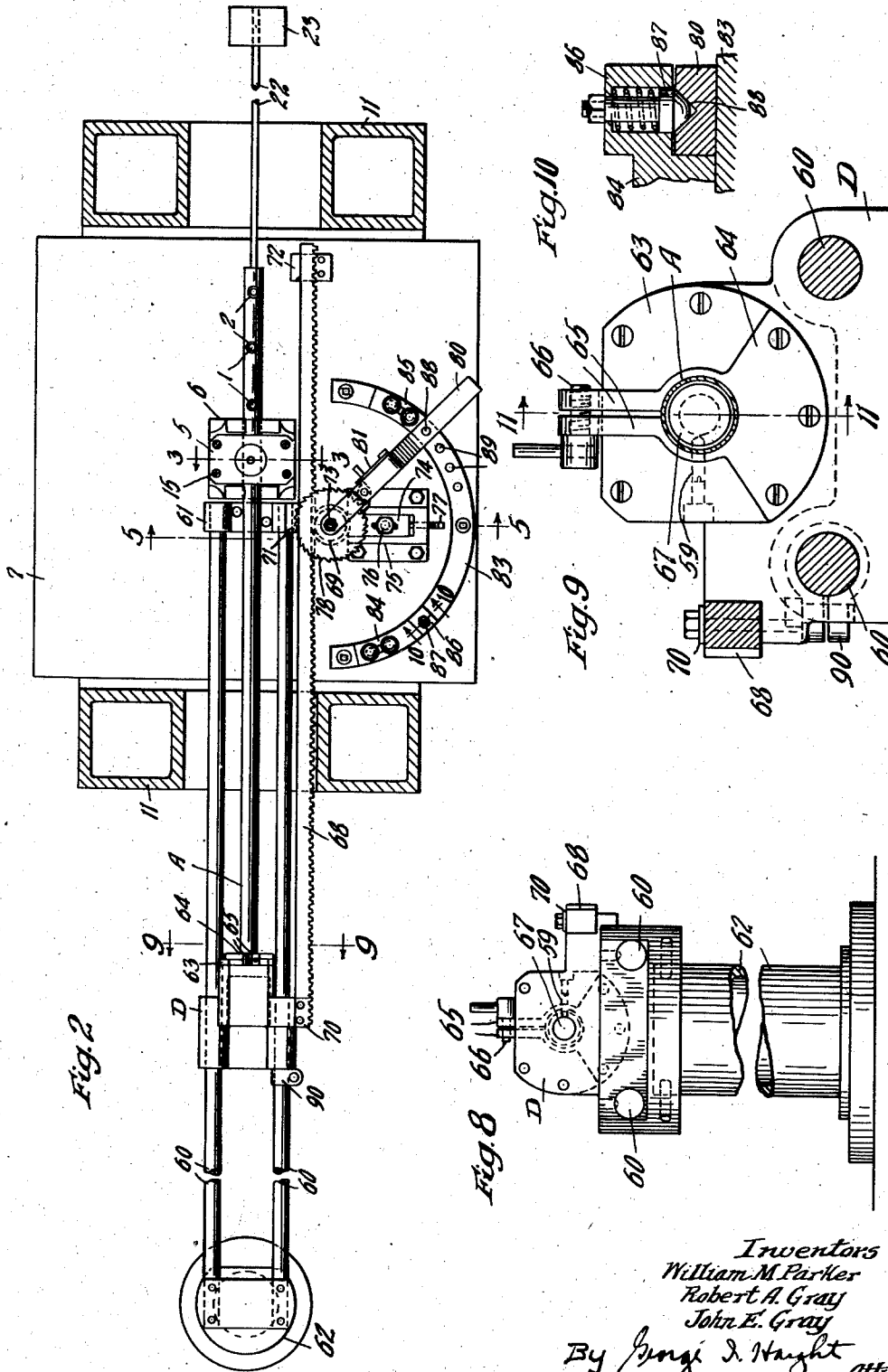
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Fig. 4

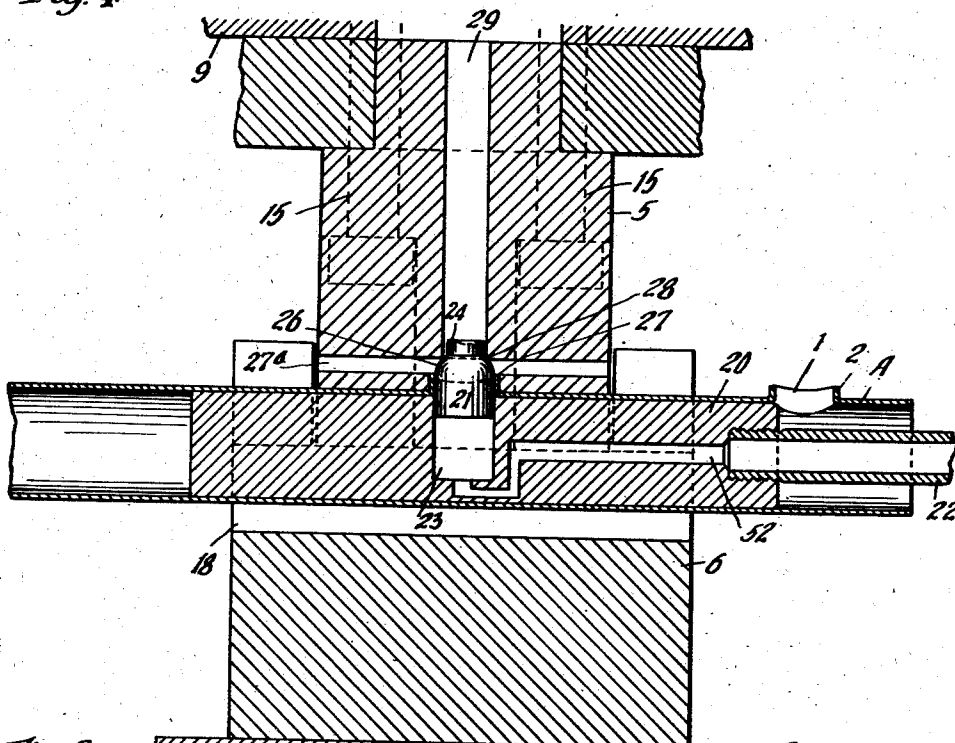


Fig. 3

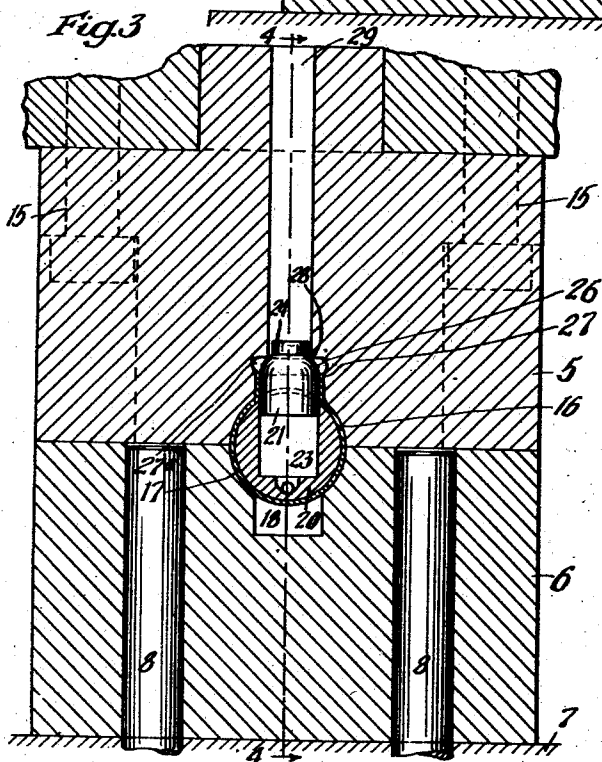
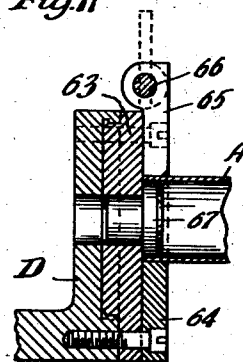


Fig. 11



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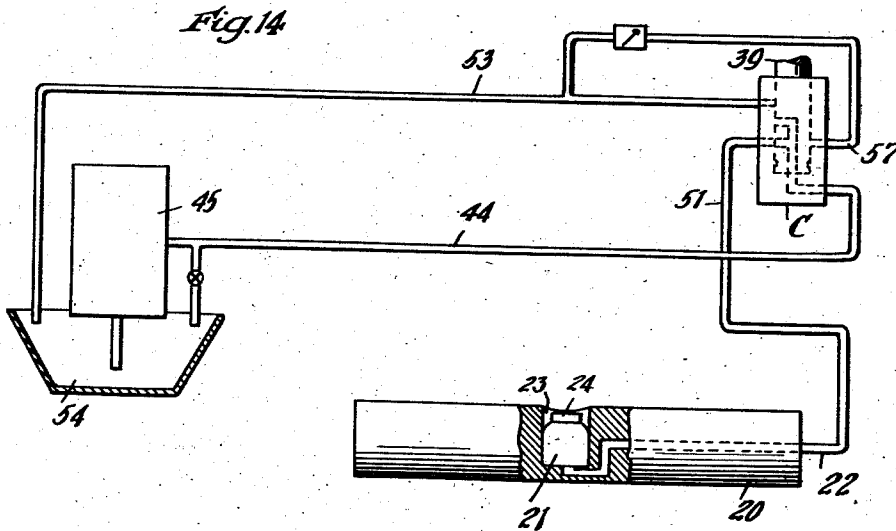
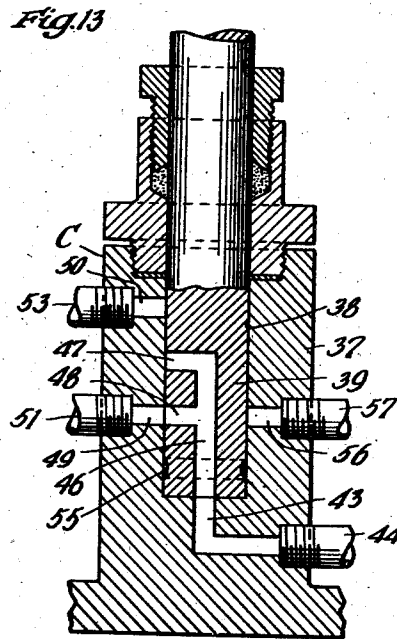
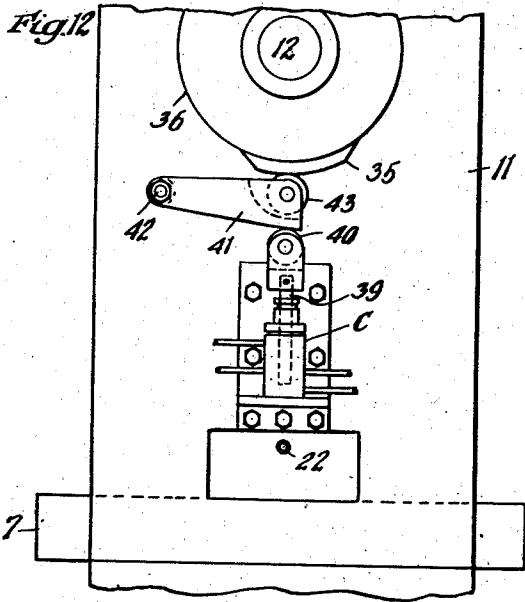
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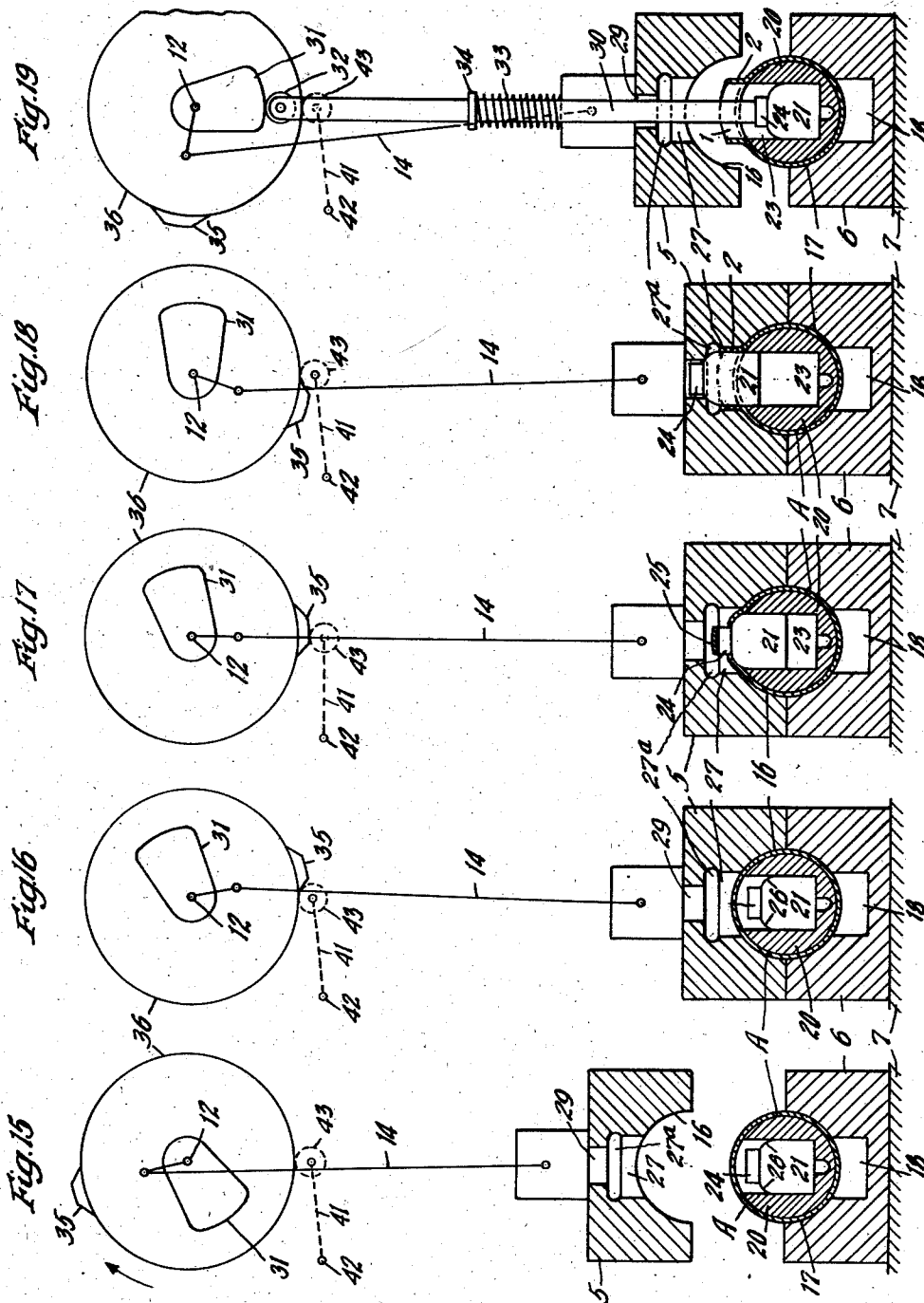
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UNITED STATES PATENT OFFICE

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APPARATUS FOR MAKING HEADERS

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5 Claims. (Cl. 153—2)

Our invention relates to improvements in apparatus for making wrought metal headers.

One of the objects of our invention is the rapid, accurate and economical formation of flanged openings in a wrought metal tubular member.

Another object is the formation of flanged openings in the wall of standard wrought metal tubing or pipe without pre-treatment of the tubing other than that involved in the formation of the tubing itself.

Another object is the provision of mechanism by which a series of flanged openings can be formed in long lengths of tubing which can afterwards be cut to suitable lengths for header purposes.

Another object is the formation of different sized flanged openings in different parts of the wall of the wrought tubular member.

These and other objects are accomplished by the improvements herein disclosed and set forth in the appended claims.

The accompanying drawings illustrate one embodiment of the means and method of carrying out our invention.

Referring to the drawings,

Fig. 1 is a view in front elevation of a forming mechanism and tube feeding mechanism embodying our invention;

Fig. 2 is a plan view of the tube feeding mechanism shown in Fig. 1;

Fig. 3 is an enlarged detail vertical section of the tube clamping and flange forming mechanism substantially on the line 3—3 of Fig. 2;

Fig. 4 is an enlarged detail section on the line 4—4 of Fig. 3;

Fig. 5 is an enlarged detail view, partly in section, on the line 5—5 of Fig. 2;

Fig. 6 is a detail plan of the ratchet of the tube feeding mechanism;

Fig. 7 is a detail elevation of the mechanism of Fig. 6;

Fig. 8 is an end elevation of the tube feeding mechanism at the left side of Fig. 2;

Fig. 9 is an enlarged transverse section on line 9—9 of Fig. 2;

Fig. 10 is a detail section on line 10—10 of Fig. 2;

Fig. 11 is a detail section on line 11—11 of Fig. 9;

Fig. 12 is an end elevation at the right side of Fig. 1 of the fluid control valve;

Fig. 13 is an enlarged detail section of the valve shown in Fig. 12;

Fig. 14 is a diagrammatic view of fluid pres-

sure system for operating the flanged opening forming mechanism; and

Figs. 15 to 19, inclusive, are diagrammatic views illustrating the operations of the forming mechanism and controls through the cycle involving the clamping of the tubular member, the formation of the flanged opening, and the release of the mechanism.

Our invention is intended more particularly to form outwardly flanged openings at intervals in long lengths of wrought metal, preferably copper, tubing from which shorter lengths are cut to form headers. A length of such wrought tubing is shown at A in Fig. 2 having several flanged openings 1 formed in the wall thereof. The flanged openings are very accurate since they are intended to receive the ends of inserted tubing or pipe so that a soldered joint can be made, and the flanges thus form sockets for the tube ends with capillary spacing between the flange walls and the tube walls for the solder. The flanged openings are shown most clearly in Figs. 3, 4, and 19. The flanges 2 are integral with and extend outwardly from the wall of the tubing A, are cylindrical, and their axes are at right angles to the longitudinal axis of the tubing A.

The machine is arranged to handle any length and size of tubing desired. The tubing may be first cut to the desired lengths for header purposes and then flanged, but it is more economical and rapid to flange long lengths of tubing and then cut it into header lengths.

The tubing A is gripped between upper and lower clamping members 5 and 6, and held thereby while the flanged openings are formed therein. The lower clamp 6 is stationary and held in position in the base or bed 7 of the machine by pins 8, so that it may be changed to provide for different sized tubing. The upper clamp 5 is movable vertically toward and from the lower clamp, so that the tube may be inserted, shifted and removed. This clamp is carried by a head member 9 which is guided vertically by gibs 10 mounted on the upright members 11 of the frame, and is operated by a crankshaft 12 also mounted in said frame uprights. The crankshaft is connected with the head by means of connecting rods 14, so that vertical reciprocation is imparted to the upper clamp. Any suitable power means and control therefor may be used to drive the crankshaft so that at each revolution of the crankshaft the clamp will be given a cycle of movement during which the flanging operation takes place. The upper

clamp 5 is removably secured to the head by means of bolts 15, which permits the use of different sized clamps for different size tubing.

Both clamping members 5 and 6 have semi-cylindrical channels 16 and 17 conformed to the diameter of the tubing and adapted, when the clamps are together, to firmly grip a portion of the length of the tubing and hold it against distortion or movement while the flanged opening is being formed. The lower clamp in addition has a groove 18 merging with and depressed below the clamping channel 17. In the event that a series of flanged openings are to be formed on opposite sides of the tubing, the series may be formed along one side and the tubing rotated 180° and the second series formed. The groove 18 permits the first formed flanges to clear when the tubing is shifted longitudinally during the formation of the second series.

Within the channels 16 and 17 of the clamping members is a cylindrical mandrel 20 which carries a piercing and flanging die 21. This mandrel is held against longitudinal movement by a long tubular member 22, to one end of which it is attached (Fig. 4). The other end of the tubular member 22 is held in a post or other suitable support 23 (Fig. 2), which is spaced far enough away from the flange forming mechanism to accommodate the full length of tubing A. This tubular member 22 also serves as a connection for carrying fluid under pressure to the mandrel and flange forming device. The mandrel fits the tubing A sufficiently close to prevent distortion of the tubing by the clamping pressure of the clamps 5 and 6 and by the flange forming operation, but sufficiently loose to permit the tubing A to be shifted longitudinally when the clamping pressure is released.

The piercing and flanging die 21 is cylindrical in form and operates in a cylindrical recess 23 in the mandrel in much the same manner as a piston within a cylinder. It is of such length that when in a lowered position in the cylindrical recess 23 it is entirely within the confines of the diameter of the mandrel, but when fluid under pressure is admitted to the cylinder 23 the die 21 is forced radially upward through the wall of the tube to pierce the tube and form the flange 2. The upper end portion 24 is smaller in diameter and formed as a piercing die for piercing a hole in the wall of the tubing by removing therefrom a small disc or slug of metal 25, Figs. 3 and 4. The shoulder 26 formed by the reduced diameter of the piercing die is tapered or rounded so that after the piercing die has formed the hole in the wall of the tubing, the continued movement of the member 21 causes this shoulder to engage and begin a drawing operation upon the marginal metal surrounding the opening. This drawing operation continues until the marginal metal is forced outwardly into the cylindrical flange 2. The inside diameter of the flange is accurately determined by the cylindrical portion of the member 21.

The piercing and forming die 21 enters a cylindrical recess 27 in the upper clamping member 6 which is sufficiently larger in diameter than the member 21, to accommodate the metal of the flange 2 and which forms the female die which determines the outer diameter of the flange. The bottom of this recess 27 is formed by a shoulder 28 which acts as a stop for the piercing and flanging die 21 to prevent its being forced outwardly farther than necessary to complete the drawing operation. A bore or opening 29 of less

diameter extends from the shoulder 28 upwardly through the upper clamping member 5 and head 9, and in this bore is provided a push rod 30 (Figs. 1 and 19) which engages the end of the piercing and forming die 21 and pushes it downwardly into its normal position within the cylinder 23 as the upper clamping member 5 recedes or separates from the lower clamp after the flange formation is complete. The push rod 30 is given a downward stroke by a cam 31 on the crankshaft 12. It carries on its upper end a roller 32 which rides on the cam. The rod is given an upward or restoring stroke by a spring 33 positioned between the head 9 and a collar 34 on the rod. The operation of the rod is timed with relation to the clamp so that as the upper clamp 5 is retracted upwardly the rod starts downwardly and pushes the forming and piercing die 21 downwardly into its cylinder 23 in the mandrel. The restoration of the die 21 occurs after the fluid pressure in cylinder 23 has been released by the control valve C.

During each operation the disc or slug 25 pierced from the tubing may be removed in any suitable manner such as by means of a stream of compressed air directed against the slug to blow the slug out of the mechanism. For this purpose a slot 27^a is provided in the clamp which intersects the cylindrical recess 27 so that as the slug is carried upward by the member 21, the stream of air through the slot carries the slug out through the slot.

The control valve C (Figs. 12 and 13) is mounted at one side of the machine on the frame uprights 11 in position to be operated by a cam 35 carried by the flywheel 36 on the crankshaft 12. The valve comprises a casing 37 having a cylinder 38 in which a piston 39 is reciprocated by the cam 35, and the piston has a roller 40 on its upper end which bears on the end of an arm 41 pivoted at 42 on the machine frame. The arm in turn carries a roller 43 adapted to be engaged by the cam 35. Thus when the cam 35 engages the roller during its rotation by the flywheel, the valve piston 39 is moved downwardly to its lower position in cylinder 38. The piston is moved to its upper position by fluid pressure when the cam 35 has moved from engagement with roller 40.

Fig. 14 shows the hydraulic system of connections by which pressure is applied to the flange forming die 21.

As shown in Figs. 13 and 14, the valve casing has a passage 43 which communicates with the lower end of the cylinder chamber and is connected by a pipe 44 with a suitable source of fluid under pressure, such as a pump 45. The valve piston has a passage 46 having two ports 47 and 48. The port 48 registers with a port 49 in the casing when the piston is in its lower position, and the port 47 registers with the port 50 when the piston is in its upper position. The port 49 is connected by the pipe 51 to the long pipe 22 to which the mandrel 20 is connected, as hereinbefore described. The mandrel has (Fig. 4) a passage 52 which leads to the lower end of the forming die cylinder 23 to carry fluid pressure to said cylinder. Thus when the valve piston is in its lower position, fluid under pressure is applied directly to the die cylinder 23 to actuate said die member for piercing the tubing and forming the flange therein, as hereinbefore explained. The port 50 of the valve is connected by a pipe 53 which leads to a suitable reservoir 54. Thus when the piston is in its upper posi-

tion, the port 49 is closed and the fluid under pressure will circulate through the valve and pipe 53 back to the reservoir 54.

In order to relieve the pressure upon the forming die 23, the piston has an annular groove or channel 55 which connects the port 49 with another port 56 when the piston is in its upper position, this port 56 being connected by a pipe 57 to the return pipe 53. This forms a by-pass which not only relieves the pressure on the pipe 51, but also permits whatever fluid is displaced in the cylinder by the downward movement of the forming die 21 to flow into the return pipe 53 and thence to the reservoir.

The diagrammatic views (Figs. 15 to 19) are intended to illustrate the cycle of operation in the formation of the flanged opening in the tubing A, and in this particular embodiment of our invention this cycle of operation is intended to occur during one revolution of the crankshaft, this being a convenient way to operate the machine so that it can be stopped each time after each revolution of the crankshaft to permit the tubing to be shifted to a new position.

Referring to Figs. 15 and 19, the crankshaft, fly-wheel and connecting rods for operating the clamp 5, and the cams for operating the ejector or push rod 30, and the control valve are illustrated diagrammatically to show their timed relation. The direction of rotation of the crankshaft is indicated by an arrow.

In Fig. 15, the clamp 5 is shown in raised position, the tubing A is in position in the lower clamp and enclosing the mandrel 20, and the forming die 21 in its lower or normal position. The crankshaft is started and the clamping member 5 is brought down in clamping relation to the tubing A, as shown in Fig. 16. The cam 35 is about to engage the roller 43 and force the valve piston to its lower position which admits of pressure to the cylinder 23 which forces the forming die 21 upwardly to pierce the tubing and form the flange. The position of the parts is illustrated in Figs. 17 and 18. During this portion of the rotation of the crankshaft, the cam 35 has actuated the valve and allowed the valve piston to move upwardly and relieve the pressure upon the forming die 21, as shown in Fig. 18. In Fig. 19, the crankshaft is shown as having carried the clamp 5 upwardly and the cam 31 as operating the push rod downwardly to restore the forming die 21 to its normal position within the mandrel. When the parts reach the position shown in Fig. 15, the cam 31 will have ridden off the push rod which will be restored to its upper position by the spring 33. The crankshaft is then stopped, the tubing A is shifted lengthwise to a new position, and the cycle is repeated.

We have illustrated the formation of a single flanged opening by a single piercing and forming die, but it is obvious that several flanged openings may be simultaneously formed by multiplying the number of piercing and forming dies. It is likewise obvious that the piercing and flange forming operations may be made by separate dies simultaneously operated; that is, one of the die members 21 may be simply a piercing die to pierce the hole in the tubing and the other die 21 employed as a flange forming die. In this manner a flange can be formed and a hole can be simultaneously pierced in the tubing in advance of the formation of the flange. At each shift of the tubing the flange will be formed around the hole previously pierced in advance.

The tube feeding mechanism (Figs. 1 to 10) includes a carriage D which is mounted to slide lengthwise on supporting guide rods 60. The guide rods 60 are secured at their inner ends in blocks 61 mounted on the bed 7 of the machine adjacent the tube clamps, and at their outer ends are secured to a post or standard 62. The carriage D has a clamp for gripping the outer end of the tube length A so as to impart movement to the tube and prevent the rotation of the tube to insure the alignment of the series of flanged openings. This clamp consists of the head plate 63 upon which is removably mounted a clamping member 64. This clamping member consists of a segmental plate having a central opening for the tubing formed between two parallel arms 65 which extend upwardly and which are adapted to be drawn together by a screw 66 to grip the tubing. This clamping member is made removable so that different sized clamps may be used for different sized tubing. A removable plug 67 (Fig. 11), fitting within the end of the tubing is provided to prevent the distortion of the tube by the clamping of the end thereof. This plug is held in place by a set screw 59 (Fig. 9).

The carriage D is moved along the guides 60 to feed the tubing by a rack 68 and pinion 69. The rack is secured at one end 70 to the carriage D and is guided and supported by a shoulder 71 on the block 61 to which the guide rods are secured. Farther to the right the rack is also supported and guided by a guide member 72 mounted on the base 7 of the machine. The pinion 69 is rotatable on a stud 73 on an adjustable support consisting of the two members 74 and 75 which are clamped together by screws 76. An adjustment screw 77 permits the pinion to be adjusted with respect to the rack or to be disconnected entirely from the rack in the event that the feed mechanism is not to be used. A ratchet wheel 78 is connected with the hub of the pinion 69 and is adapted to be engaged by a pawl 79 carried on a hand-operated lever 80 for rotating the pinion in the direction to feed the tubing A. A latch 81 on the lever engages a tailpiece 82 on the pawl for holding the pawl out of engagement with the ratchet wheel. The pawl is latched out of engagement with the ratchet wheel after the completion of the flange forming operations throughout the length of the tube, so that the carriage and the tubing can be manually retracted for its full length and removed from the machine.

The hand lever 80 is pivoted on the stud 73 and swings over a quadrant 83 which carries limit stop blocks 84, 85. The stop 84 is fixed in place and has an overhanging portion 86 having a spring-pressed button 87 which engages a depression 88 in the lever for holding the lever in position against the stop. The other stop 85 is adjustable on the quadrant, holes 89 being provided for this purpose, to vary the arc of movement of the lever. This provides a means by which the tubing A can be advanced a definite distance each time to accurately space the flanged openings, and the adjustable block 85 enables the spacing to be changed as desired.

On one of the guide rods 60 is a slidable stop 90 which can be adjusted along the guide to act as a gauge for determining the location of the first flanged opening formed for each length of tubing.

It is obvious that other forms of mechanism than that shown in the drawings, within the

scope and spirit of the invention, may be employed for carrying out the invention, and it is to be understood that the mechanism shown and described is intended as illustrative and not as limitation within the scope of the appended claims.

We claim:

1. In a mechanism for forming an outwardly flanged opening in the wall of tubing, the combination of clamping mechanism for the tubing including separable jaws adapted to embrace the tubing, means for separating said jaws to release the tubing, a mandrel within the tubing between the jaws, and a hydraulically actuated die member within said mandrel arranged to be forced radially outwardly to perforate the tubing wall and form a flange of the metal surrounding the perforated opening; means for supplying fluid under pressure to actuate said die; and means operable upon the separation of said jaws for restoring the die member.

2. In a mechanism for forming an outwardly flanged opening in the wall of tubing, the combination of separable clamping jaws adapted to embrace the tubing, a mandrel positioned between the jaws and within and substantially fitting the tubing to retain the form of the tubing, a cylindrical, radially movable die member, said mandrel having a cylindrical recess for said die member, and means for supplying fluid under pressure to said recess to force the die member outwardly through the wall of the tubing, said die member being formed to pierce an opening in the tube wall and flange outwardly the metal surrounding the opening during the outward movement of the die member; and an exterior plunger acting through the flanged opening for moving the die member radially inwardly to restore it to its normal position in the cylindrical recess.

3. In a mechanism for forming an outwardly flanged opening in the wall of tubing, the combination of a pair of clamping jaws arranged to embrace the tubing and a mandrel positioned between the dies and within the tubing; flange forming die mechanism for forming an opening in the wall of the tubing and a flange of the metal surrounding the opening, said mechanism including a cylindrical female die portion in one

of said jaws and a radially movable male die member in said mandrel adapted to pierce the tubing wall and enter said recess to draw the metal surrounding the wall outwardly to form a cylindrical flange; a source of fluid under pressure connected with said mandrel for actuating said movable die; and means operable upon the separation of said jaws for pushing the die member radially inwardly to a position within the confines of the mandrel.

4. The combination of a tube clamping mechanism, a cylindrical mandrel within and substantially fitting the tubing to retain the form thereof and having a cylindrical recess therein connected with a source of hydraulic pressure, a piston in said recess normally within the confines of said mandrel and responsive to fluid pressure and having a perforating die portion and a cylindrical flange forming portion; means controlling said pressure to force the perforating die and flange forming portion outwardly through the wall of the tubing; and a plunger positioned exteriorly of the tubing and acting through the opening formed by the die to push said piston inwardly to normal position within said recess.

5. In a mechanism for forming a series of flanged openings along the wall of a long length of metal tubing, the combination of separable clamping jaws, a mandrel positioned between the clamping jaws and substantially fitting within the tubing to retain the form of said tubing and having a hydraulically actuated die member for forming an outwardly flanged opening in the wall of the tubing, a pipe connected to said mandrel for holding said mandrel in position and forming a connection for hydraulic pressure to said flange forming mechanism, said pipe being itself supported sufficiently distant from the mandrel to accommodate the full length of the tubing, a carriage to which the tubing is secured at one end for shifting the tubing lengthwise on said mandrel after each flanged opening is formed to space the flanged openings in alignment along the tubing, and means for actuating said carriage.

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