May 24, 1932. D. L. SUMMEY 1,859,753

METAL EXTRUDING APPARATUS

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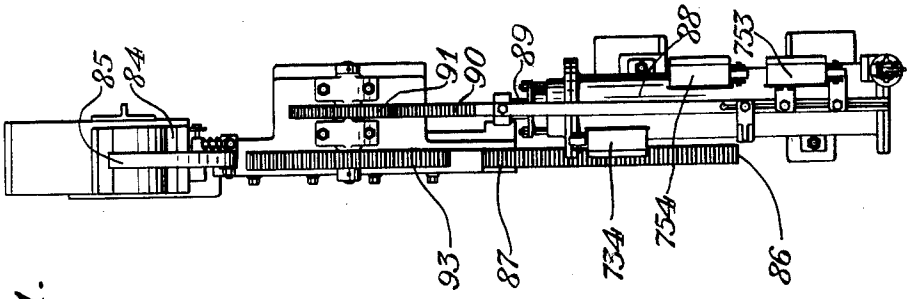


Fig. 1.

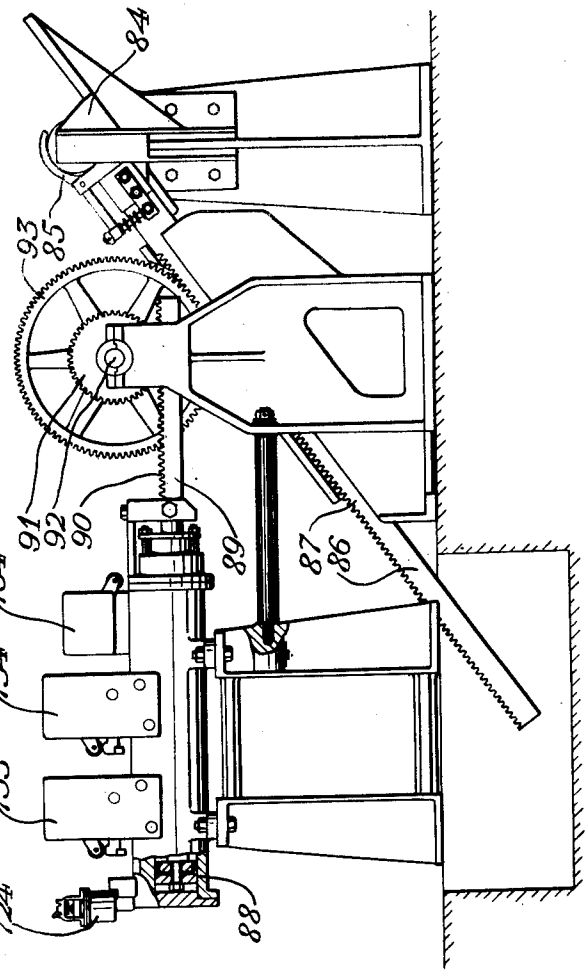


Fig. 2.

INVENTOR
David L. Summey
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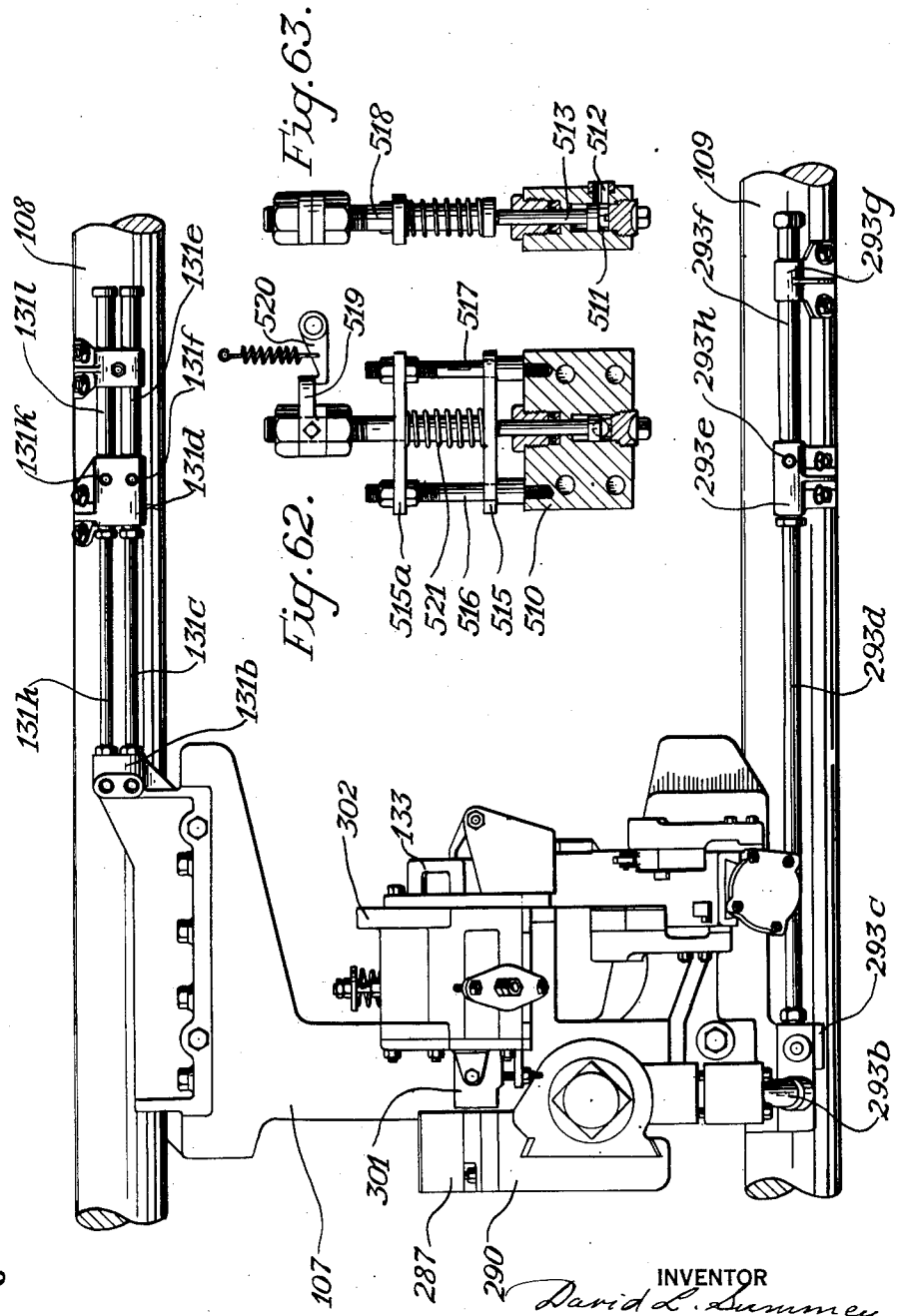


Fig. 3.

Fig. 62.

Fig. 63.

INVENTOR
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Philipp Sawyer Rice & Kennedy
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METAL EXTRUDING APPARATUS

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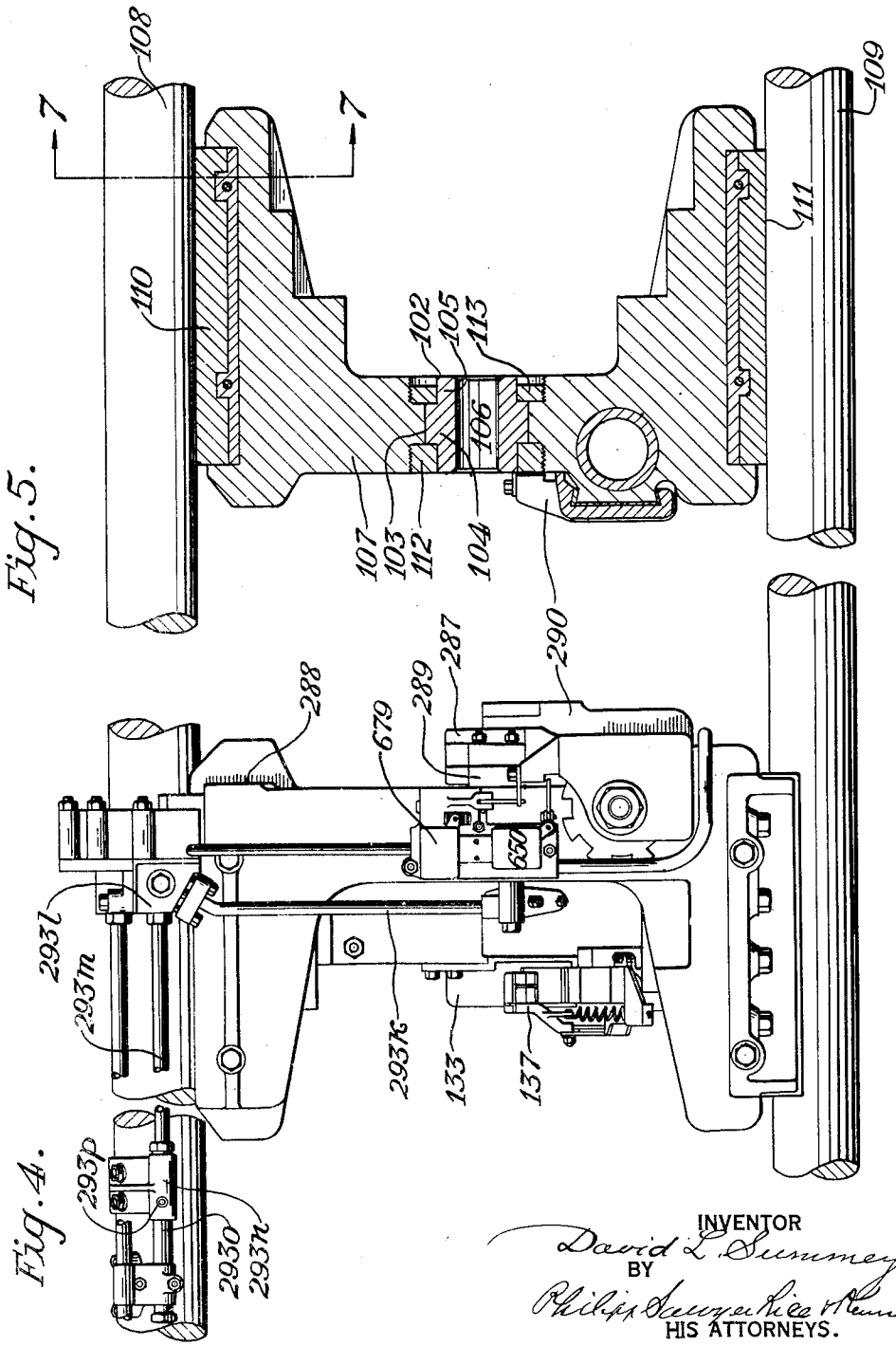


Fig. 5.

Fig. 4.

INVENTOR
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Philips Lemon Rice & Kennedy
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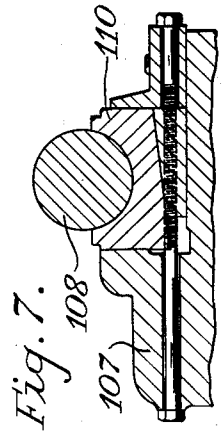


Fig. 7.

Fig. 6.

INVENTOR
David L. Summey
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Philip Sawyer Rice Kennedy
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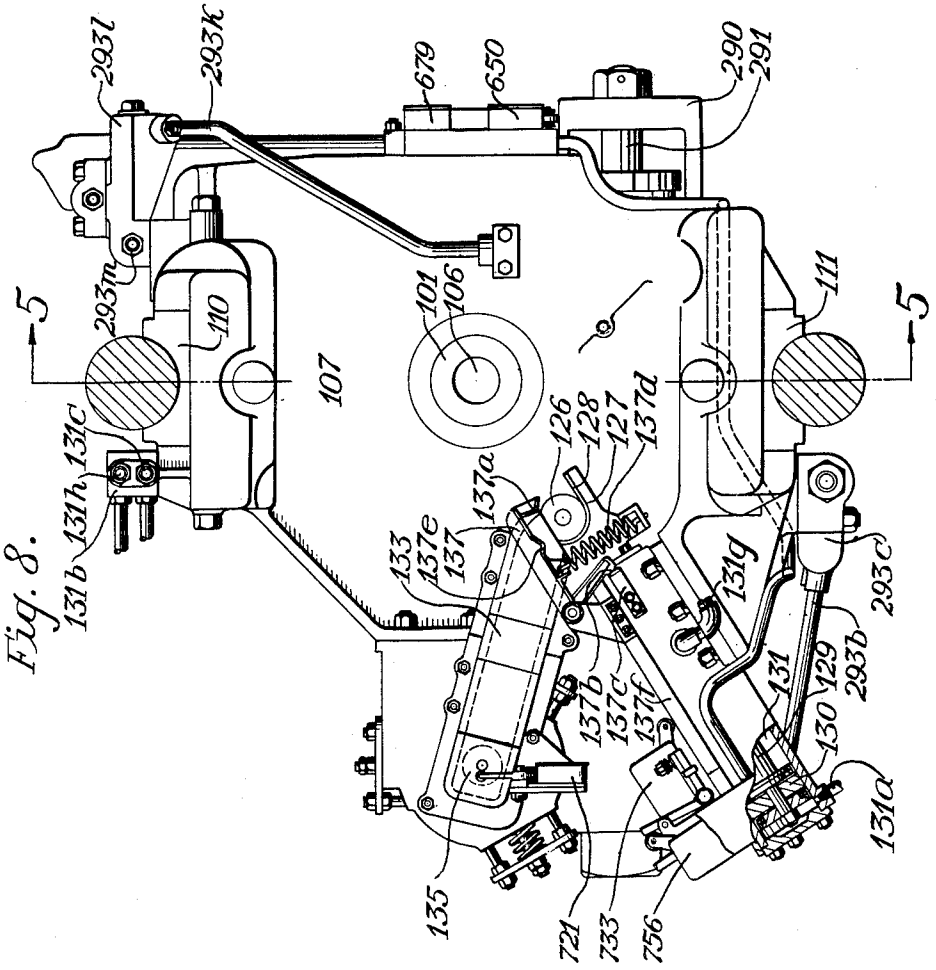


Fig. 8.

INVENTOR
David L. Summey
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Philip Lawrence & Kennedy
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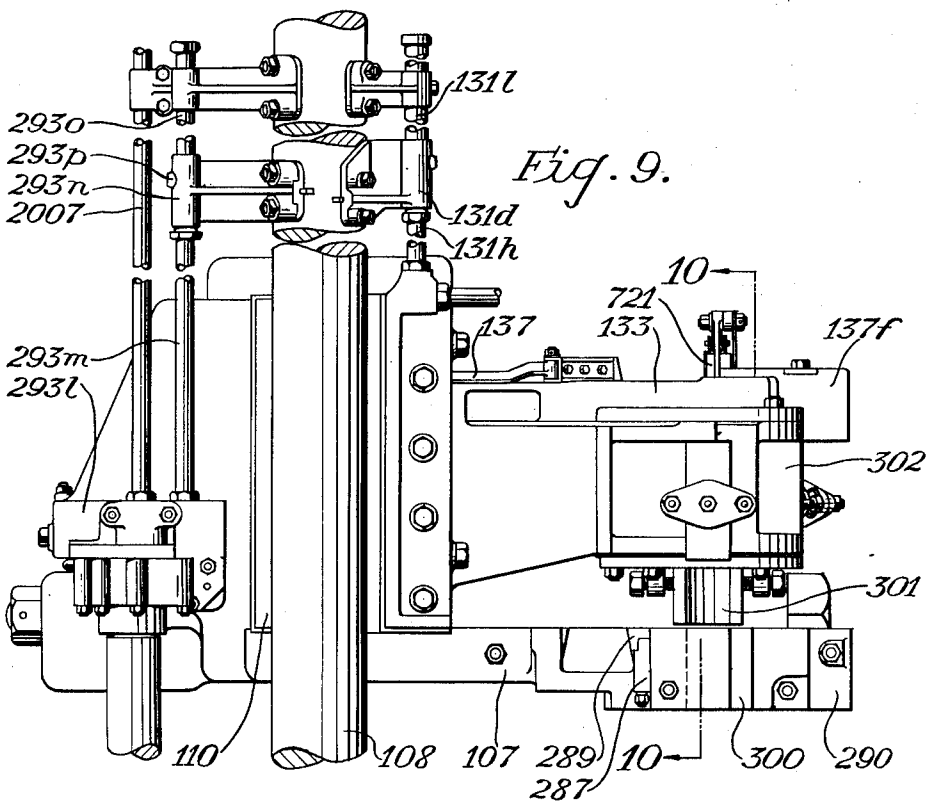


Fig. 9.

Fig. 10.

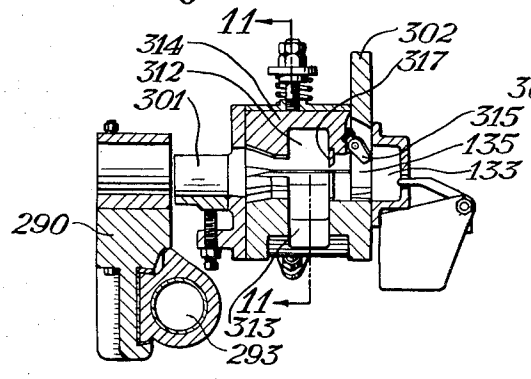
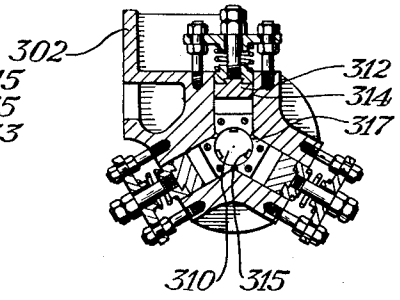


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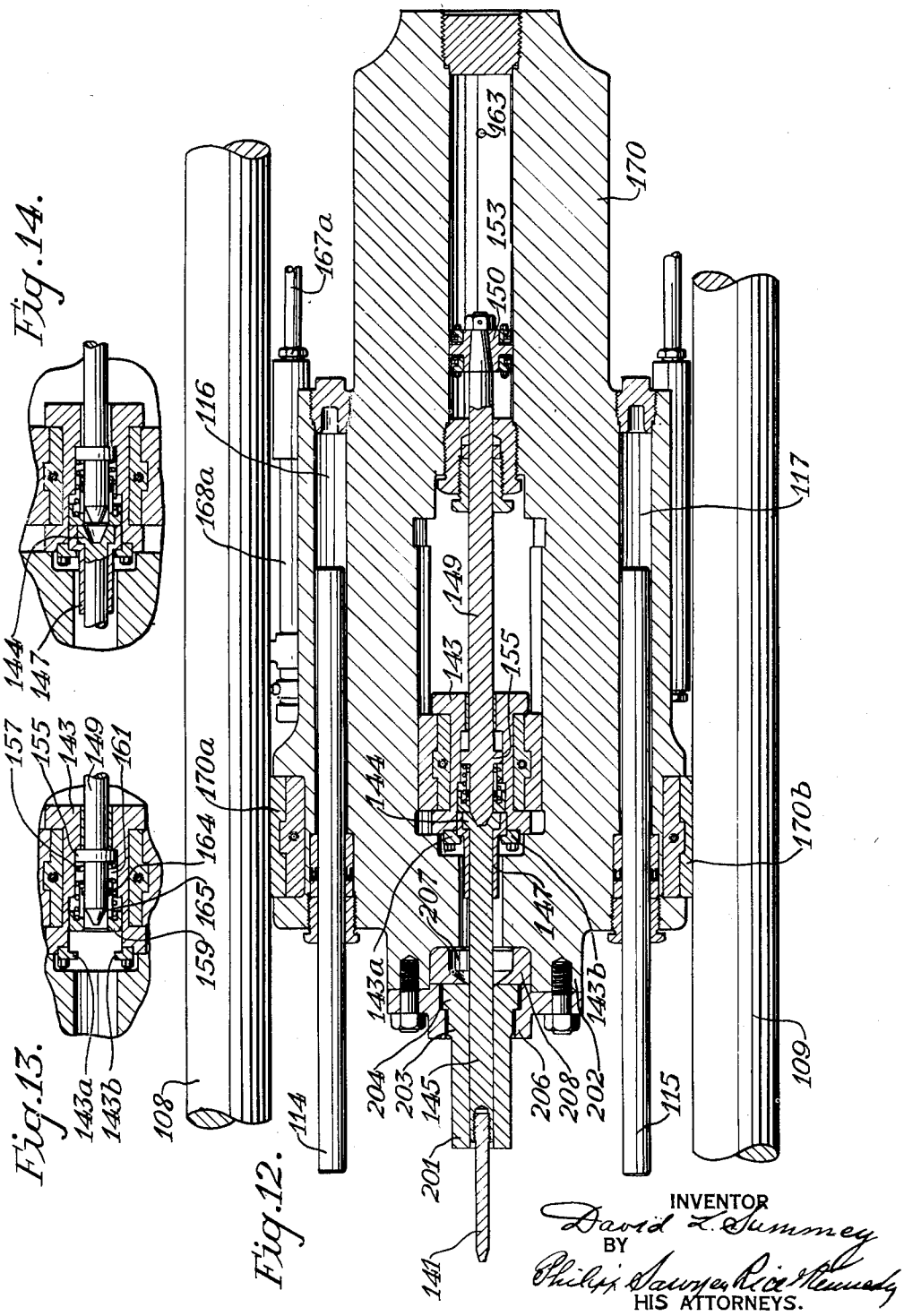


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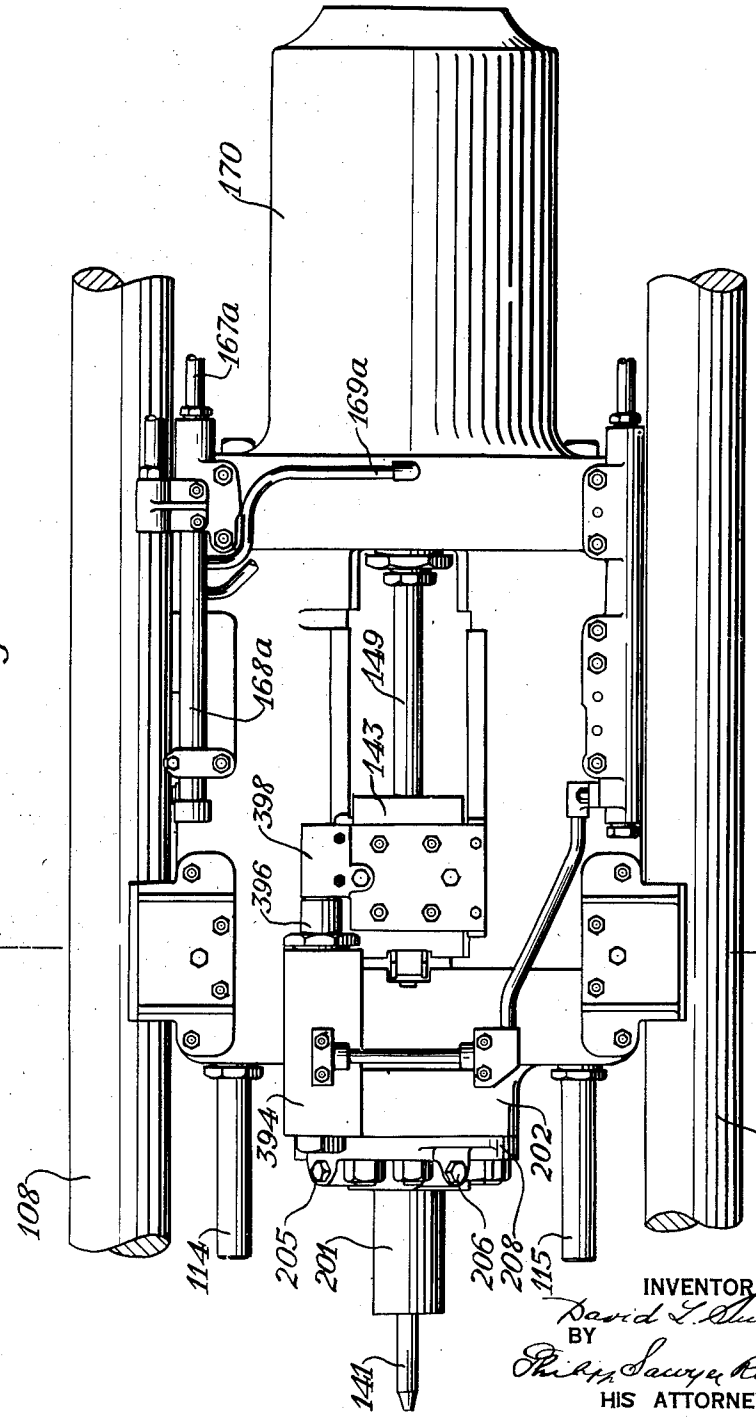


Fig. 15.

INVENTOR
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Philipp, Sawyer, Rice & Kennedy
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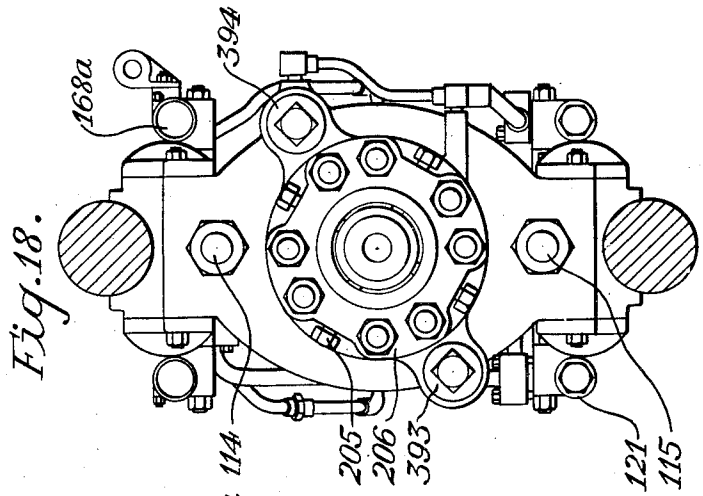


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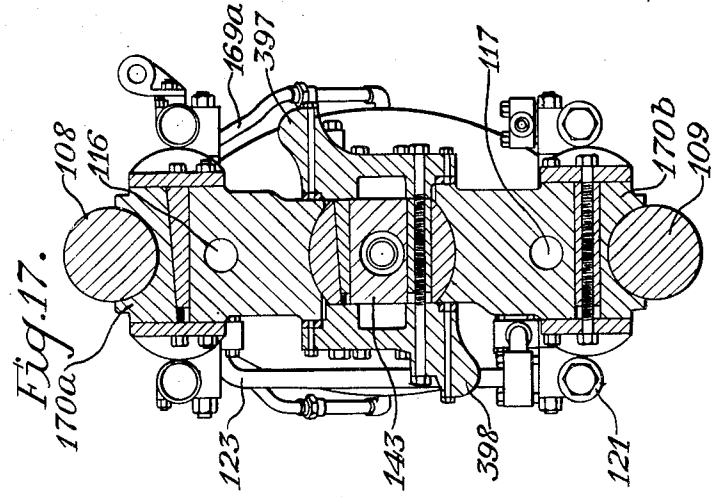


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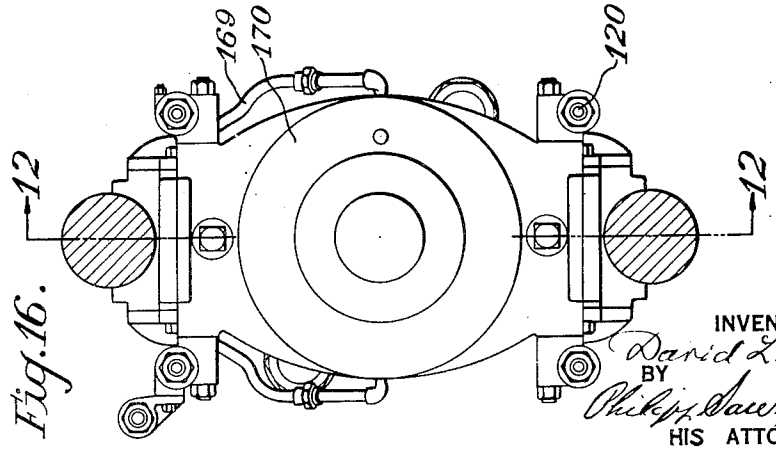


Fig. 16.

INVENTOR
David L. Summey
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Philip P. Sawyer, Rice & Kennedy
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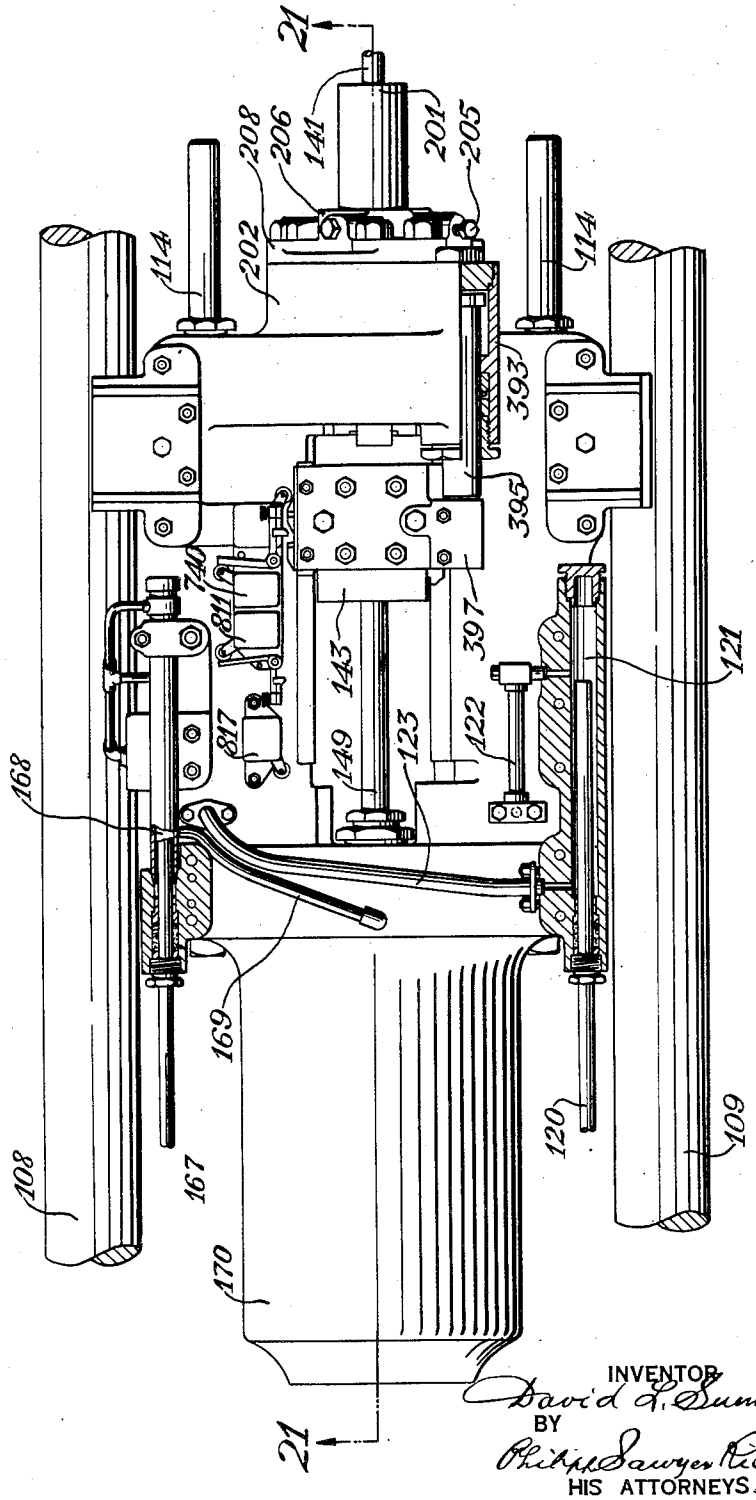


Fig. 19.

INVENTOR
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Philipp Sawyer Rice & Kennedy
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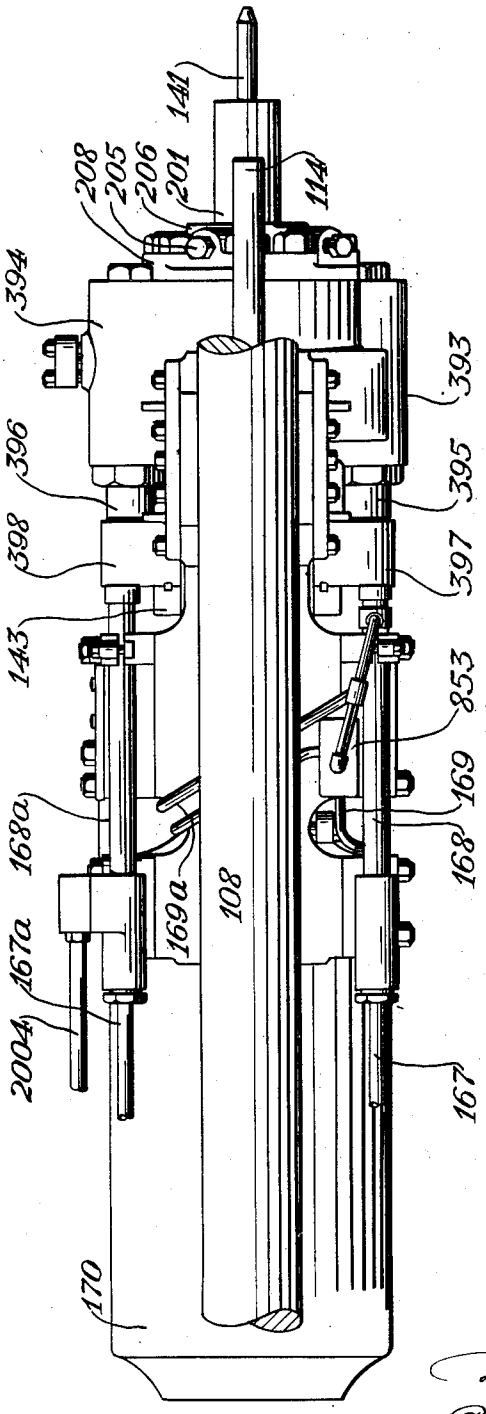


Fig. 20.

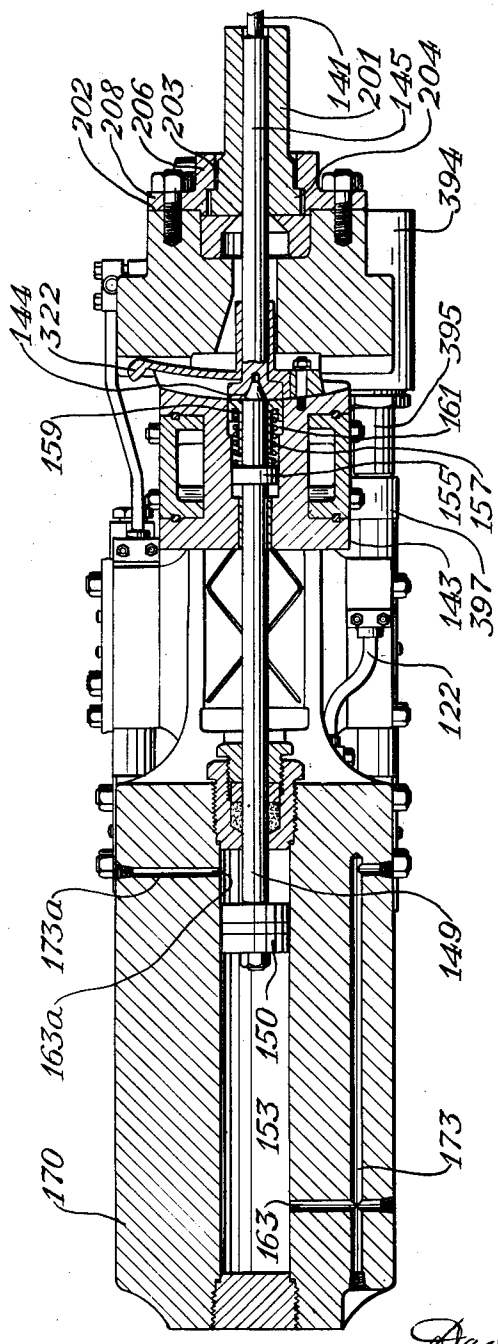
INVENTOR
David L. Summey
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Philip Sawyer Rice Kennedy
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Fig. 21.



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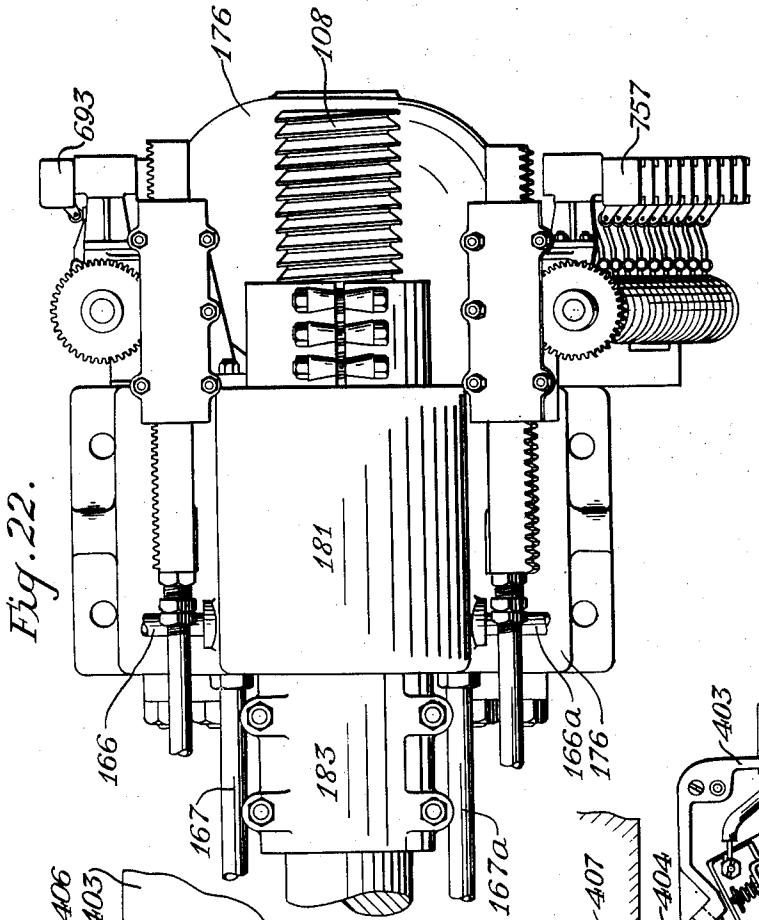


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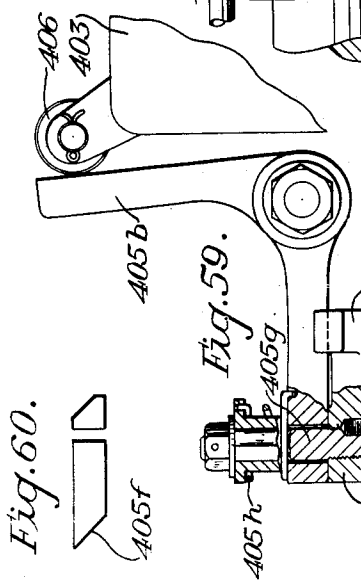


Fig. 59.

Fig. 60.

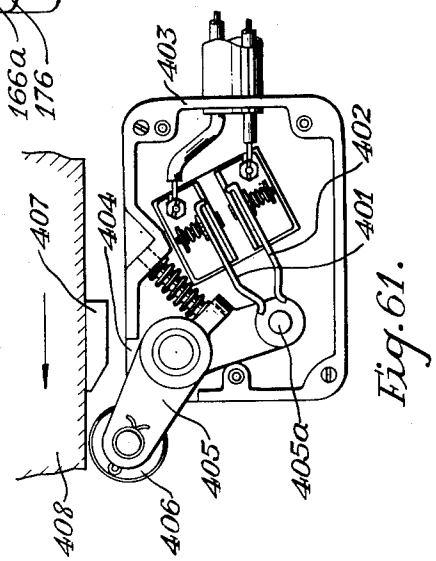


Fig. 61.

INVENTOR
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Philip, Sawyer & Reed Kennedy
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Fig. 24.

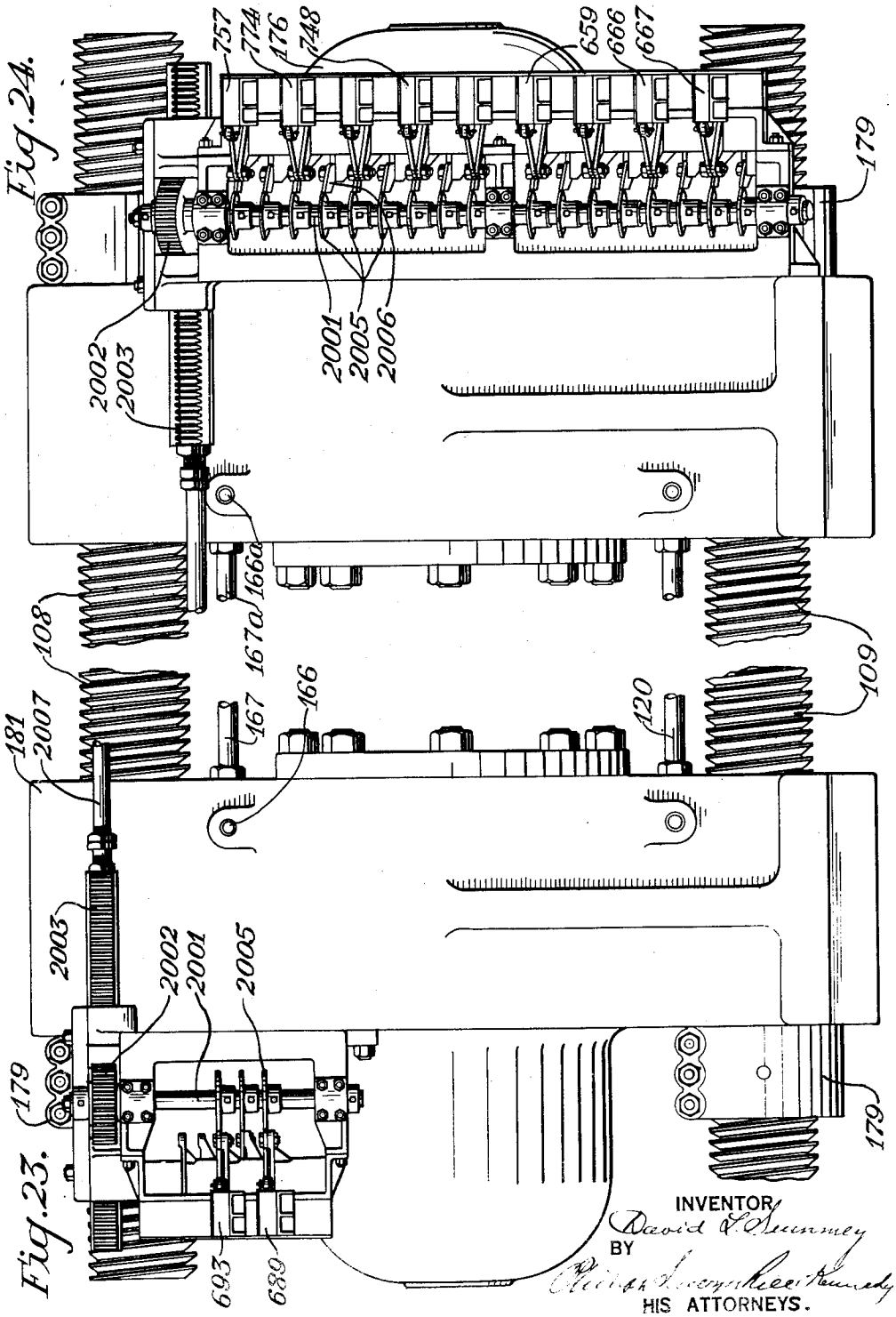


Fig. 23.

INVENTOR
David L. Summey
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Williamson, Lucey, Kee & Kennedy
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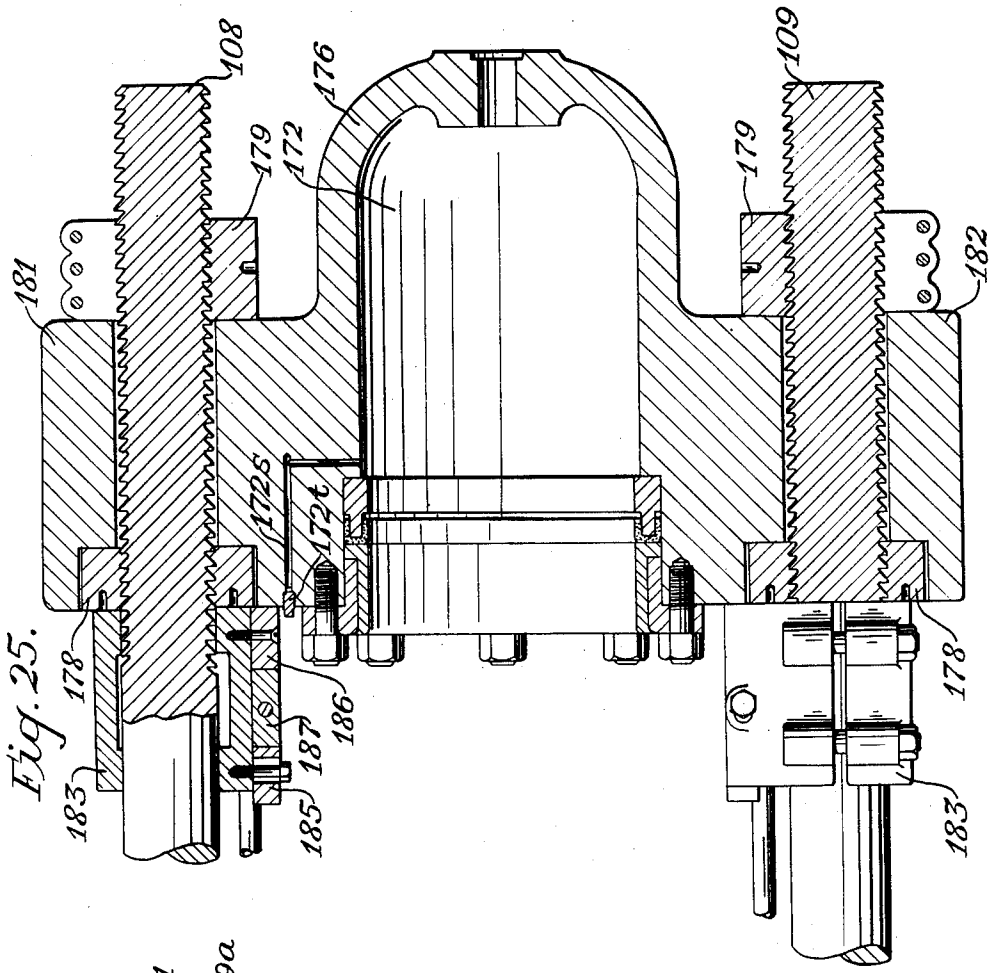


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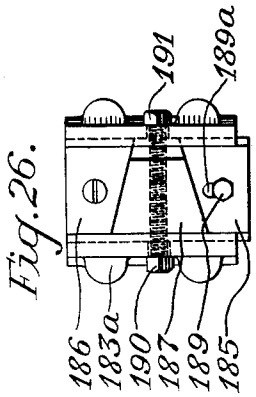


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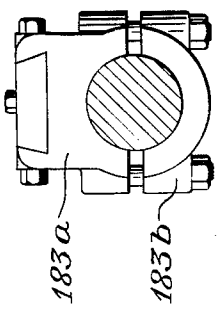


Fig. 27.

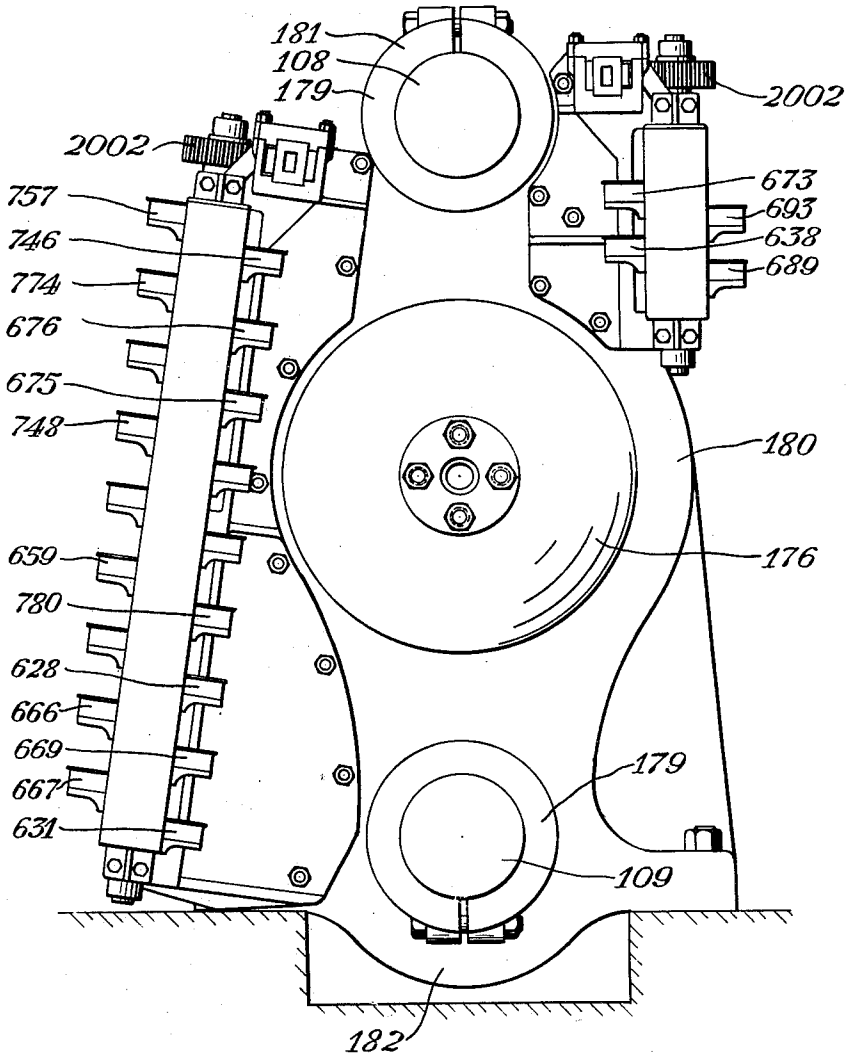
INVENTOR
Dagvil L. Summey
BY
Philip, Swayne, Rice & Kennedy
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Fig. 28.



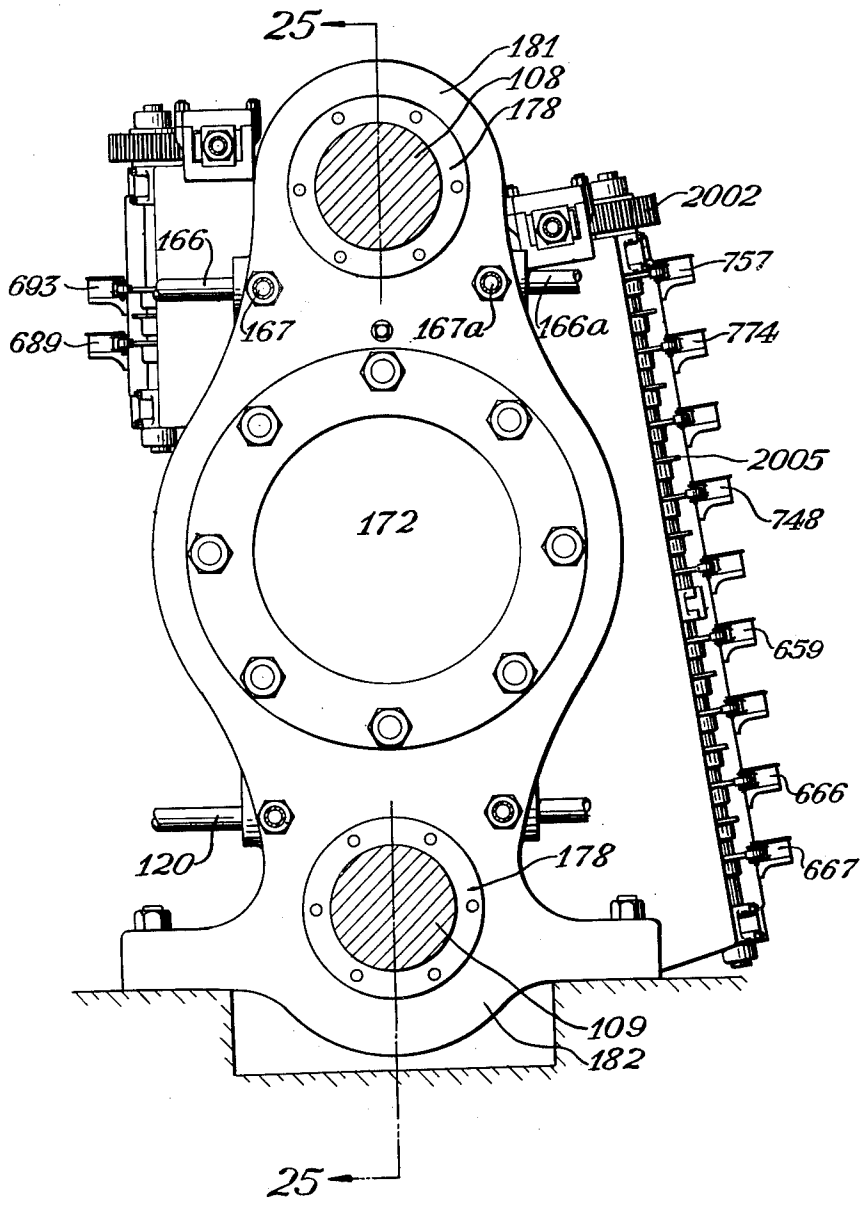
INVENTOR
David L. Summey
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Fig. 29.



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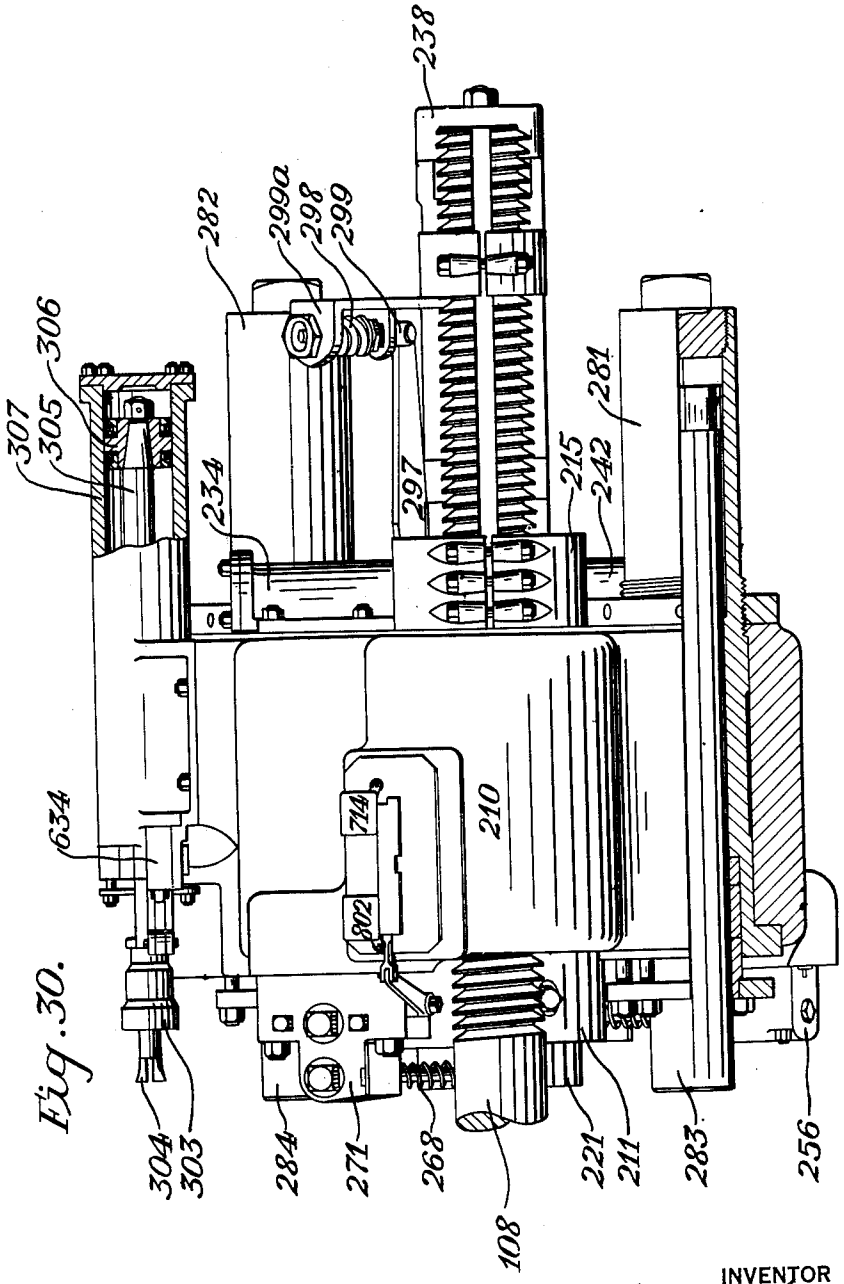


Fig. 30.

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Philips, Sawyer, Rice & Kennedy
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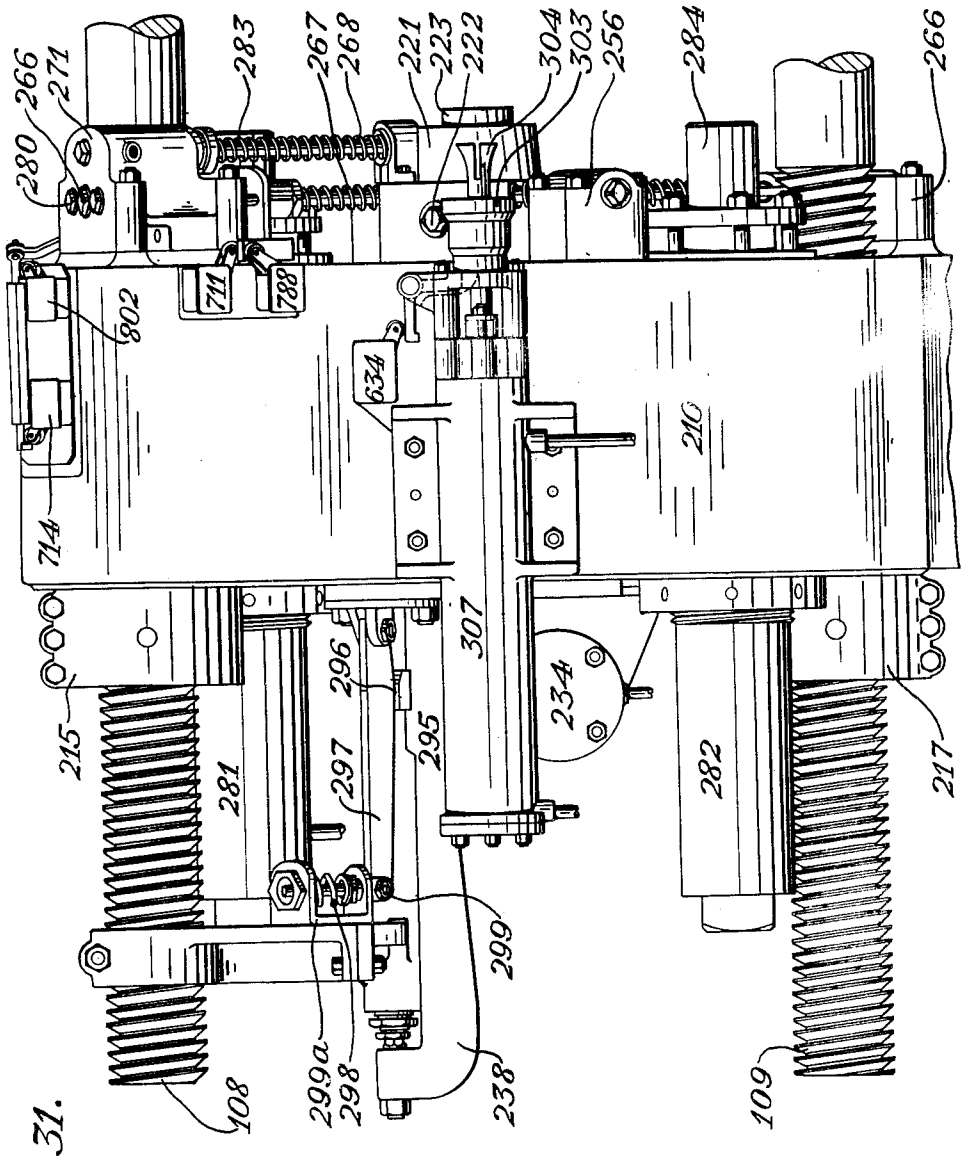


Fig. 31.

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Philips, Sawyer, Rice & Kennedy
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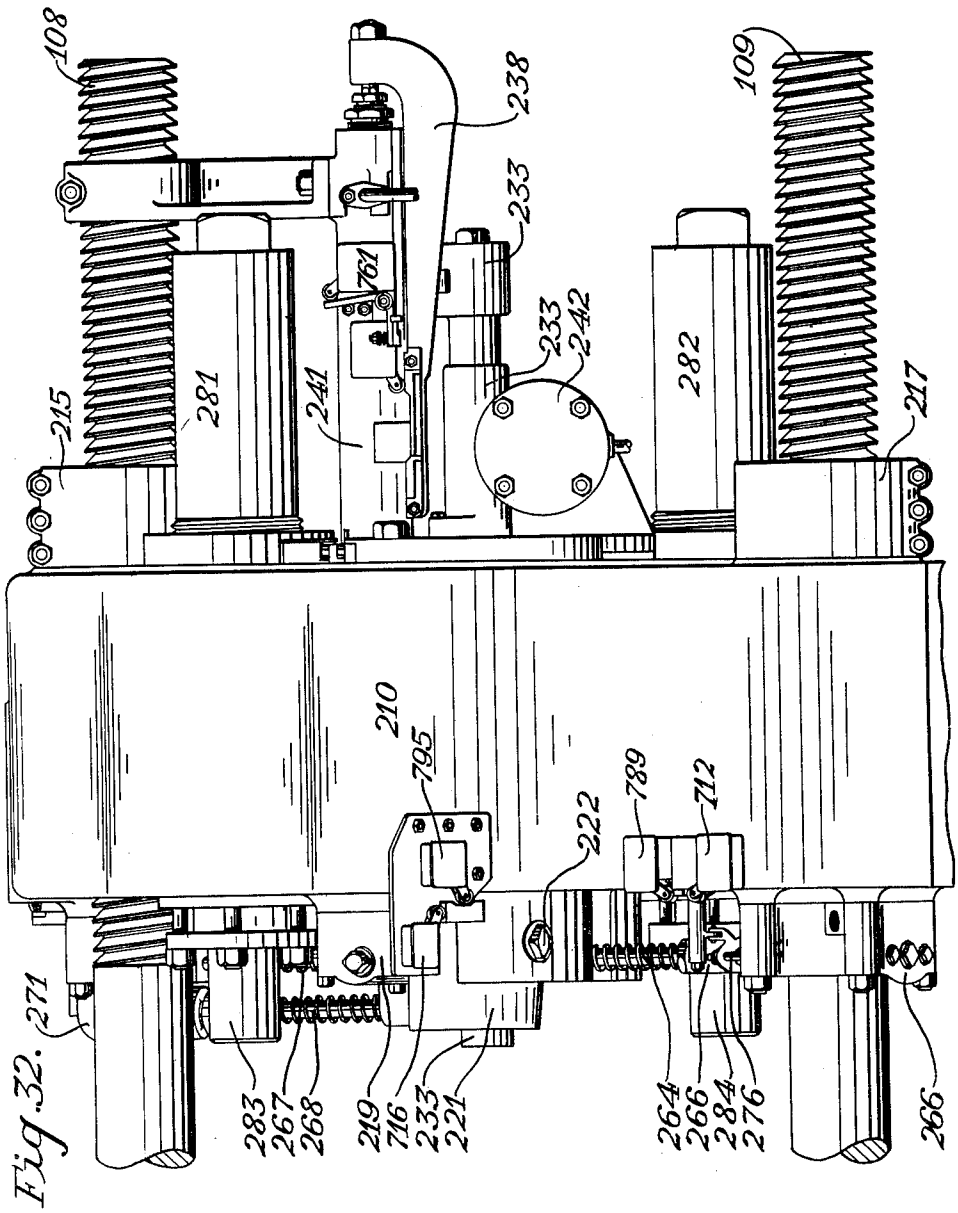


Fig. 32.

INVENTOR
David L. Summey
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Philip, Sawyer, Rice & Hunt
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METAL EXTRUDING APPARATUS

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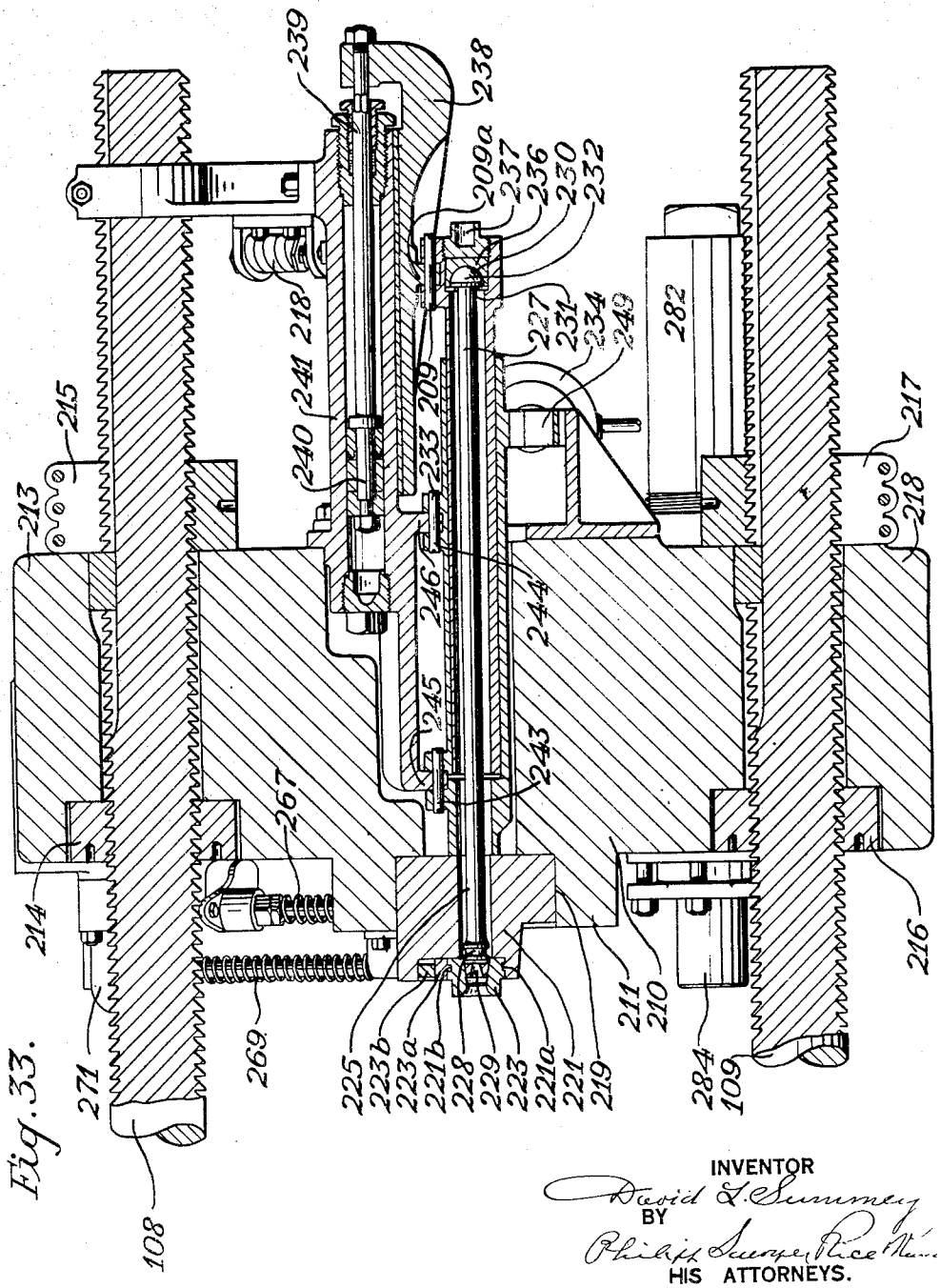


Fig. 33.

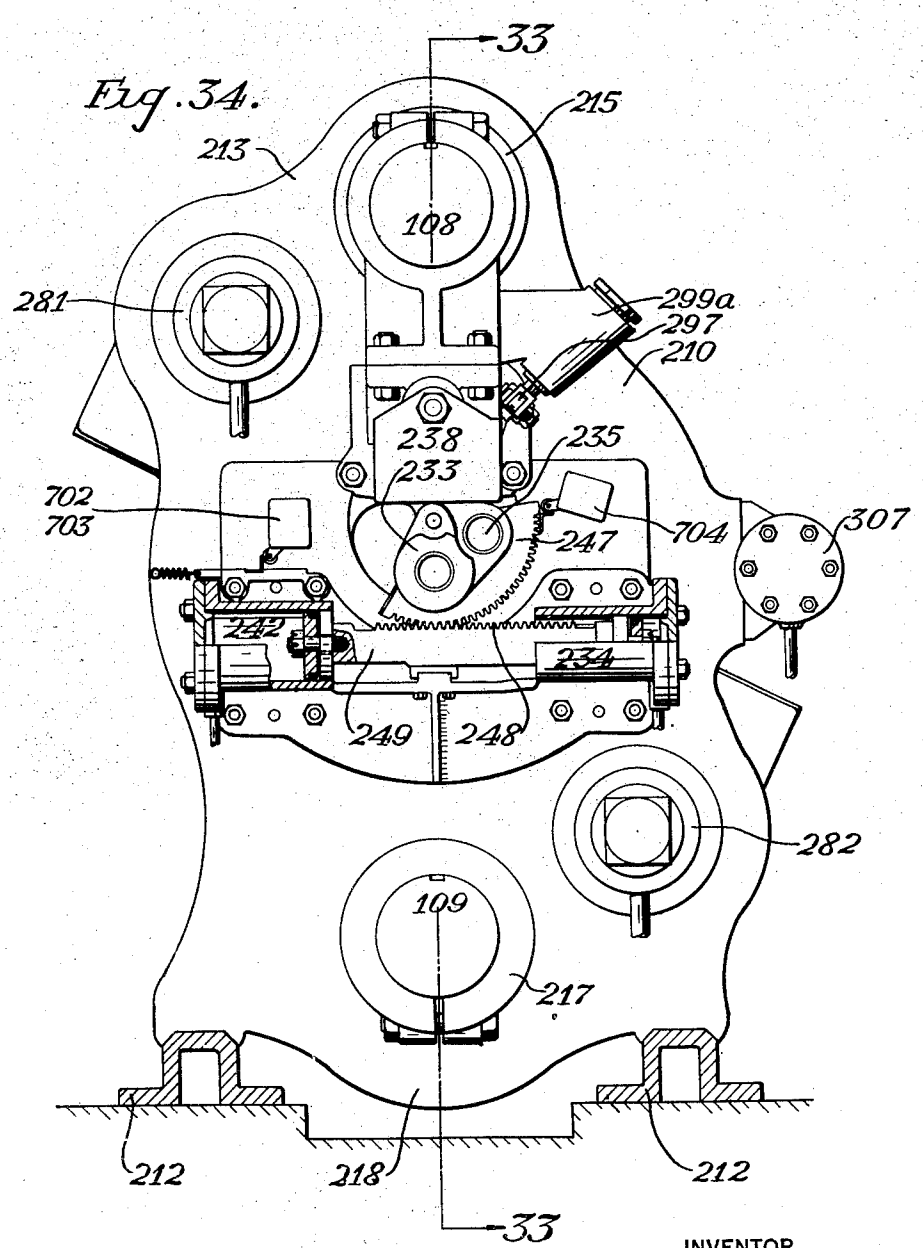
INVENTOR
David L. Summey
BY
Philipp Summey Rice & Kennedy
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METAL EXTRUDING APPARATUS

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Fig. 34.



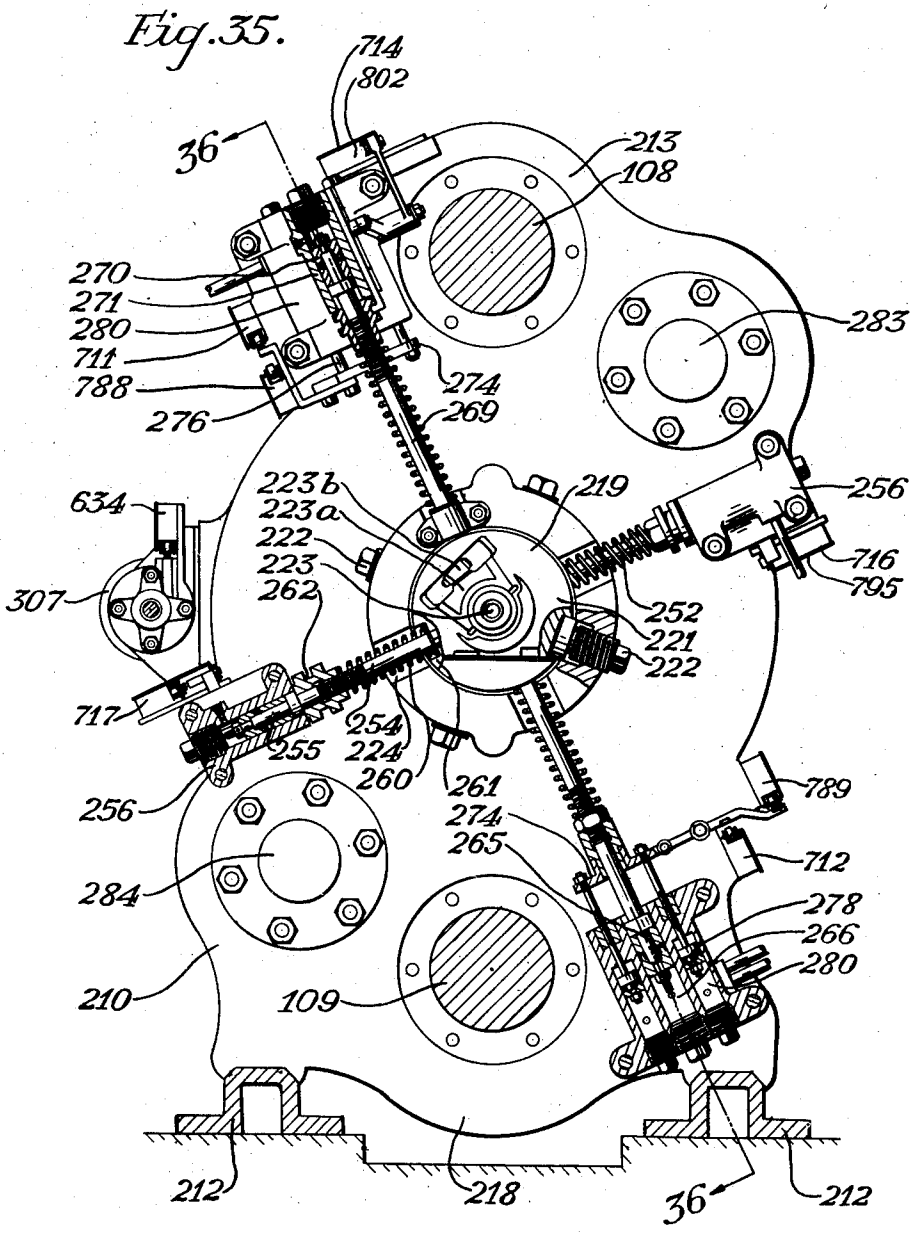
INVENTOR
David L. Summey
BY
Philip Lamson Rice & Kennedy
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Fig. 35.



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Philipp Sawyer Reed & Kennedy
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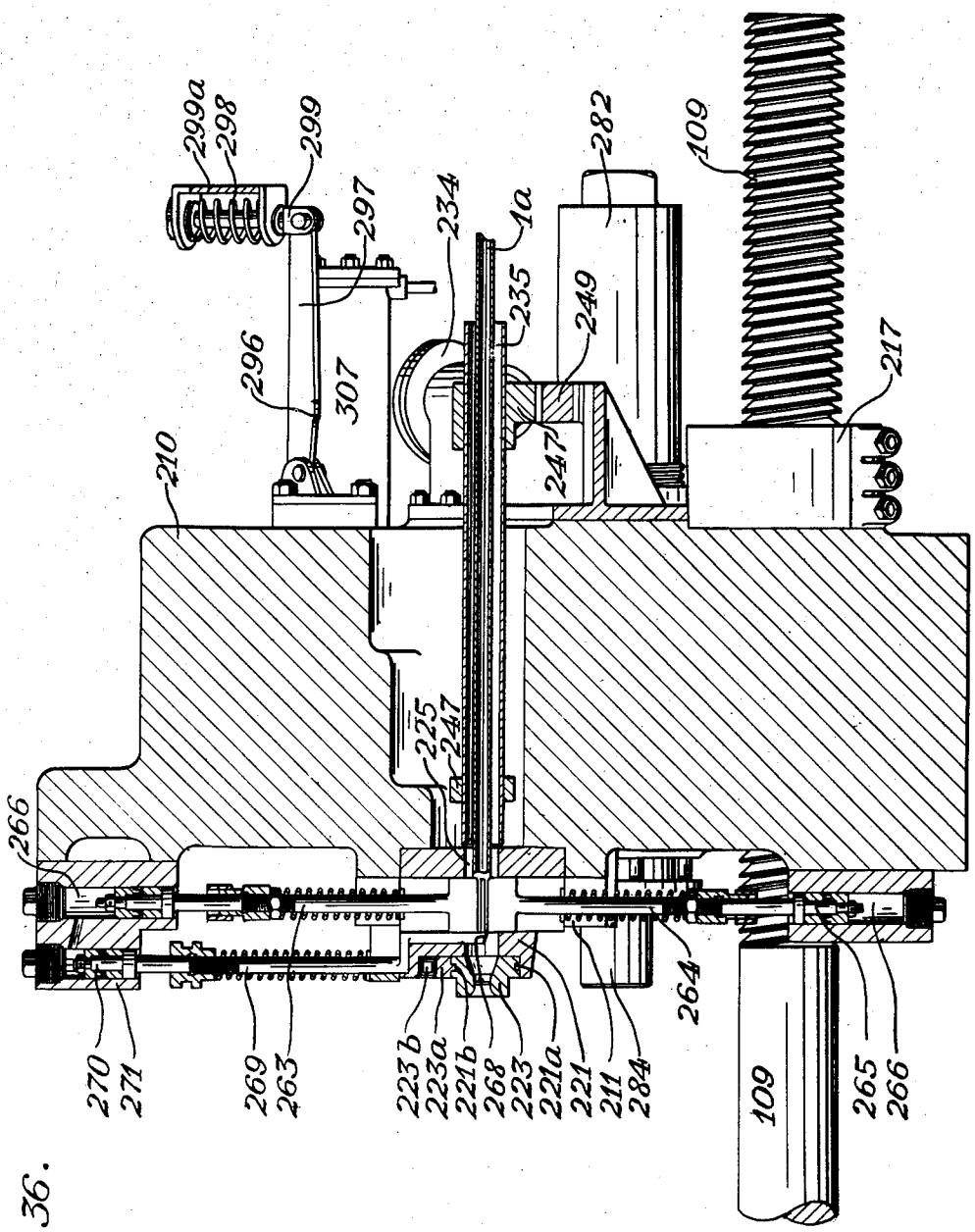


Fig. 36.

INVENTOR
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Philipp, Sawyer, Rose & Kennedy
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METAL EXTRUDING APPARATUS

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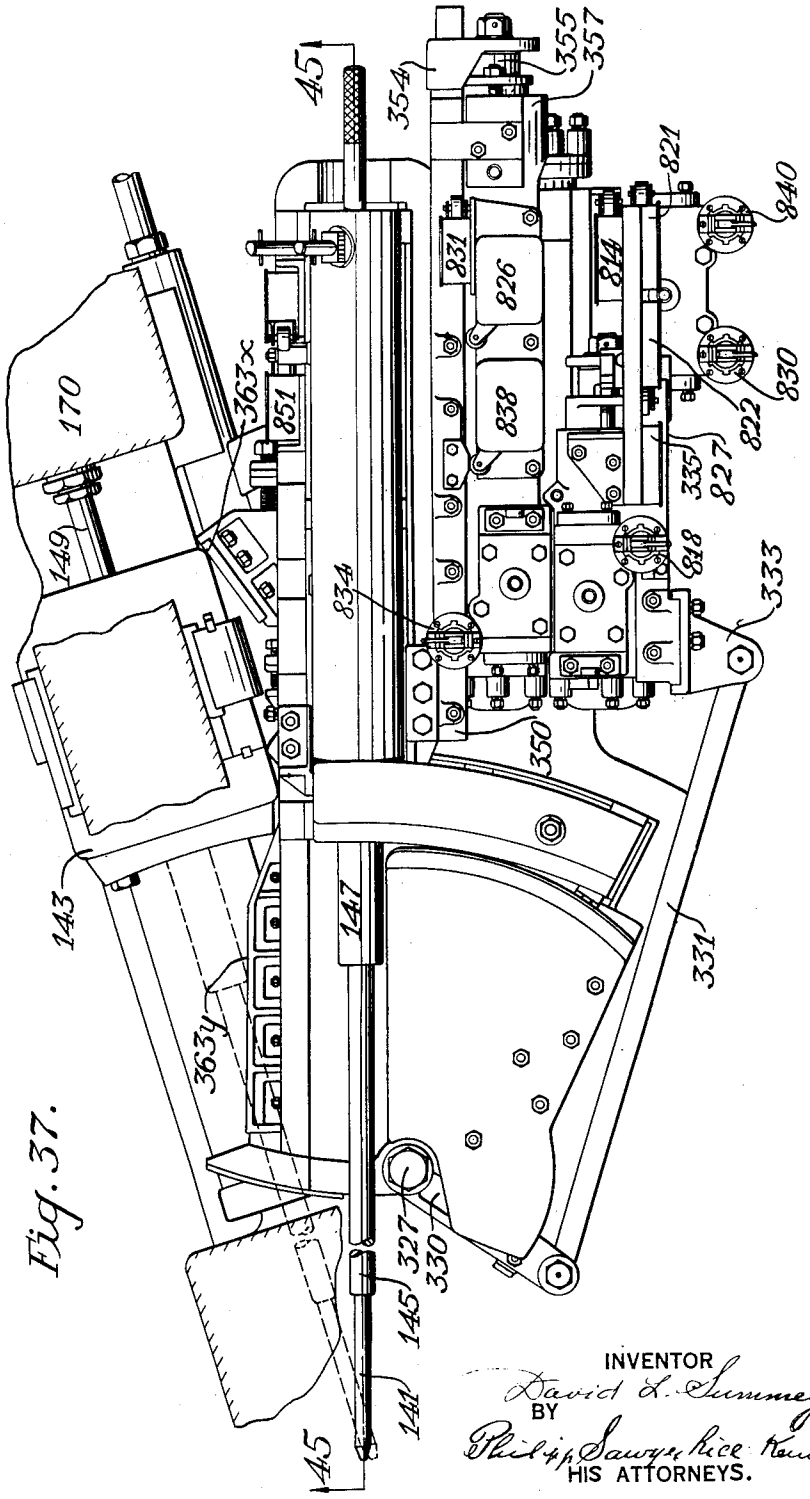


Fig. 37.

INVENTOR
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Philip Sawyer, Rice Kennedy
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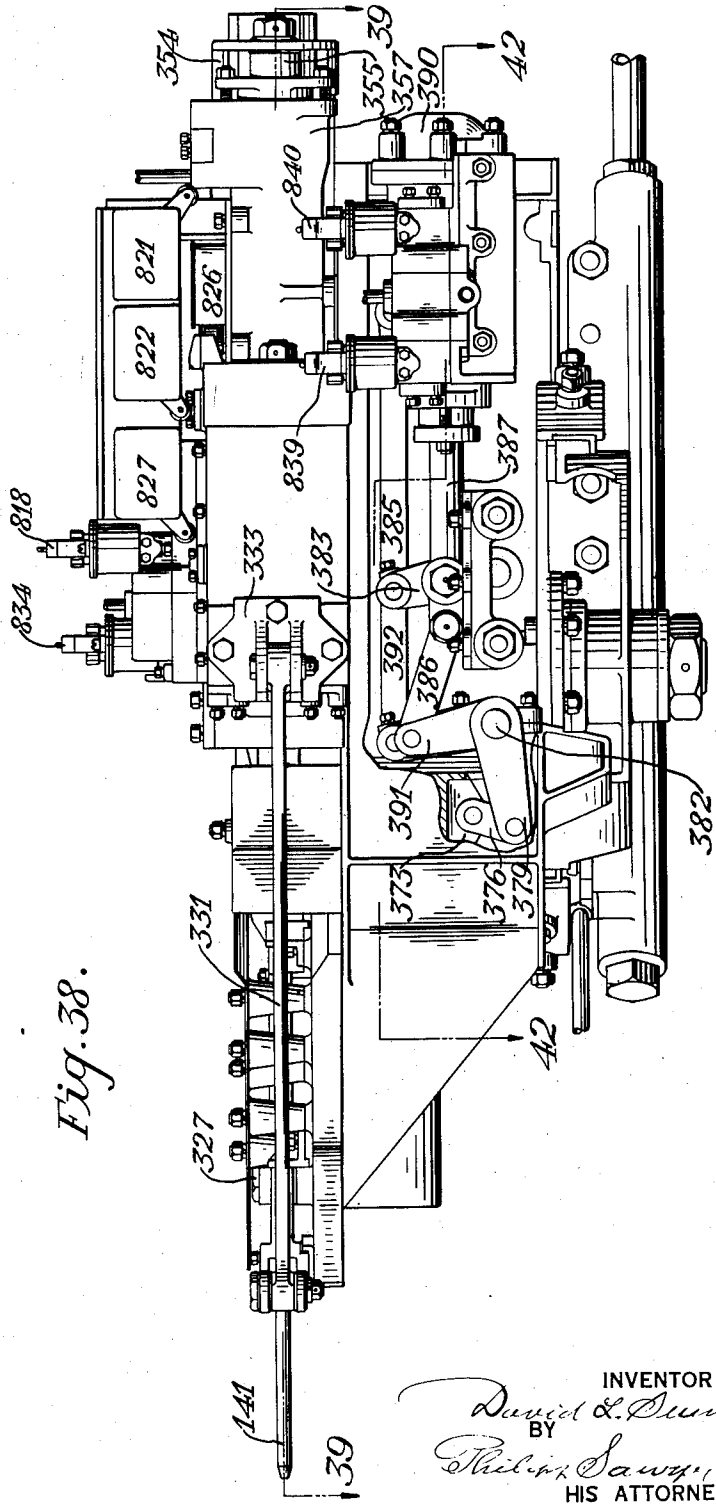


Fig. 38.

INVENTOR
Daniel L. Summey
BY
Philipp Sawyer, Reed & Kennedy
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METAL EXTRUDING APPARATUS

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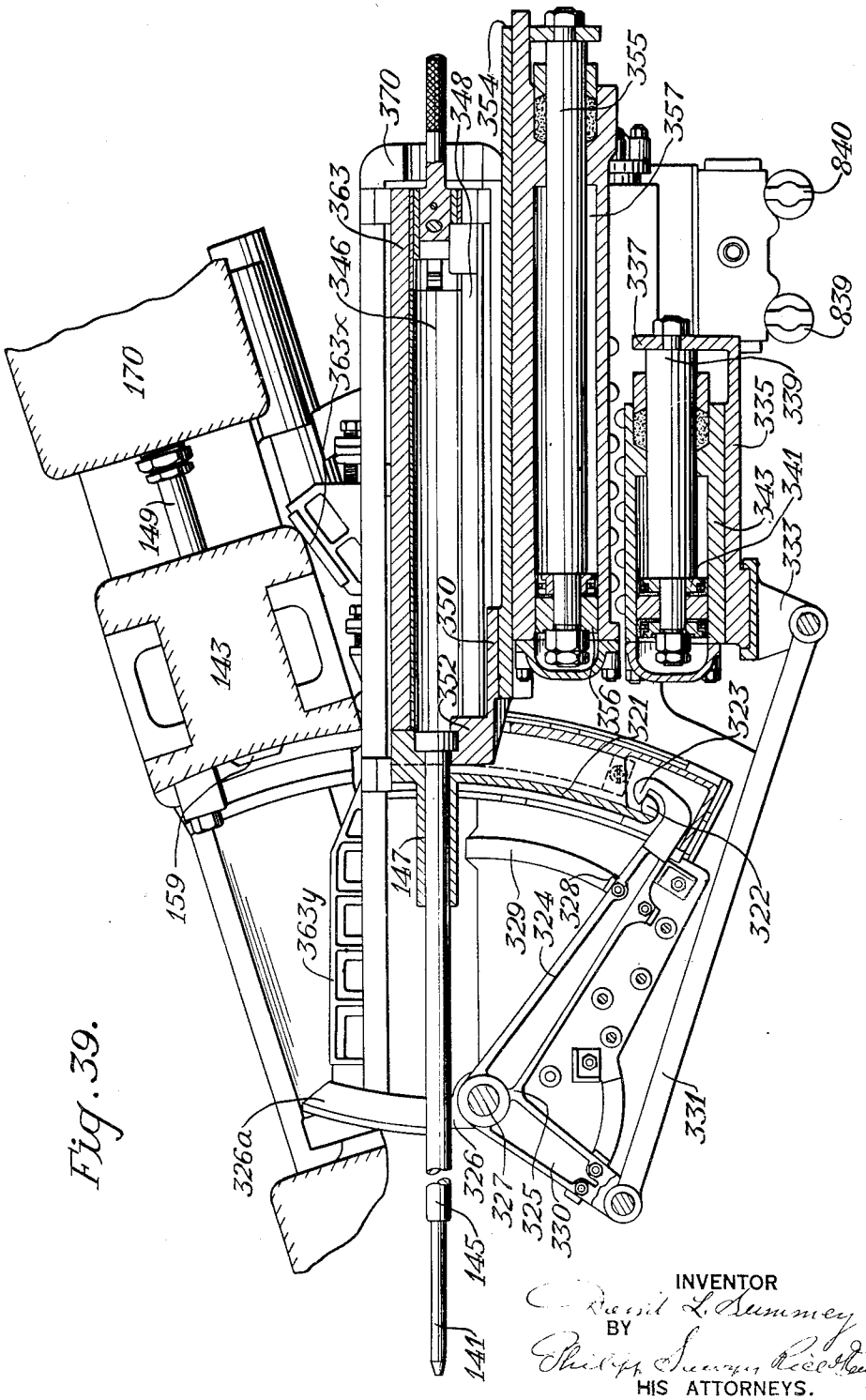


Fig. 39.

INVENTOR
David L. Summey
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Philipp, Sampson, Kiel & Kennedy
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Fig. 40.

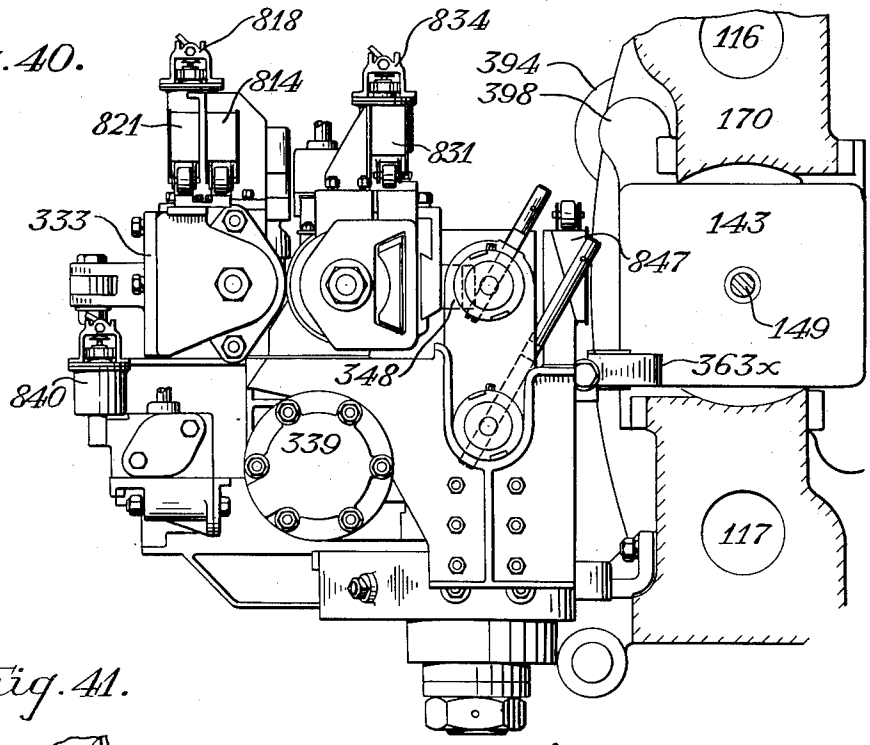
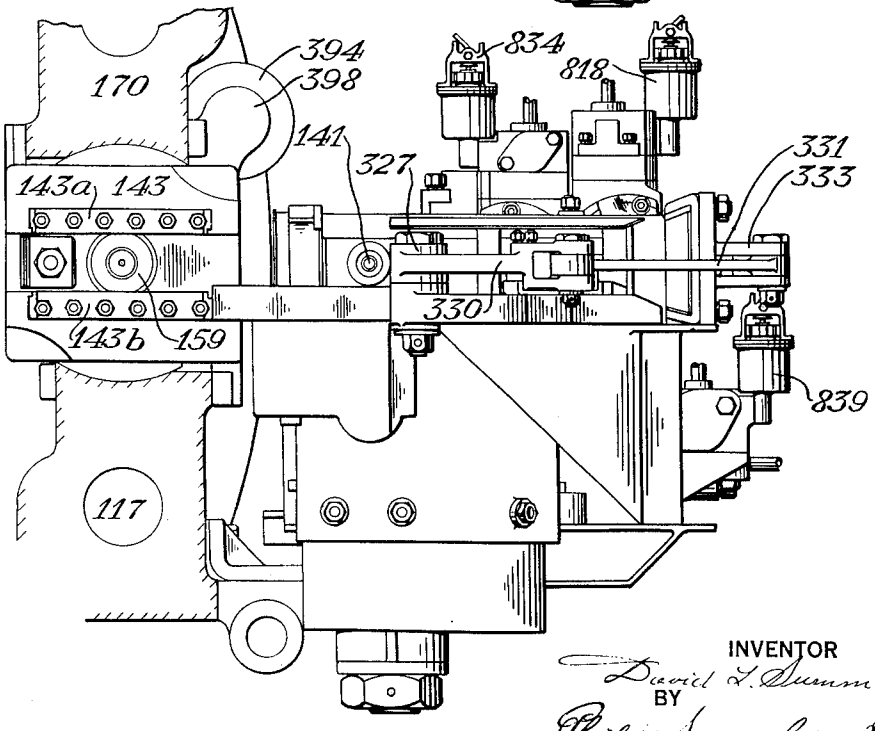


Fig. 41.



INVENTOR
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BY
Philipp Sawyer Rice & Kennedy
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METAL EXTRUDING APPARATUS

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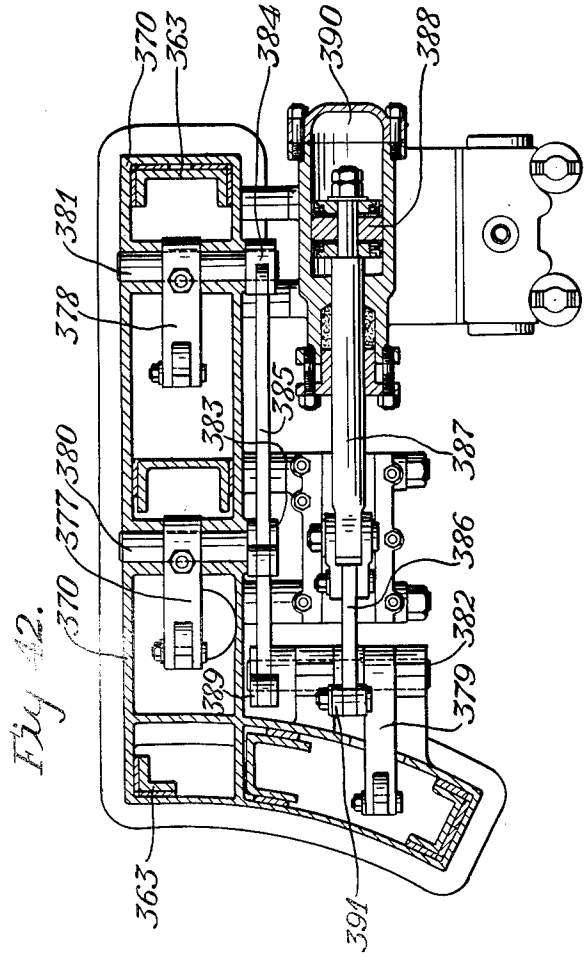


Fig. 42.

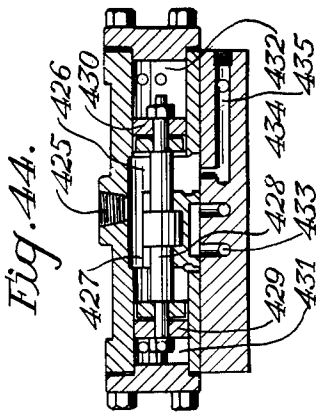


Fig. 44.

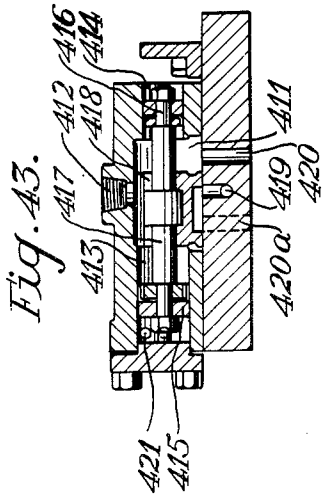


Fig. 43.

INVENTOR
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Philip Sawyer Rice & Kennedy
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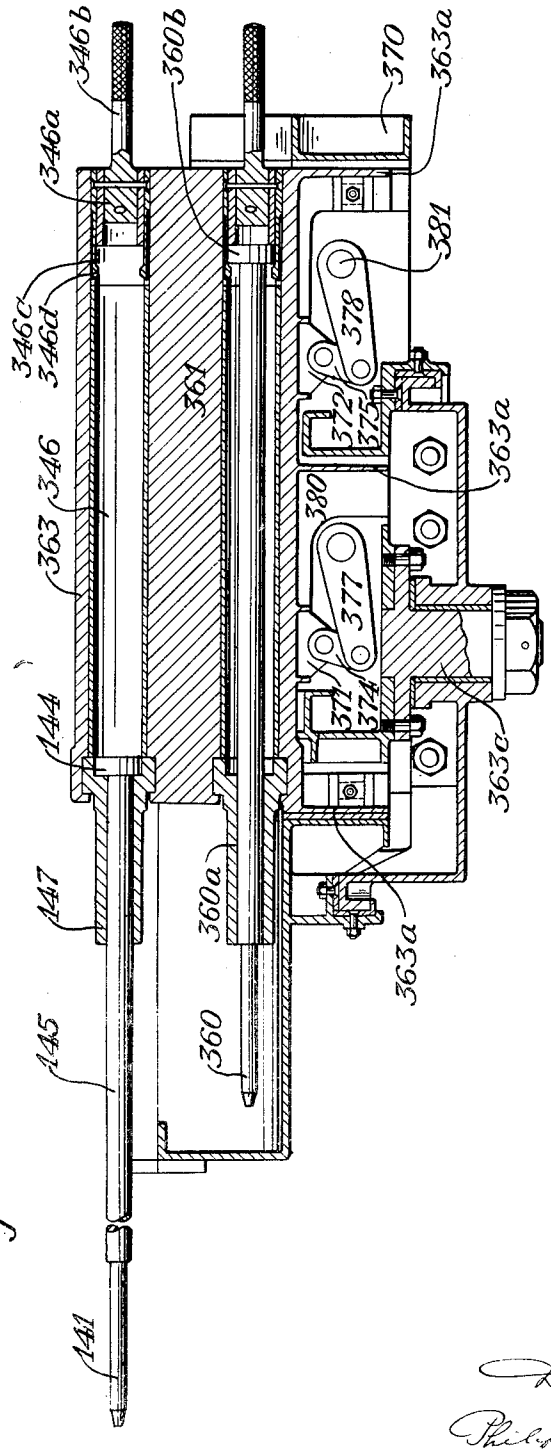


Fig. 45.

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Philbrick Sawyer Peet & Kennedy
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METAL EXTRUDING APPARATUS

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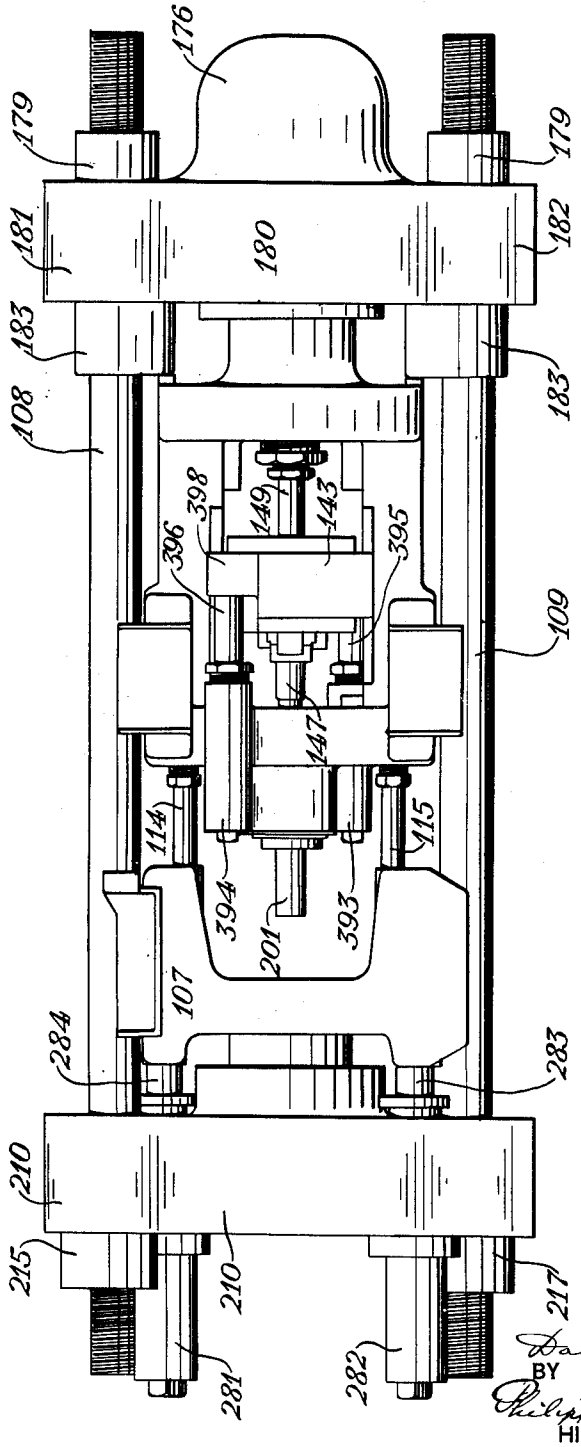


Fig. 46.

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METAL EXTRUDING APPARATUS

Original Filed Feb. 20, 1928 33 Sheets-Sheet 32

Fig. 47.

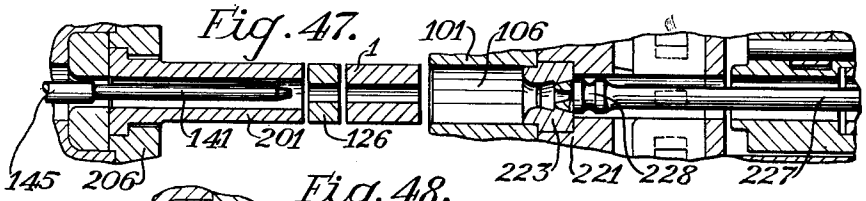


Fig. 48.

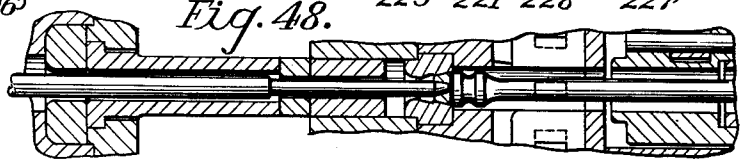


Fig. 49.

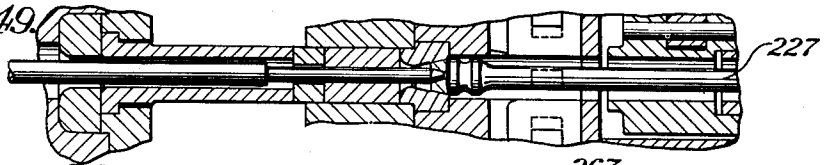


Fig. 50.

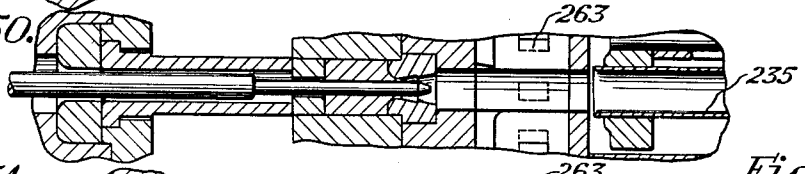


Fig. 51.

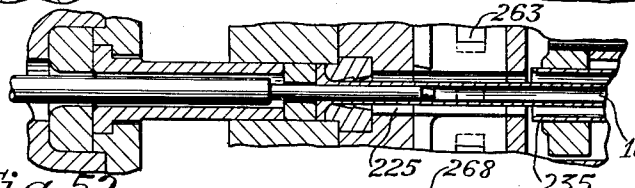


Fig. 55.

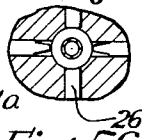


Fig. 52.

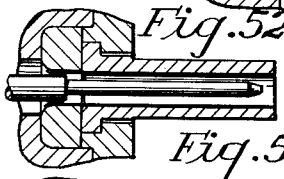


Fig. 56.

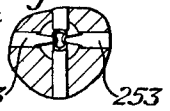


Fig. 53.

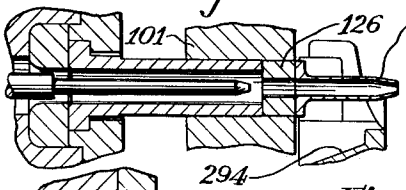


Fig. 57.



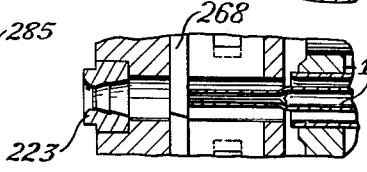
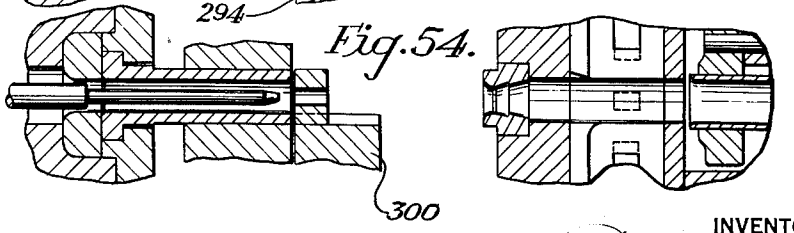


Fig. 54.



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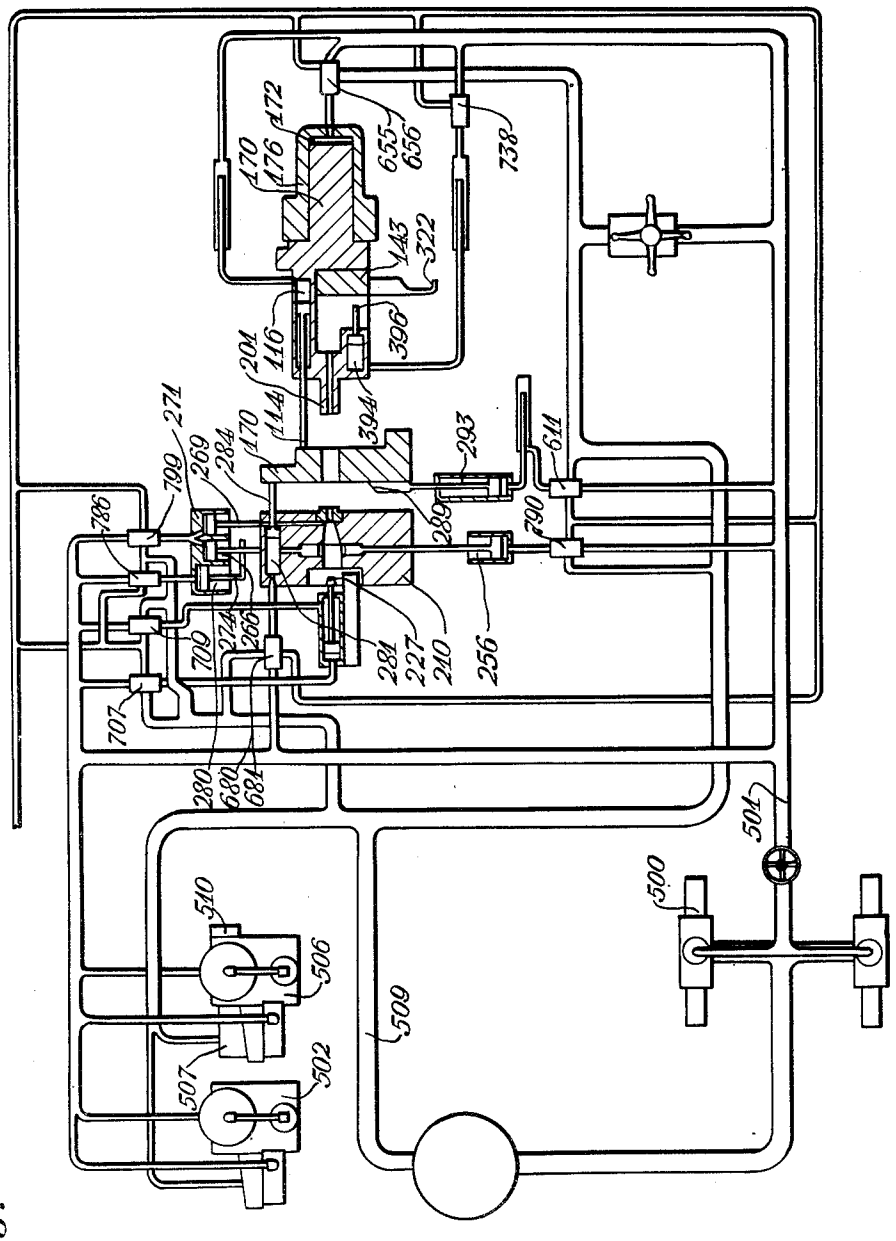


Fig. 58.

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UNITED STATES PATENT OFFICE

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METAL EXTRUDING APPARATUS

Original application filed February 20, 1928, Serial No. 255,644. Divided and this application filed June 21, 1929. Serial No. 372,575.

This invention relates to metal extruding apparatus.

The present application is a division of an application filed February 20, 1928, Serial No. 255,644.

Metal tubes, such as brass tubing and piping, have been formed by drawing and by the so-called Mannesman process. Both of these methods are expensive, involving considerable time and labor.

It is an object of the invention to provide an apparatus capable of forming metal tubes, such as brass tubing and piping, by extrusion, economically and efficiently.

With this general object in view, the invention consists in the features, combinations, details of construction, and arrangements of parts which will first be described in connection with the accompanying drawings and then more particularly pointed out.

In the drawings:—

Figure 1 is a plan view of a billet transfer mechanism;

Figure 2 is a view of the same in end elevation;

Figures 3 and 4 are views in side elevation of part of the press, showing the billet container unit from opposite sides;

Figure 5 is a sectional view taken as on the line 5—5 of Figure 8;

Figure 6 is an end elevation, with parts in section of this container unit;

Figure 7 is a detail sectional view taken as on line 7—7 of Figure 5;

Figure 8 is an end elevation with parts in section, showing the other end of the container unit;

Figure 9 is a plan view of the parts shown in Figure 3;

Figure 10 is a sectional view taken as on the line 10—10 of Figure 9;

Figure 11 is a sectional view taken as on the line 11—11 of Figure 10;

Figure 12 is a sectional view taken as on the line 12—12 of Figure 16;

Figures 13 and 14 are detail views showing part of Figure 12 with the parts in different positions;

Figure 15 is a view in side elevation of the main ram unit with its cylinder removed;

Figure 16 is a view in end elevation, with parts in section;

Figure 17 is a sectional view taken as on the line 17—17 of Figure 15;

Figure 18 is a view similar to Figure 16, showing the other end of the main ram unit;

Figure 19 is a view similar to Figure 15, showing the other side of the main ram unit;

Figure 20 is a plan view of the main ram unit;

Figure 21 is a sectional view taken as on the line 21—21 of Figure 19;

Figure 22 is a plan view of one portion of the press;

Figures 23 and 24 are views of the same in side elevation, taken on opposite sides;

Figure 25 is a sectional view taken as on the line 25—25 of Figure 29;

Figures 26 and 27 are plan and end views of a part of Figure 25;

Figure 28 is a view in end elevation of that portion of the press shown in Figure 22;

Figure 29 is a sectional view through the press showing the other end of the same portion in elevation;

Figure 30 is a plan view of the other portion of the press, with parts in section;

Figures 31 and 32 are views in side elevation, from opposite sides, of the parts shown in Figure 30;

Figure 33 is a sectional view taken as on the line 33—33 of Figure 34;

Figure 34 is a view in end elevation of that portion of the press shown in Figure 30, with parts in section;

Figure 35 is a view in end elevation of the other end of the same portion, with parts in section, looking toward the right of Figure 36;

Figure 36 is a sectional view taken as on the line 36—36 of Figure 35;

Figure 37 is a plan view of part of the press, showing the mandrel exchange;

Figure 38 is a view of the same in side elevation;

Figure 39 is a sectional view taken as on the line 39—39 of Figure 38;

Figures 40, 41 are end views of the same from opposite ends;

Figure 42 is a sectional view taken as on the line 42—42 of Figure 38;

Figures 43 and 44 are explanatory views showing, in section, two types of air control valves;

Figure 45 is a sectional view taken as on the line 45—45 of Figure 37;

Figure 46 is a diagrammatic view of the press in side elevation to show the relation of the parts;

Figures 47–57 are explanatory views showing schematically the progressive operation of the press;

Figure 58 is a digrammatic view of part of the fluid pressure system;

Figure 59 is a detail view showing one form of switch-operating mechanism;

Figure 60 is a further detail of the same;

Figure 61 is a detail view showing another form of switch-operating mechanism and a switch;

Figures 62 and 63 are side and end elevations, with parts in section, of a pressure control device;

Figures 64–66 are wiring diagrams.

The present apparatus is designed particularly for extruding tubes of non-ferrous metals or alloys. The billets may be formed in any suitable manner. For example, they may be formed from lengths of cast cylindrical stock slightly oversize as to diameter. The stock is cut to convenient lengths, turned to proper diameter, and centrally bored for receiving a mandrel.

In the extrusion press hereinafter described, the billet is first placed endwise on the holder 84 of a press feed slide (Figs. 1, 2) either by hand or by a suitable feeding mechanism. The holder has a spring-pressed pivoted finger 85 (Fig. 2) to retain the billet in place in the holder. The holder 84 is given a slanting upward movement to position the billet in line with the press container. To this end, as shown, the holder is mounted on a suitably guided oblique drive rod 86 having rack teeth 87 meshing with a pinion 93 on a shaft 92. Also mounted on this shaft is a pinion 91 meshing with a rack 90 formed on the piston rod 89 of a fluid pressure unit 88. The advance stroke of piston rod 89 causes holder 84 to be moved obliquely upward to place the billet endwise in line with the press container, the stroke of the rod 86 governing the billet position.

The extrusion press here illustrated as an example is designed for extruding tubes but it will be understood that many features of the invention are applicable to other forms of extrusion presses, e. g. for rods.

There is provided a billet container movable longitudinally of the axis of the press. As here shown as an example (Figs. 3 et seq.), sliding between press tie rods 108, 109 is a U-shaped container cross head 107, its arms serving as long bearing guides (Fig. 3). This cross head has an open ended cylindrical container sleeve 102 (Fig. 5) forming a container chamber 106 for the billet. This sleeve has a collar-like portion 103 between end portions 104, 105 and is held in place by cylindrical nuts 112, 113, which firmly fit the end portions of the sleeve and are threaded into the cross head bore in the manner illustrated in Fig. 5. The cross head has adjustable bearing pieces 110, 111 (Figs. 5, 7) for taking up wear in order to keep the container on the proper center line.

While the container cross head may be moved in any suitable manner, as here shown as an example, it is moved forward, i. e. toward the die or in the direction of extrusion, by piston rods 114, 115 (Figs. 12, 46), the free ends of which abut the cross head. These pistons work in the fluid pressure cylinders 116, 117 under constant pressure. The cross head is moved back in the opposite direction by means of piston rods 283, 284 (Figs. 30 and 46) working in the cylinders of fluid pressure units 281, 282 and also arranged to abut the cross head. It will be noted that piston rods 114, 115 are of smaller diameter than piston rods 283, 284. Consequently the constant pressure of units 116, 117 is effective only when units 281, 282 are at exhaust.

As appears in Fig. 12 cylinders 116, 117 are formed in the main ram 170, later more fully referred to. As this ram reciprocates, the cylinders, of course, move with it. There is provided means for delivering pressure fluid to these cylinders without the use of flexible pipes. This may be accomplished by telescoping conduits. As here shown as an example, (Figs. 18, 19) a stationary pipe 120, adapted for connection in the pressure line, extends through a suitable packing into a cylinder or conduit 121 carried by the main ram and which telescopes the pipe as the main ram moves. Cylinder 121 is connected with pressure fluid cylinder 117 by a pipe 122 and with pressure fluid cylinder 116 by a pipe 123 both of which pipes are carried by the ram. With this construction flow of pressure fluid is not interfered with by the movement of the ram.

For the reception of the billet the container is advanced and the main ram withdrawn. With the parts in this position a billet is brought into line between container and ram as above described. In order to avoid having the extruding plunger make direct contact with the billet, a dummy block is used. There is provided means for positioning a dummy block 126 behind the billet. This dummy block is of the same diameter as, but shorter than, the billet. In the present embodiment, a seat 128 (Fig. 8) for the dummy block is carried on a slide 127. This slide is formed on a piston rod 129 the piston 130 of which operates in a pressure fluid

cylinder 131. When the slide is withdrawn, seat 128 is located just below the mouth of a chute 133. A dummy block supplied to this receptacle, as later described, slides down the chute onto the seat for transfer to position in line with the billet.

Upon the advance stroke of piston rod 129, seat 128 is moved obliquely upwardly to position the dummy block behind the billet.

There is provided a mandrel for cooperating with the extrusion die in the formation of tubes and in structures embodying the invention to what is now considered the best advantage the mandrel is carried by the main plunger but is movable independently thereof. This mandrel, in the present embodiment, is utilized to hold the billet and dummy block in place so that holder 84 and slide 127 may be withdrawn out of the way. Although capable of various constructions, in that here shown as an example, an extrusion mandrel 141 (Fig. 12) is threaded into the end of a mandrel extension rod 145 slidable in the forward end of the main plunger 170. This extension rod is connected with a cross head 143 slidable in a suitable opening in the main ram. To this end, the inner end of extension rod 145 has a head 144 which seats in a mandrel carrier block 147. This block, later more fully described, has a sleeve portion, as appears in Fig. 12, embracing the inner end of extension rod 145. As later described, block 147 is slidable sidewise, that is, to and from the plane of Fig. 12 to remove the mandrel. It is held to the cross head 143 as respects forward and back movement, i. e. along the axis of extrusion, by upper and lower guides 143*a*, 143*b*, which are bolted to the forward end of the crosshead and take over suitable shoulders on block 147, as shown in Fig. 12. Extending into an internal bore 161 in cross head 143 is the end of a piston rod 149 the piston 150 of which works in a fluid pressure cylinder 153 formed in the main ram 170. The forward end of this piston rod is tapered to take into a tapered recess in the head of extension rod 145. When piston rod 149 is advanced, it pushes rod 145 forward to advance the mandrel, cross head 143 being moved forward by the engagement of block 147 with guides 143*a*, 143*b*. The reverse movement of the mandrel is later described.

Since cylinder 153 is formed in the main ram, means is provided for supplying pressure fluid regardless of ram movement. This may be accomplished by telescoping conduits. In the exemplification here illustrated, cylinder 153 is arranged to have a variable pressure at each end. Pressure fluid, e. g. air, is admitted to one end of the cylinder through an inlet port 163 (Figs. 12, 21) which communicates with a pipe 169 (Figs. 19, 20) leading to a valve unit 853 on the main ram. This valve unit is connected with a pipe or conduit 168 carried by the ram and telescoping over a stationary pipe 167 as the ram moves. Pipe 167 is tapped into a stationary casting 181 (Fig. 23), later referred to, and communicates with a tapped hole 166 connected to the pressure line. The other end of cylinder 153 receives air through a port 163A (Fig. 21) at the end of a bore 173A in the main ram. This bore communicates through a pipe 169A (Fig. 15) with valve unit 853 (Fig. 20). This valve unit is of any suitable construction, such as those elsewhere described, to connect either pipe 169A or pipe 169 with the pressure source, the other pipe being connected to exhaust.

Fig. 15 shows supplemental telescoping conduits 167*a*, 168*a*, normally idle, which may be connected up if it is desired to connect one end of cylinder 153 for constant return pressure.

After the billet and dummy block, which are centrally pierced (Fig. 47) have been positioned as above described, the mandrel is advanced and threaded through them. This supports the billet and dummy block and thus permits holder 84 and slide 127 to withdraw out of the way.

The main ram 170, which carries the extruding plunger, as later described, is, in effect, a large piston rod working in a fluid pressure cylinder 172 (Fig. 25). This cylinder is formed within a large casting comprising a rearwardly extending cylindrical portion 176, a wide central portion 180, and narrower upper and lower wing portions 181, 182. This casting is securely but adjustably anchored to tie rods 108, 109. To this end, as here shown, the ends of the tie rods are screw-threaded and pass loosely through bores in the wing portions of the casting. At the front side, the wing portion 181 is recessed to receive a countersunk nut 178 threaded onto the tie rod and at the rear side is a split nut 179. Duplicate nuts are provided on the lower tie rod. These nuts adjustably anchor the casting to the tie rods.

The rear portion of the main ram 170, that is, the right hand end as viewed in Fig. 12, works in the cylinder 172 as a piston and the ram is advanced by the variable, i. e. valve controlled, pressure in this cylinder. The forward portion of the ram has bearing members 170*a*, 170*b*, riding on tie rods 108, 109, to guide the ram in its movement. In the present embodiment, the extrusion plunger is removably and adjustably mounted on the main ram. To this end, as shown, extruding plunger 201 (Fig. 12), tubular to accommodate the mandrel, is secured to the forward end of ram 170. The inner end of plunger 201 has a plurality of stepped shoulders or collars 203, 204. Fitting over these stepped shoulders with a loose fit is a retaining ring 206. This ring is bolted to the annular front end of plunger 170. The inner

rim of ring 206 takes into a recess formed in the end of the ram, as appears in Fig. 12. Threaded through equally spaced radial holes in retaining ring 206 (Fig. 18) are a plurality of adjusting screws 205. The ends of these screws bear against the peripheral surface of shoulder 203 on the plunger. With the construction described the extruding plunger is held on the center line and its position may be trued by the adjusting screws. Between the inner end of the plunger 201 and the ram is a pressure-transmitting ring 208 (Fig. 12) of hardened steel.

In the present embodiment the billet and dummy block are inserted in the container chamber by a preliminary advance of the main ram. This takes place after or partly simultaneously with the advance of the mandrel. The preliminary stroke is sufficient to push the billet and dummy block, now strung on the mandrel, into the container chamber. Fig. 47 illustrates the parts with the billet and dummy block held by the holder 84 and slide 127 (not shown). Fig. 48 shows the mandrel advanced through the dummy block and billet. The main ram is advancing and the extrusion plunger has already inserted the billet. In Fig. 49 the advancing ram has partly inserted the dummy block.

The metal of the hot billet in the container chamber is extruded by the ram, through a die. While the extrusion die and its associated parts may vary in construction, in the embodiment here illustrated as an example, a die holder 221 (Figs. 31–35), having a bore 225, is mounted in a recess in the face of a large casting 210. This casting rests loosely on floor rails 212, to accommodate expansion and contraction of the tie rods and other parts. The casting is generally cylindrical, with upper and lower wing portions 213, 218, bored to receive the tie rods 108, 109. The casting is adjustably secured to the tie rods by countersunk nuts 214, 216, and split nuts 215, 217, like the nuts 178, 179, above described.

Removably secured in the die holder is an extrusion die 223 having the proper bore to give the extruded tube the desired outside diameter. The inside diameter is, of course, governed by the mandrel. As shown, the die (Figs. 33, 35) seats in a recess in the face of a holder 221 and has a suitable groove interlocking with an arcuate tongue 221*a* on the lower wall of the recess. Above the die is a removable wedge shaped piece 223*a* seating in the recess of holder 221 and having an arcuate tongue 221*b* which forms a continuation of tongue 221*a* to take into the groove of the die. Locking piece 223*a* is normally held in position by a locking pin 223*b*. Upon removal of this pin, piece 223*a* may be lifted away and the die removed.

Means is provided for adjustably centering the die. To this end, as here shown, die block 221 is loosely mounted within a boss 211 (Figs. 33, 35) on the casting 210. Threaded through this boss are a plurality of micrometer adjusting screws 222 bearing against the periphery of holder 221. By manipulation of these screws, the holder 221, and hence the die, may be properly centered and retained.

The invention in its entirety includes means for centering the mandrel and in structures embodying the invention to what is now considered the best advantage, the mandrel is first centered by a centering tool and thereafter is held by a preliminary upset of the billet. The mandrel centering tool may conveniently be mounted so as to be interchangeable with an extrusion guide conduit. Although capable of various constructions, in that here shown as an example, the centering tool is a rod 227 (Fig. 33) having a conical head 228 arranged to fit into the conical discharge mouth of the die bore. This head has a tapered recess 229 to take over the tapered end of the mandrel 141. Rod 227 is connected, at its other end, with a reciprocating sleeve 231 to have a certain amount of universal play. To this end, as shown, the inner end of rod 227 has a rounded head 232 which is confined in the socket 230 of a shouldered socket piece 236 held to the sleeve by an end nut 237.

To advance and withdraw the mandrel centering rod 227, sleeve 231 is slidable endwise in a pivoted carrier 233. To reciprocate the sleeve, it is connected, as here shown, by a connection later described, with a slide 238 somewhat like an inverted planer slide. The hooked end of this slide is connected with the end of a piston rod 239, the piston 240 of which works in a fluid pressure cylinder 241, valve controlled at each end.

The centering rod being advanced to the position shown in Fig. 33, its head fits in the die bore whereby it is accurately centered. Any necessary play is taken up by the ball and socket connection described. When the mandrel is advanced, as above described, its tapered end takes into the tapered recess in the head of centering rod 227, whereby the mandrel is accurately centered with respect to the die. This contact, of course, stops the mandrel.

With the mandrel thus definitely held in centered position, the main ram is advanced to cause a preliminary upset of the metal of the billet sufficient to cause the metal to fill out the container chamber and flow into the annular space between the end of the mandrel and the die bore. As a result, the upset metal grips the mandrel and holds it in its centered position so that the centering rod 227 may be withdrawn. This preliminary or upsetting advance of the main ram may conveniently be the same advance that inserts the billet, as previously referred to. Referring

back to Figs. 48, 49, these figures represent the preliminary stroke of the ram, with the extruding plunger pushing the billet and dummy block into the container chamber. The mandrel is shown centered by centering rod 227. Fig. 50 represents the position of the parts at the end of this preliminary advance of the main ram. Extruding plunger 201 has upset the billet sufficiently for the metal to grip the mandrel and mandrel centerer 227 has been withdrawn. The method of controlling the stroke of this preliminary advance is hereinafter described.

There is provided means for preventing retractive movement of the centering rod 227 during the preliminary upset of the billet above described. To this end, as here shown on the upper face of slide 238 is a brake block 295 (Fig. 31) adapted to engage a braking surface 296 formed on the underside of a pivoted lever 297. The free end of this lever is connected by a link 299 with a spring 298 secured to a bracket 299*a*. Should slide 238 have a tendency to move, during the preliminary upset, such movement is prevented by the braking action of lever 297 spring-pressed against block 295.

There is provided a guide conduit for the extruded tube and in structures embodying the invention to what is now considered the best advantage, this guide conduit is mounted on a carrier which also carries the mandrel centering tool and is movable across the axis of the die to position these elements alternately. Although capable of various constructions, in that here shown as an example, a swinging carrier 233 (Figs. 33, 34) carries a guide conduit or tube 235. The sleeve 231 of the mandrel centering tool is slidable in this carrier, the sleeve and conduit being disposed on different radii. Carrier 233 is pivoted by pins 243, 244, to lugs 245, 246, on an extension to the casting forming cylinder 241. To accord with the pivotal movement of the carrier, sleeve 231 of the mandrel centering unit is pivotally connected to slide 238 by a pin 209 passing through a lug 209[a] on the slide. To swing the carrier on its pivot, the lower part of the carrier has a gear sector 247 (Fig. 34) meshing with a rack 248 on a double pistoned piston rod 249. The left hand piston, as viewed in Fig. 34, which is the larger, works in a variable pressure fluid cylinder 242. The other piston works in a constant pressure cylinder 234.

After the preliminary advance of the main ram and withdrawal of the centering tool 227, piston rod 249 is moved to the left (as viewed in Fig. 34). This swings carrier 233 on its pivot to move the mandrel centering unit out of line and substitute guide conduit 235. In this position, as represented in Fig. 50, the conduit adjoins the end of the bore through the die carrier to receive the emerging extruded product.

The main ram is now advanced into the container on its extruding stroke, whereby the metal of the billet is extruded in the form of a tube 1*a*. This tube passes out through bore 225 in the die holder and is received by guide conduit 235 (Fig. 51). In the present embodiment, the main ram is given its preliminary stroke under relatively low pressure and its extruding stroke under high pressure. Pressure regulating valves are known and means for an automatic pressure change is disclosed in applicant's copending application Serial No. 94,334, filed March 12, 1926.

After the mandrel centering tool is withdrawn, and upon the extrusion stroke of the main ram, the mandrel is carried forward to substantially the position represented in Fig. 51. This movement is due in part to the continued stroke of piston rod 149 (Fig. 12) and part to the advancing movement of the main ram which, as above described, carries the entire mandrel unit.

As soon as the extrusion operation is completed pressure is taken off the main ram and the mandrel is withdrawn.

In the present embodiment this mandrel withdrawal is effected in part by the piston rod 149, previously described but there is provided auxiliary means for giving additional force at the first part of the stroke. As elsewhere pointed out, unit 150, 153 is an air unit and the auxiliary means makes use of water pressure to insure the mandrel being freed from the billet stump. As here shown as an example, on the forward or die end of the main ram (Figs. 15, 19) are two fluid pressure units 393, 394 having piston rods 395, 396, arranged to abut bosses 397, 398 on mandrel cross head 143. These units are now placed under pressure to push back the mandrel cross head. At the same time cylinder 153 is placed under return pressure to withdraw piston rod 149. This results in a backward movement of the mandrel unit.

The parts are so arranged that the mandrel may be freed from piston rod 149 on this back stroke. As here illustrated as an example, the piston rod 149 has a collar 155 located in the inner space 161 in cross head 143. When the parts are advanced (Fig. 12) this collar is spaced from the end wall of space 161. At some point in the back stroke of the mandrel unit, the piston rod makes a differential movement, until collar 155 engages this end wall, thereby withdrawing its tapered end from the inner end of extension rod 145. The auxiliary units are used to free the mandrel from the stump. Thereafter the crosshead is pulled back by the engagement of collar 155, on piston rod 149, with the cross head. In either case the cross head movement withdraws the mandrel by the connection above described.

Means is provided for latching the man-

drel extension rod to hold it on the center line during this withdrawing movement. As shown, slidable in the inner space of cross head 143 is a grooved ring 159 pressed outwardly by a spring 157 bearing against collar 155. As appears in Fig. 14 this latching ring bears against the unit comprising block 147 and head 144 and counteracts any tendency of this unit to move sidewise, during withdrawal. This latching force, however is not sufficient to interefere with the positive sidewise pull on the block 147 later referred to. As appears in Fig. 13, when the mandrel unit is removed, as later described, the latching ring projects slightly beyond the face of the cross head. It is displaced inwardly against its spring by the act of replacing a mandrel. To limit the extent of projecting movement of ring 159, rod 149 carries a double ended stop pin 164 which takes into slots 165 formed in ring 159.

During this withdrawal of the mandrel the main ram is withdrawn. In the present embodiment this results from placing cylinder 172 at exhaust. Referring to Fig. 12, the main ram carries cylinders 116, 117, for the container advancing piston rods 114, 115. These rods, as above described, were advanced to move the container unit up against die-back casting 210 (Fig. 46). When the main ram was advanced, cylinders 116, 117 were telescoped over their piston rods due to the great pressure differential between these cylinders and ram cylinder 172. When cylinder 172 is placed at exhaust, the constant pressure in cylinders 116, 117, becomes effective. Since piston rods 114, 115 cannot advance because they abut the container, backed by casting 210, cylinders 116, 117, and consequently the main ram, move back.

There is provided means for delivering an extruded tube having one end pointed for threading into a draw die. This may be accomplished by crushing in the tube at the trailing end just in advance of the point where the tube is to be cut from the stump, whereby the tube has the proper point at the cut end. Although capable of various constructions in that here shown as an example, mounted on the die-back casting 210 are two pair of pointing tools equally spaced about the die axis (Figs. 35, 36). One pair which may be termed indenting tools comprises two diametrically located heads 253 formed to indent the extruded tube along a portion of its length. These indenting heads are carried on piston rods 254, the pistons 255 of which work in fluid pressure cylinders 256 mounted on the casting 210. The tools work through suitable radial openings 224 formed in boss 211 and die holder 221. Spaced 90° from these tools are two diametrically opposed gripping and crushing tools. These comprise heads 263 formed to correspond to the curvature of the extruded tube. The heads are mounted on piston rods 264, the pistons 265 of which work in fluid pressure cylinders 266. These tools also work through suitable radial openings like openings 224.

For the pointing operation heads 263 are first advanced to function as grippers to hold the extruded tube and prevent distortion of the metal outwardly under the force of the indenting tools. To this end, supplemental advancing means is provided to give these tools 263 the proper stroke, i. e. a stroke less than the full stroke of piston rods 264 for the crushing function. For this purpose, as shown, each rod 264 is connected to a cross head 274. This cross head is mounted on a pair of small piston rods 276, the pistons of which work in fluid pressure cylinders 280 formed in the casting of cylinder 266. The advance stroke of piston rods 276 moves tools 263 into gripping contact with the extruded tube (Fig. 55). While the extruded tube is so held, the indenting tools 253 are advanced to form elongated indentations in the tube (Fig. 56). Tools 253 are then withdrawn and tools 263, now functioning as crushers, are further advanced by their main pistons 265. This crushes in the tube walls, as illustrated in Fig. 57.

Following the pointing operation the extruded tube is severed from the sprue. To this end, as here shown as an example (Figs. 35, 36, 52, 53) a shearing tool or cutter 268 is carried by a rod 269 connected with a piston 270 which works in a fluid pressure cylinder 271 mounted on casting 210. The cutting unit is mounted just in front of one of the crushing tool units, that is, between the back of the die and the crusher unit (Fig. 36). This brings the line of cut at approximately the trailing end of the pointed portion of the tube. Advance of cutter 268, the tube being still gripped by the crushing tools, severs the tube (Fig. 53) which may be removed in any suitable manner. The cut end, as the tube is delivered from the press, is already pointed for threading into a draw die. The crushing tools are then withdrawn. In order to make sure of the proper withdrawal, each of the four pointing tools has a return spring 260. These springs are coiled about the tool rods and are confined between washers 261 on block 219 and nuts 262 on the rods.

The cutting operating leaves a waste stump 285 comprising an unextruded sprue and a short length of tube left in the die.

In the present embodiment the stump is withdrawn from the die and ejected from the container by a back movement of the container. To this end, following the cutting operation described, the container unit is moved back, away from the die, by means of piston rods 283, 284 (Figs. 30–46) already described. This back stroke of the container unit withdraws the stump from the die and

then brings the dummy block against the end of the withdrawn extrusion plunger 201 to expel the stump from the container chamber (Fig. 53).

In the present embodiment, the parts are so arranged that at the end of this back stroke of the container the stump is out of the container chamber and the joint between the stump and dummy block is substantially in the plane of the face of the container. To this end, means is provided for adjustably controlling the back stroke of the main ram so that the stump will have the position just referred to (Fig. 53). This may be accomplished by adjustable stops for engagement by the ram unit. As here shown as an example (Figs. 25, 26, 27), mounted on the tie rods just in advance of the main ram cylinder casting 180 are stops 183. Each stop comprises upper and lower saddle elements 183*a*, 183*b*, bolted together about the tie rod. The abutment portion of the stop comprises a three-piece plate carried by saddle element 183*a*. The middle piece 187 of the three is wedge-shaped and the end pieces 185, 186, are formed to provide a wedge-shaped slot, as appears in Fig. 26. As shown, rear end piece 186 is secured in place and front end piece 185 is adjustably held in place by a lock bolt 189, working in a slot 189*a*. Adjustment is made by moving the wedge-shaped piece 187 in or out, whereby the abutment piece 185 is moved backard or forward, sliding in a dove tailed groove in the saddle member, to have an adjusted stopping position. The wedge-shaped piece is moved by adjusting screws 190, 191, going through the saddle and threaded into the wedge from opposite sides in the manner of micrometer screws.

When the ram unit is moved back it engages stop plates 185 and its position at the end of the stroke is definitely fixed.

There is provided means for separating the stump from the dummy block in the event that they become "frozen" together during extrusion. Although capable of various constructions, in that here shown as an example, a cut-off 287 (Fig. 6) carries a knife-like element 289 and is mounted on a transverse slide 290. This slide is connected with a piston rod 291, the piston 292 of which works in a fluid pressure cylinder 293. Upon advance of slide 290 across the axis of the press, the knife 289 wipes across the face of the container and knocks or cuts off the stump 285 (Fig. 53) which falls into a pocket 294 (Fig. 6).

This pocket has a slanting floor and is open at the back. When the slide is advanced, as just described, crosshead casting 107 serves as a back or closure for the pocket. But upon return of the slide to its original position (Fig. 6) the pocket is carried beyond its back wall and the stump slides out of the pocket and out of the press, e. g. onto the floor.

In the present embodiment the dummy block is carried away by this same operation of the slide 290. To this end, as soon as the knife has knocked off the stump, in the left hand movement of the slide (Fig. 6) the main ram is advanced sufficiently to kick out the dummy block from the container. The dummy block is received by a holder 300 carried by slide 290. The main ram is at once placed at exhaust and again returns to withdrawn position by pressure in cylinders 116, 117, as previously described.

Since the slide 290 is carried by the container cross head and since the latter moves back and forth along the axis of the press, there is provided telescoping means for supplying pressure fluid, in this case water, to cylinder 293. To this end, as here shown as an example (Fig. 6) fluid is supplied to the variable pressure end of the cylinder through a conduit 293^a connecting with a pipe 293^b leading to a coupling 293^c. This coupling is connected by a pipe 293^d (Fig. 3) which passes into a stuffing box 293^e bolted to the tie rod 109. Tapped into this stuffing box is a pipe 293^f supported by a bracket 293^g. Pipe 293^d telescopes inside of pipe 293^f as the container cross head reciprocates. In the side of stuffing box 293^e is a tapped hole 293^h which may be connected with the pressure line in any suitable manner. The constant return pressure end of cylinder 293 receives pressure fluid, through a bore 293^i (Fig. 6) communicating through a suitable bore (not shown) with a pipe 293^k leading to a coupling 293^l (Fig. 4). Leading from this coupling is a pipe 293^m passing into stuffing box 293^n. Also tapped into this stuffing box is a pipe 293^o within which the pipe 293^m telescopes. Fluid is supplied to the stuffing box through a bore 293^p which may be direct connected in any suitable manner to the pressure line.

After the dummy block is removed from the container it is reconditioned for further use. To this end, there is provided means for trimming the bore and the outer surface of the block. Although capable of various constructions, in that here shown as an example, upon the return stroke of slide 290, the dummy block is brought into line (Figs. 10, 11) with a conduit 301 leading to a trimmer 302. This trimmer has a bore 310 provided with a bell mouth for reception of the block. Located in equally spaced radial openings in the trimmer housing 302 are three spring-pressed slidable holders 314 carrying trimming knives 317. As appears in Fig. 11, these knives 317 are so arranged as to form a complete circular cutting edge for trimming the outside of the dummy block, the springs serving to position the knives so as to project normally into the bore 310.

The dummy block is pushed through this

trimmer by a combined pusher and scraper. This element comprises a head 303 (Figs. 30, 31) mounted on a piston rod 305, the piston 306 of which works in a pressure fluid cylinder 307 carried by die-back casting 210. On the head 303 is mounted a scraping device 304 comprising a flaring tube split in two directions at right angles to each other and formed with a knife-edge rim. This scraping tool is of a size to pass through the bore of the dummy block when collapsed inwardly. As piston rod 305 is advanced, the rim of scraper 304 engages the dummy block and pushes it forward until the block enters the bell mouth of the trimmer device (Fig. 10). The resistance of the spring-pressed knife holders 314 is sufficient to stop the dummy block temporarily, whereupon the scraper device 304 enters the bell mouthed bore of the dummy block and scrapes the same clean in its passage through the same. By the time the rim of scraper 304 has passed through the bore, head 303 engages the trailing end of the block and forces it forward. The dummy block being forced against the holders 314 spreads the same apart so that the leading end of the dummy block can clear the trimming knives. By the time this takes place the trailing end of the dummy block has entered an enlarged chamber 312 formed around the trimmer bore. The knife holders 314 being no longer held back close in under the force of their springs and knives 317 are thus held against the outer periphery of the block. As the block moves forward it is scraped clean by the knives, the scrap being received in chamber 312 from which it can pass out through an opening 313. The continued stroke of piston rod 305 pushes the dummy block on until it makes contact with the far wall of chute 133. The piston rod is then withdrawn to free the scraper device from the dummy block. Means is provided for preventing the block from following the scraper back. As shown, three spring-pressed latches 315 are spaced at equal intervals around the bore of the trimmer just inside the mouth of chute 133. As the dummy block moves into the mouth of the chute these latches are forced back against their springs but as the dummy block passes they drop down in behind the latter to prevent it from moving back with the scraper head. As the scraper moves back any scrap metal, e. g. a ring of scrap, is retained in enlarged chamber 312 by contact with the shoulders of knife holders 314 at the wall of the chamber.

The dummy block meanwhile has slid down chute 133 into pocket 128 for subsequent delivery to the press.

There is provided latching means for holding the dummy block to its seat. This comprises, as shown, a pivoted latch 137 having a heel 137^a and mounted on an L-shaped slide 137^f which is secured to piston rod 129. In the position of Fig. 8, the latch is held raised by a lever 137^b bearing against a stop 137^c on cylinder 131. As soon as piston rod 129 starts forward, lever 137^b moves away from its stop whereby the spring 137^d pulls down the latch until its heel 137^a engages the dummy block to hold it in its seat. This holds the dummy block to its seat on its travel to the press. The latch, however, in the Fig. 8 position acts to hold the dummy block from bouncing out of its seat after it comes down the chute. The mouth of the chute also prevents the dummy block from moving endwise in its seat. As the dummy block is moved into position on the line of the container chamber, a projection 137^e on the latch rides over extrusion plunger 201 and raises the latch so that the dummy block is free to be moved into the container as previously described.

Since the dummy block feed unit is carried by the container cross head, which reciprocates on the axis of the press, telescoping means is provided for delivering pressure fluid, in this case air, to cylinder 131. As here shown as an example the variable pressure end of this cylinder is connected by a pipe 131^a (Fig. 8) with a double coupling 131^b (Fig. 3). The complete piping is not shown and may be of any suitable arrangement. From the coupling a pipe 131^c leads to a double stuffing box 131^d. Also tapped into this stuffing box is a pipe 131^e within which pipe 131^c telescopes. The stuffing box and pipe 131^e are mounted on tie rod 108. Air is supplied to the stuffing box through a bore 131^f connected with the pressure line in any suitable manner. Air is delivered to the constant return end of cylinder 131 by a pipe 131^g leading to the other half of coupling 131^b. From this half of the coupling a pipe 131^h leads to the other half of stuffing box 131^d and telescopes within a pipe 131^i. A bore 131^k in the stuffing box is direct connected with the pressure line in any suitable manner.

Meanwhile the container unit has been advanced into original position against the die unit. As it takes this position, swinging carrier 233 is swung on its pivot to move guide conduit 235 out of line and replace the mandrel centering tool in line. The mandrel centering rod 227 is then advanced into centering position as previously described. The parts are now in a position for the next cycle.

Figs. 47–57 illustrate diagrammatically the successive steps of the extrusion press. In Fig. 47 the mandrel centering tool is in centering position and the billet and dummy block are in position for insertion in the container. In Fig. 48 the mandrel has been advanced to support the dummy block and billet and the slides (not shown) have withdrawn. The mandrel has advanced into the mouth of the die and is centered by the centering tool. The ram has advanced to

insert the billet and dummy block in the container. In Fig. 50 the ram has given the billet its preliminary upset to grip the mandrel, the centering tool has been removed and the guide conduit is in receiving position. In Fig. 51 the billet has been extruded into a tube. In Figs. 52 and 56 the ram and mandrel have been withdrawn and the pointing tools have indented the trailing end of the tube. In Figs. 53 and 57 the crushing tools have completed the pointed formation of the end of the tube; the cutter has severed the tube from the stump; the container has been moved back to eject the stump beyond the face of the container; and (in dotted lines) the stump has been separated from the dummy block. In Fig. 54 the ram has advanced slightly to eject the dummy block, which is being carried away to the trimmer. To complete the cycle the dummy block is trimmed and returned to its slide; the ram is again withdrawn; the container is advanced against the die; the guide conduit is removed and the centering tool substituted; and the dummy block and a new billet are moved into position. This returns the parts to the position of Fig. 47.

Provision is made for bleeding the main ram cylinder of entrapped air. As here shown as an example, a bore 172^s (Fig. 25) leads from cylinder to atmosphere. This bore is normally closed by a plug 172^t. In case the water system is drained, for repairs or the like, upon resumption of water flow, air may become trapped in cylinder 172 and interfere with proper operation. This air can be bled out by removing plug 172^t.

The invention in its entirety includes means for removing and replacing a mandrel. This may be accomplished by a mandrel exchange device carrying a plurality of mandrels into which the withdrawn mandrel may be transferred and from which a substitute mandrel may be inserted. In the present embodiment the exchange device has capacity for two mandrels so that one may cool while the other is in use. Although capable of various constructions, in that here shown as an example, block 147 has an arcuate extension 321 extending outwardly (Fig. 39) to the side of the main ram. At its end this extension has a hook 322 adapted to be engaged by a hook 323 on the end of one arm 324 of a bell crank lever pivoted at 327 on the frame 326 of the exchange device which is carried by the main plunger. The other arm 330 of the bell crank is pivoted to a link 331 pivotally connected to a bracket 333. This bracket is mounted on an L-shaped slide 335, the short leg 337 of which is secured to a piston rod 339. This rod is on a piston 341 working in a fluid pressure cylinder 343.

The mandrel unit having been withdrawn so that the mandrel clears extrusion ram 201 (Fig. 12) piston 341 is moved to the left (as viewed in Fig. 39). During the withdrawal of the mandrel, hook 322 is engaged by hook 323. By this movement of piston 341, block 347 is drawn outwardly to the position of Fig. 39, carrying with it the mandrel extension rod and mandrel. During this removal operation the forward end of the mandrel unit rests on an arcuate support 326*a*.

After the mandrel unit has thus been removed from the press it is placed in a cooling chamber and a cool mandrel substituted. To this end, as here shown, the mandrel exchange includes a housing 363 having capacity for a plurality of mandrels and having means whereby any one of the mandrels may be brought in line with the position of Fig. 39. This may be conveniently accomplished by a housing having a plurality of mandrel chambers, the housing having an indexing movement to place the desired chamber in the position referred to. In the present embodiment the housing has two mandrel chambers 346 and 361 (Fig. 45) located one above the other and the housing is indexed up or down to position the proper chamber.

Assuming the parts to be in the position of Figs. 39 and 45, the housing 363 is down and mandrel 141 has been removed from the press and is in line with chamber 346. As the mandrel unit takes the removed position the head 144 of extension rod 145 takes into a recess in a hook block 352 mounted on an L-shaped slide 354. The short leg of this slide is secured to the end of a piston rod 355 the piston 356 of which works in a fluid pressure cylinder 357. Upon movement of piston 356 to the right (as viewed in Fig. 39) slide hook 352 draws the mandrel extension rod and mandrel into chamber 346. Housing 363 has a slot 348 to accommodate the slide hook.

Housing 363 is now raised to move this cooling chamber out of line and bring the other chamber with its cool mandrel into line. To this end, as here shown as an example, housing 363 has a depending skirt portion 363^a adapted to have a sliding bearing in a box-like frame 370 forming part of the mandrel exchange unit (Fig. 45). The housing has a three point link suspension. Pivoted to lugs 371, 372 and 373 (Figs. 38, 45, 42) on housing 363 are links 374, 375, 376 respectively. These links are mounted respectively on rocker arms 377, 378, 379, in turn mounted on rock shafts 380, 381, 382. Rock shafts 380, 381 are rocked from shaft 382. To this end, mounted on shafts 380, 381, are rocker arms or levers 383, 384 pivoted to a link 385. This link is pivotally connected to a rocker lever 389 mounted on rock shaft 382. This latter shaft is rocked by a rocker lever 391 mounted thereon and pivoted to a link 386 connected by a cross head 392 with a piston rod 387. This rod is on a piston 388 working in a fluid pressure cylinder 390 valve controlled at each end. When piston 388 is

moved to the right (as viewed in Fig. 42) the three rock shafts are rocked clockwise (as viewed in Fig. 45), thus elevating housing 363. Reverse of piston 388 reverses the parts and lowers the housing.

As shown in Fig. 45, in the lower cooling chamber is a substitute mandrel unit 360 including block 360^a that is a duplicate of block 147. When housing 363 is elevated, the hot mandrel unit is brought out of line and the cool mandrel unit brought into line. This automatically places head 360^b of the substitute cool mandrel into the grip of hook 352 which is, as above described, at the end of its stroke opposite the position of Fig. 39. Similarly, substitute block 360^a is brought into the position formerly occupied by block 147, with its hooked end hooked into hook 323 of lever 324.

Upon reversal of piston 356, slide 354 moves to the left (as viewed in Fig. 39) and advances the substitute mandrel unit into the position formerly occupied by the hot mandrel unit (Fig. 45). Piston 341 is now given its reverse stroke and by a reverse movement of bell crank lever 324, 330 substitute block 360^a, carrying substitute mandrel 360, is moved into the press to the operative position of Fig. 12. On the next extrusion cycle, therefore, the substitute cool mandrel is used.

Meanwhile the first mandrel is cooling. If desired, the withdrawn mandrel may be subjected to a cooling medium, e. g. a blast of cool air, in any suitable manner.

After the next extrusion the operation of exchanging mandrels is the same except that the hot mandrel is received in the lower chamber (housing 363 being elevated) and the housing is then lowered to bring the cooled mandrel into line.

In the present embodiment the mandrel exchange is moved into and out of exchanging position and this movement is dependent on the position of mandrel cross head 143. To this end, as here shown as an example, the entire mandrel exchange unit is mounted on a trunnion 363^c (Fig. 45) journalled in and carried by the main plunger 170. On the exchange is a cam track 363^x (Fig. 39) arranged to be engaged by the rear corner of cross head 143 as the latter moves back to withdraw the mandrel from extrusion position. This engagement swings the mandrel exchange unit into exchange position (Fig. 39). The unit also has a cam track 363^y arranged to be engaged by a front corner of cross head 143. When the cross head is advanced to insert the mandrel in extrusion position, this engagement swings the exchange unit in the opposite direction, i. e. counter clockwise as viewed in Figure 39. The exchange unit is thus moved out of the way of the other parts for the extrusion operation.

There is provided means for conveniently removing a mandrel unit in case of wear or the like. This may be accomplished by removable elements which receive the mandrel unit while in the cooling chamber. Although capable of various constructions, in that here shown as an example (Fig. 45) the rear end of each cooling chamber of the mandrel exchange is normally closed by a removable element comprising a plug 346*a*, pinned into the open mouth of the chamber, and a handle 346*b*. Carried by the plug are two leaf springs 346*c*. The ends of these springs extend into the chamber beyond the plug and terminate in oppositely facing lugs 346*d*. These lugs extend into the path of head 144 (or 360*b*) on the mandrel extension rod. When the mandrel unit is drawn into the cooling chamber, as above described, the head spreads the springs and passes the lugs which then drop in behind the head. In this position, as shown in the lower chamber Fig. 45, the mandrel unit is latched in place during the movement of the cooling housing. When the mandrel is drawn forward again, for reinsertion in the press, the head simply wipes over lugs 346*d* to spread the same.

To remove a mandrel from the apparatus, the pin which holds plug 346*a* in place is removed. The plug element is then grasped by handle 346*b* and withdrawn. The two springs, with their lugs engaging the head of the mandrel unit, serve in the nature of a pair of tongs that draw the mandrel extension rod and mandrel out of the cooling chamber. A new mandrel unit is substituted by reversing the steps just described.

The invention in its entirety includes means for automatically effecting the operation of the various fluid pressure units whereby each succeeding machine operation is dependent for its initiation upon the completion of a preceding operation or operations. This may be accomplished, generally speaking, by control valves for the pressure units, which valves are, in turn, automatically controlled by electric circuits. While such valves and their controlling circuits may vary in construction and arrangement, a suitable form of valve and a suitable electric control are disclosed in a copending application filed March 12, 1926, Serial No. 94,334. For convenience, an example of one of these valve units is shown in Fig. 43. This valve comprises a valve chamber 411 having an inlet 412 connected with a pressure line, e. g. compressed air. The valve chamber has two cylindrical extensions 413, 414 of different diameter, the smaller one being opened to atmosphere and the larger one closed. In these extensions work pistons 415, 416 carried on a piston rod 417. Mounted on this piston rod is a D-slide valve 418. Opening out of the valve chamber 411 is an exhaust passage 419 leading to atmosphere and a passage 420 adapted for connection with the variable pressure end of an air-operated power cylinder. Under what may be

termed normal conditions, the pressure in the valve chamber holds the D-slide valve moved to the left, as viewed in Fig. 43. In this position passage 420 connects the controlled cylinder with the pressure line to advance the piston of the controlled unit. The D-slide valve is moved in the opposite direction by admitting air pressure, as by a by-pass through a passage 421, into the closed extension 413. When this takes place the D-valve is moved to the right, due to the piston differential, and the D-valve spans passages 419, 420. This connects the controlled cylinder with exhaust so that the piston of the unit moves back under its constant return pressure as previously described. When the passage 421 is again closed, the D-valve moves back to the left under chamber pressure.

As is more fully described in the application referred to, the admission of air via passage 421 is controlled by a solenoid-operated valve which connects the cylindrical extension either with the pressure line or exhaust. The circuit of the latter is controlled by a switch suitably placed to be actuated by some predetermined operation or at some predetermined time. A closed circuit may result in a closed solenoid valve or vice versa, according to the desired arrangement. These valve units may be termed, for convenience, magnetic valves.

For some purposes it is desired to operate the power unit in both directions by variable pressure. In that case, each end of the cylinder has one of these valve units, one end of the cylinder being at exhaust while the other end is connected with the pressure line.

In the following description of the automatic operation, the several air power units are referred to as being actuated by opening valve number so-and-so. It is to be understood that the word "valve" in this connection is intended to cover the complete unit including the D-slide valve and its controlling solenoid-operated valve, or some equivalent construction. In the drawings the reference numerals have been applied, for convenience, to the solenoid of the valve unit. Unless otherwise specified, an energized circuit for the solenoid is referred to as "opening" the valve. This means that the D-valve is in such position as to connect the controlled cylinder to main line pressure. Conversely, a "closed" valve, upon breaking of the circuit, means a D-valve in such position that the controlled end of the cylinder is at exhaust.

In the case of hydraulic power units, that is, units in which the machine part is actuated by water pressure, the controlled end of the cylinder, as described in the application referred to, has associated therewith a water inlet valve and a water exhaust valve, both of the poppet type. These water valves are actuated by pistons working in air cylinders, the air supply being controlled by magnet valves of the type illustrated in Fig. 43. In such cases valve chamber 411 has a third passage 420^a, indicated in dotted lines in Fig. 43, and adapted for connection with the air cylinder in place of a constant return connection. The D-slide valve, in such case, connects either end of the controlled cylinder with the pressure line, the other end being at exhaust. When the D-valve is in one position the water valve is opened, in the other position it is closed.

In the case of such hydraulic units, reference to an "open" valve means a D-valve in such position that the controlled hydraulic valve is open, be it the inlet or exhaust valve. Similarly a "closed valve" means a D-valve in such position that the controlled hydraulic valve is closed.

The application referred to discloses also a hydraulic unit in which both water valves are controlled from a common magnetic valve. In such case the air passages of the D-valve are cross-connected to the opposite ends of the air cylinders of the hydraulic inlet and exhaust valves. That is, in one position of the D-valve, one end of the air cylinder for the inlet valve and the opposite end of the air cylinder for the exhaust valve are connected with main line pressure, the other ends of the two cylinders being connected with exhaust.

In such cases reference to an "open valve" means a D-valve in such position that the hydraulic inlet valve is open and the exhaust valve closed so that the hydraulic cylinder is under pressure. A "closed valve" means a D-valve in such position that the inlet valve is closed and the exhaust valve open.

The piping diagram shows the units actuated by water power. Where only one "valve" is referred to in the case of a hydraulic unit, it is to be understood that it is of the cross-connected type just described.

The units not shown in this diagram are, in the present embodiment, air operated.

For certain uses some modification of the D-valve unit may be desirable. For example, in the case of the unit (cylinder 390) for holding mandrel exchange housing 363 raised or lowered, a control valve such as illustrated in Fig. 44 is used. This may be termed a "stay-put" valve. This unit has a valve chamber 426 connected with the pressure line by an inlet 425. In the valve chamber is a D-slide valve 427 mounted on a piston rod 428 having pistons 429, 430 working in cylindrical extensions 431, 432. These extensions are of the same diameter and are both closed to atmosphere. Opening out of the valve chamber are three passages. Passages 433 and 435 are connected with opposite ends of cylinder 390 and passage 434 to exhaust, e. g. atmosphere. The D-valve is arranged to span either of passages 433, 435 and exhaust passage 434 so that one end of cylinder

390 is receiving pressure and the other end is at exhaust.

Extensions 431, 432 both have air inlet passages like passages 421, each being controlled by a solenoid-operated valve. The D-valve is moved by admitting air to one of the cylindrical extensions, the other being at exhaust. Assuming the valve to be in the position of Fig. 44 it will stay put in that position even if the air pressure for right hand extension 432 is cut off, as by the closing of the solenoid-operated valve. It will remain in this position until pressure is admitted to the end of extension 431. Similarly, when moved to the right it will remain there until pressure is again admitted to extension 432, even though extension 431 is at exhaust.

The solenoid-operated valves may be conveniently controlled by having the coils in D. C. lines, in which are contactors or relays having their coils in A. C. lines. These latter may be controlled by one or more switches operated by the movement of some part of the apparatus. While these switches may be of any suitable construction Fig. 61 illustrates a convenient example. As shown, a housing 403 encloses a pair of contacts 401, 402 normally separated. Pivoted to housing 403 is an operating lever 405 its outer end projecting through a slot 404. This lever is spring-held in normal position, i. e. the position of Fig. 61. When the lever is moved on its pivot, the conductor pin 405^a, mounted on its inner end, is inserted between the contacts to bridge the same and close the circuit. If it is desired to have a normally closed circuit, the switch contact arms may be arranged to be normally in contact with pin 405^a, this contact being broken, on actuation of the lever, to open the circuit.

The several switches hereinafter referred to may conveniently be operated by means of cam elements carried by or moved by various parts of the apparatus. These cam elements act directly, or through an intermediate lever, on a roller 406 (Fig. 61) carried on the switch operating lever and which may be considered typical. By the formation and location of the cams and the arrangement of the switches, the desired time, type and duration of switch contact may be obtained to effect the circuit conditions hereinafter described. The type of actuation depends on the circuit condition desired and the character of the actuating part. For example, Fig. 61 illustrates a typical example of instances where it is desired to operate a switch as some moving part completes a stroke, the switch being held in actuated position until the moving part withdraws. As here shown, roller 406 is arranged to engage a cam 407 on a moving part 408. When the latter moves in the direction of the arrow of Fig. 61, the roller rides up the cam thus closing (or opening) the switch. The cam has a high on which the roll remains until the part typified by 408 is withdrawn.

Fig. 59 illustrates an example of instances where it is desired to operate a switch on relative movement of the parts in one direction only. The switch lever roller is engaged by a bell crank lever 405^b. Connected by a pin 405^s to one arm of this bell crank is a lever 405^c carrying a cam engager 405^d. This latter is arranged for contacting with a cam 405^e on a moving part of the apparatus 408^a. When the latter moves in the direction of the arrow in Fig. 59, engager 405^d slides up cam 405^e and the bell crank is swung on its pivot to actuate the switch lever. As the cam passes by, the lever swings back under its own weight. When part 408^a reverses its stroke, a bevel 405^t (Fig. 60) on the cam engages a like bevel on cam engager 405^d and swings lever 405^c on pin 405^s without affecting the bell crank so that the switch is not operated. As the cam passes by, lever 405^c is returned to normal position by a spring 405^h.

It will be apparent from the description of the circuits hereinafter which switches are operated by machine parts such as typified by parts 408, 408*a* and the several cams are not specifically referred to. Given the desired circuit conditions and the moving part involved it will be understood that the switch and cam may be arranged in any suitable manner.

In the present embodiment of the invention certain parts of the press, namely the main ram and the container crosshead, control the operation of a plurality of switches. There is provided means for operating a group of switches in timed relation with the movement of these units. This may be accomplished by grouping a number of switches and grouping the actuating cams on a drum that is rotated by the movement of machine part in question. To this end, as here shown (Figs. 23, 24, 28, 29), at the rear of the press, carried by the main ram cylinder casting, is journaled a drum shaft 2001 having a gear 2002 meshing with a rack 2003. This rack is connected by a tubular link 2004 with the main ram unit (Fig. 20). Also mounted on the drum shaft are a number of cams 2005 engaged by pivoted wipers 2006 which in turn engage the rollers like roller 406 of the typical switch of Fig. 61 of a number of switches elsewhere referred to. As the main ram moves, the drum and its cams are rotated to actuate the switches. By the arrangement of the high points of the cams and by the relation of switches and their wipers to the drum, the various switches are made to open or close at the proper time with relation to the ram movement to effect the circuit conditions hereinafter described.

A similar grouped set is mounted on the

opposite side of the main ram cylinder casting, its rack being connected by a tubular link 2007 with the container crosshead (Fig. 9). The switches of this set are actuated in timed relation with the container movement to effect the circuit conditions hereinafter described.

Links 2004, 2007 are tubular to serve as conduits for carrying wires to various parts of the apparatus.

In the embodiment of the invention here illustrated as an example, the solenoid coils of the various magnetic valves are included in circuits of a D. C. system. These circuits are controlled by make and break devices. For the automatic operation the make and break devices are relays or contactors comprising a coil, a core and a contact bar, the several contact bars having various contact terminals. Two types of contactors are here illustrated. In one a single lifting solenoid is used to raise a contact bar; in the other a pair of oppositely disposed solenoids move a contact bar into contact with one or another set of terminals depending on which solenoid is energized. The several contactors may be conveniently collected on a panel board.

The coils of the contactors are included in circuits of an A. C. system and these circuits are controlled by the switches above referred to and hereinafter mentioned.

The circuits controlling the several magnetic valves also have hand switches, which may be collected on a panel board, to enable an operator to control the various operations of the apparatus manually in case of an emergency and causing the parts to move into the initial position above referred to.

The wiring diagrams are shown in Figs. 64, 65 and 66. In the wiring diagram the several switches are shown and arranged diagrammatically. They are, however, in most cases, illustrated in the apparatus drawings.

In describing the automatic operation of the apparatus, it is assumed that the press parts are in the position in which an extruded tube has been pointed and cut, the container is away from the die, and the main ram is withdrawn (Fig. 53). The press parts may be brought to this position by manual control of the circuits and valves. As presently described, the automatic operation, in starting a run, is put into effect by means of certain hand switches. Thereafter the apparatus functions through successive cycles automatically without cessation, until stopped.

For starting the operation, a double-throw hand switch (not shown) is closed to connect up the current sources. The next step is to place all the controlling contactors in what may be termed an initial or normal setting. This setting is controlled by closing two contactors 603, 604. To this end, the desired operating coil of each of the several contactors is connected by means of a suitable conductor to one of a plurality of contacts 608 on contactors 603, 604. To simplify the diagram only one of the contacts is shown connected, namely, that connected with the right hand coil of contactor 609.

Contactors 603, 604 are closed by closing a hand switch 602 in a circuit including one side of the A. C. source on conductor 605, conductor 606, the coils of contactors 603, 604 in parallel, to the other side of the A. C. source on conductor 607.

Current controlling contactor 609 having been moved right, through the connection of its right magnet, with contactors 603, 604, is moved left by closing hand switch 896, the circuit extending from A. C. line 607, through its left magnet, conductor 897, switch 896, to line 605.

In tracing the circuits hereinafter described they will be ordinarily carried only to the nearest bus. A. C. line 607 connects through upper left contacts of contactor 609 (normally left) and conductor 613 to bus 614. This is connected by conductor 615 to bus 616. A. C. line 605 connects through the lower left contacts of contactor 609 to bus 625. D. C. line connects through current controlling contactor 640 (normally left) with bus 641, connected in turn to bus 642. D. C. line 647 connects through the same contactor and conductor 646 with bus 645.

The various contactors being thus placed in their normal or initial setting, the automatic operation is started by preparing circuits for opening control valve 611 of cylinder 293 to start slide 290 to the left, as viewed in Fig. 6. This is accomplished by closing hand switch 610. As a result, contactor 612 is moved to the left by the completion of the following circuit—from bus 616, to the left magnet of contactor 612, conductors 617, 618, contacts of hand switch 610, conductor 619, lower right contacts of contactor 620, which is normally to the right, conductor 621, contacts of switch 622 on the pressure control device (later described) and which is assumed to be closed at this time, conductors 623, 624, to bus 625. Contactor 626 now moves upward to close its contacts, being energized in a circuit which extends from one side of the A. C. source on conductors 607 and 616, previously traced, through the lifting magnet of contactor 626, upper left contacts of contactor 612, conductor 627, switch 628, which was closed by the withdrawal of the main ram to bus 625. Contactor 636 thereupon is energized to close its left contacts in a circuit also extending from one side of the A. C. source on conductor 616, through the left magnet of contactor 636, upper contacts of contactor 626, conductor 630, switch 631, also closed by the ram withdrawal, to bus 625.

Contactor 632 is energized to move toward the left in a circuit extending from one side of the A. C. source on conductor 616 through the left magnet of contactor 632, conductor 633, through the contacts of switch 634 on the trimmer and which, in normal position, is closed, conductor 635, upper right contacts of contactor 620, which is moved to this position initially, uppermost left contacts of contactor 636, conductor 637, contacts of switch 638, controlled by the container and which is closed with the container moved away from the die, conductor 618, closed hand switch 610, conductor 619, lower right contacts of contactor 620, conductor 621, contacts of switch 622, conductor 623, conductor 624 to bus 625.

This movement of contactor 632 prepares a circuit for energizing the coil of magnetic valve 611, traceable from bus 642 through the coil of the valve 611, conductor 644, upper left contacts of contactor 632 to bus 645. Valve 611, thus opened, controls the admission of water into cylinder 293 and slide 290 is advanced to knock or cut the stump off as hereinbefore described.

This movement of slide 290 closes a switch 650 to control the advance of the main ram for ejecting the dummy block. The lifting magnet of contactor 648 is now energized to close its contacts, the circuit extending from conductor 616 through the magnet, conductor 649, through the contacts of closed switch 650, conductors 651, 652, to the other side of the A. C. source on conductor 625. The closure of the contacts of contactor 648 effects the energization of the lifting magnet of contactor 653 in a circuit extending from conductor 616, through the magnet of contactor 653, conductor 654, next to the upper left contacts of contactor 636, right closed contacts of contactor 648, lower left contacts of contactor 632, to the other side of the A. C. source on conductor 625, as above traced. The closure of the contacts of contactor 648 also moves contactor 620 to the left over the following circuit—from one side of the A. C. source on conductor 616, left magnet of contactor 620, left contacts of contactor 648 to the other side of the source on conductor 625. The magnetic valve for intake valve 655 of cylinder 172 is now actuated, by a circuit extending from bus 645, upper contacts of contactor 653, conductors 657, 658, through the contact of switch 659, controlled by the main ram and which is closed with the ram in this position, conductor 660, lower right contacts of contactor 661, which is initially to the right, conductor 662 through the operating coil of valve 655, conductor 663 and emergency switch 665, (which is normally closed), conductor 664, through the contacts of switch 666 closed with the ram in its present position, to bus 641. The circuit for the operating coil of exhaust valve 656, as will later appear, is traceable through the lower contacts of contactor 653 and valve 656 is, therefore, closed, since the lower contacts of this contactor are open.

The lift of contactor 648 causes contactor 723 to move left, its circuit extending from bus 614 through left magnet of contactor 723, left contacts of contactor 684 (moved left initially as later described) upper contacts of contactor 648 to bus 625.

Valve 655, upon opening, admits pressure fluid into the main ram cylinder 172 advancing ram 170 to eject the dummy block, as above described.

As soon as the dummy block has been ejected from the container chamber, the ram is withdrawn again. To this end, upon the ejecting stroke of the ram, switch 667 is closed to effect closing of inlet valve 655 and opening of exhaust valve 656 of the main ram unit. On the closure of switch 667 contactor 661 is moved to the left in a circuit extending from bus 614 through the left magnet of contactor 661, inner right contacts of contactor 648, conductor 668, switch 667, to the other side of the source over conductor 625. Contactor 661 moving left breaks the circuit for valve 655 which closes. A circuit is completed for moving contactor 636 to the right, extending from conductor 616, right magnet of contactor 636, conductors 670, 671, left contacts of contactor 661, conductor 674, switch 673 which is closed with the container in this position, to conductor 625. Contactor 636 may also be swung to the right upon the closure of switch 669 which takes place upon further movement of the ram past switch 667, if the ram over-travels and carries the container with it, opening switch 673. The energizing circuit for contactor 636 then passes through the magnet of the contactor, conductors 670, 671, switch 669 to conductor 625. Upon the breaking of the left contacts of contactor 636 the circuit through the magnet of contactor 653 is opened, causing this contactor to drop. This also breaks the circuit for intake valve 655 as well as closing a circuit for exhaust valve 656, from bus 645, lower contacts of contactor 653, conductor 672, operating coil of valve 656 to conductor 663, and back to conductor 641 as previously traced for intake valve 655. Upon the resulting opening of exhaust valve 656, the ram moves back under the constant pressure of cylinders 116, 117. This movement of the ram effects return of slide 290 to normal position by causing valve 611 for cylinder 293 to close. To this end, as the ram moves back it closes, in passing, switches 675, 676. The closure of switch 675 causes contactor 661 to move to the right, the circuit for this contactor extending from conductor 614 through the right magnet of contactor 661, conductor 677, through the contacts of switch 675, to the

other side of the line on conductor 625. Closure of switch 676, completes a circuit to move contactor 632 to the right, this circuit extending from one side of the A. C. line on conductor 616, through the right magnet of contactor 632, lower left contacts of contactors 620, upper right contacts of contactor 636, conductor 678, through the contacts of switch 676 to the other side of the line over conductor 625. This opens the circuit of the operating coil of valve 611 whereupon this valve closes and slide 290 is returned to normal position under the constant pressure in cylinder 293 (Fig. 6), as above described. The return of the stump cutoff effects the opening of switch 650, which was closed upon its forward advance, opening the circuit to contactor 648 which thereupon falls, opening its contacts.

As the ram reaches its withdrawn position, switches 675 and 676 are opened and switch 631, also mounted to be controlled by the ram, is closed, whereupon contactor 636 is returned to the left over a circuit which extends from one side of the A. C. source on conductor 616, left magnet of contactor 636, right contacts of contactor 626, conductor 630, contacts of switch 631, to the other side of the line on conductor 625.

The return of slide 290 effects advance of the container unit to its normal position against the die by closing switch 679. As a result, contactor 682, initially to the right, is moved to the left, its energizing circuit extending from one side of the current source on conductor 616, through the left magnet of contactor 682, conductor 683, uppermost left contacts of contactor 684, conductor 685, upper left contacts of contactor 620, conductor 686, contacts of switch 679 to the other side of the line on conductors 651, 652, 625. The closure of switch 679 also moves contactor 687 to the left in a circuit which extends from one side of the line on conductor 616 through the left magnet of contactor 687, middle left contacts of contactor 620, over conductor 686 as traced with respect to contactor 682. Contactor 687, upon closing its left contacts, opens at its right contacts, the circuit controlling the operating coil of the intake valve 680 for cylinders 281, 282, causing this valve to close, and closes at its left contacts the circuit controlling exhaust valve 681, causing this valve to open. This latter circuit extends from one side of the D. C. source on conductor 641, conductor 696 through the operating coil of valve 681, conductor 688, left contacts of contactor 687, conductor 646, to bus 645. Thereupon the container crosshead is moved forward to its normal position against the die by piston rods 114, 115, actuated by the constant pressure in cylinders 116, 117, as above described.

The container unit, upon moving toward the die, passes and closes switch 689, whereupon contactor 620 is moved to close its right contacts, its circuit being traced from one side of the A. C. line on conductor 616, right magnet of contactor 620, upper left contacts of contactor 682, conductor 690, contacts of switch 689 to the other side of the line on conductor 625.

The movement of the container unit into normal position effects movement of swinging carrier 233 to remove the guide tube and bring the mandrel centering unit into line and also effects the advance of the piston rod 305 of the dummy block pusher-scraper. To this end, upon the end of the advance stroke of the container unit, switch 693 is closed. As a result, contactor 691, normally down, is energized to close its upper and open its lower contacts, its circuit extending from one side of the A. C. line on conductor 616, through the magnet of contactor 691, conductor 692, contacts of switch 693, to the other side of the line on conductor 625. Upon the opening of the lower contacts of contactor 691, the circuit for the magnetic valve 694 of cylinder 242 for carrier 233, which circuit extends over conductor 764 through the lower contacts of contactor 691, is opened. This opens valve 694, this being one of the units elsewhere referred to in which an open circuit opens the valve. By the pressure admitted to cylinder 242 the carrier is swung on its pivot to move guide conduit 235 out of line and place the mandrel-centering unit in line (Fig. 34).

The closure of the upper contacts of contactor 691 also opens valve 695 for cylinder 307 of the dummy block trimmer unit, to admit air thereto, the circuit extending from one side of the D. C. source on conductor 641, conductor 696, operating coil of valve 695, conductors 697, 698, hand switch 699, conductor 700, lower left contacts of contactor 682, conductor 701, upper left contacts of contactor 691, to bus 645. Thereupon piston rod 305 advances to push the dummy block through the trimmer.

The movement of carrier 233 just described effects advance of the mandrel-centering rod to centering position. To this end, upon the swinging movement of carrier 233, switches 702 and 703 are opened and switch 704 is closed. The closure of switch 704 moves contactor 705 to the left from its normal right hand position, the energizing circuit therefor extending from conductor 616, left magnet of contactor 705, upper closed contacts of contactor 626, conductor 706, contacts of switch 704, conductor 763 to bus 625. Valve 707 controlling the cylinder 241, which controls the lengthwise movement of the centering tool, is closed, its operating coil being energized in a circuit which extends from one side of the line on conductor 641, conductor 696, through the operating coil of valve 707, conductor 708, left contacts of contactor 705

to the other side of the line on bus 645. Unlike the majority of the magnetic valves, this valve 707 is of the type in which an energized solenoid means a closed valve, as is more fully explained in the copending application referred to. At the same time valve 709, controlling the other side of cylinder 241 is opened, its coil being energized in a circuit which extends from one side of the line on conductor 641, conductor 710, contacts of switches 711, 712, conductor 713, contacts of switch 714, conductor 715, contacts of switches 716, 717, conductor 718, operating coil of valve 709, conductor 719, left contacts of contactor 705 to the other side of the line on bus 645. Under these conditions, i. e. with the closure of valve 707 and the opening of valve 709, the centering tool is moved towards the die into centering position.

Meanwhile the dummy block pusher has pushed the dummy block through the trimmer and the completion of the advance stroke effects its withdrawal by closing switch 721. The closure of switch 721 causes contactor 682 to be moved to the right, the energizing circuit being traced from conductor 616, right magnet of contactor 682, conductor 722, switch 721 to conductors 652, 625. As contactor 682 moves to the right it breaks the circuit to the operating coil of valve 695, which extends through the left contacts of the contactor, causing this valve to close. Thereupon the piston 305 is reversed under constant return pressure in cylinder 307. The advance stroke of the dummy block pusher also closes switch 634.

The closure of the upper contacts of contactor 691 also controls advance of the billet and dummy block feeding slides. The circuit for valve 724 of billet slide cylinder 88 extends from bus 641 through the coil of the valve, conductor 725, closed hand switch 726, conductor 727, left contacts of contactor 636, left contacts of contactor 723, upper contacts of contactor 691 to bus 645. That for valve 730 of dummy block cylinder 131 extends from bus 642 through the coil of the valve, conductor 731, hand switch 726, conductor 732, left contacts of contactor 636, left contacts of contactor 723, upper contacts of contactor 691 to bus 645. Valves 724, 730 being opened the slides advance to position billet and dummy block.

This movement of the billet and dummy block slides effects advance of the mandrel by closing switches 733, 734. As a result, contactor 735 (normally right) now moves left in a circuit traced from bus 614 through the left magnet of contactor 735, conductor 736, switch 734, conductor 737, switch 733, to the other side of the line, on conductors 652 and 625. The closure of the contactor 735 to the left causes magnetic valve 738 to close the inlet and open the exhaust of cylinders 393, 394. The circuit for valve 738 extends over conductors 641, 642, operating coil of the valve, conductor 739, through the left contacts of contactor 735 to conductor 645. Thereupon mandrel 141 is moved forward under fluid pressure in cylinder 153 threading through the billet and dummy block until it engages the centering tool 228. The controlling valve 853 for this cylinder is opened as later described in connection with the automatic exchange of mandrels.

This movement of the mandrel controls the preliminary advance of the main ram to insert the billet and dummy block in the container chamber and give the billet its preliminary upset. To this end, the advance of the mandrel closes switch 740, whereupon contactor 741 is moved to the left, its circuit being traced from the A. C. source on conductor 614, left magnet of contactor 741, conductor 742, contacts of switch 740, to the other side of the line on conductors 652 and 625. Contactor 653 is now energized to close its upper contacts, its energizing circuit extending from conductor 616, through the magnet of contactor 653, conductor 654, left contacts of contactor 741, left contacts of contactor 612 (which was moved left to start slide 290 towards the center), to the other side of the line on conductor 625. The circuit for exhaust valve 656 is therefore opened and that for inlet valve 655 again closed, whereupon valve 656 closes and valve 655 opens, starting the main ram forward as previously described.

Meanwhile the mandrel has moved fully forward, opening switches 740 and 747.

The start of this advance of the ram effects withdrawal of the billet and dummy block slides by closing switch 748. Thereupon contactor 723 is moved to the right, its circuit extending from bus 614 through right magnet of contactor 723, conductor 752, switch 748, to bus 625. Valves 724 and 730 controlling the billet and dummy block slides 83, 127, respectively, now close because their energizing circuits, which were traceable through the left contacts of contactor 723, are opened upon movement of contactor 723 to the right. Thereupon both of these slides are withdrawn under constant pressure in cylinders 88, 131 (Figs. 2 and 8). Switches 733, 734 are opened by this movement of the slides.

Further advance of the ram closes switch 669 and opens switch 748, the closure of switch 669 causing contactor 636 to move to the right in a circuit traceable from conductor 616 through the right magnet of contactor 636, conductors 670, 671, contacts of switch 669 to conductor 625.

Continuing, the ram opens switches 666 and 669 before which time the dummy block and billet slides 127 and 83 have moved fully back, closing switches 753, 754, 755 and 756.

If the billet and dummy block slides have not properly withdrawn opening of switch 666 (just referred to) stops the ram, the

switch being in the normal circuit for inlet valve 655. But if the slides have withdrawn far enough to close switches 754, 755, the latter close a supplemental circuit for valve 655 from conductor 664 to bus 642.

Switch 628 is now opened by the ram, breaking the circuit through the magnet of contactor 626, which thereupon lowers, switch 757, also controlled by the ram, being closed by continued movement of the ram.

In order to be sure that the mandrel has been fully advanced before extrusion begins, the mandrel unit, in moving forward, as above noted, is arranged to open normally closed switch 747 at the same time that the ram closes switch 757. If the mandrel should fail so to open switch 747, contactor 741 would move right, upon closing of switch 757, its circuit extending from bus 614, through its right magnet, conductor 758, switch 747, conductor 759, switch 757, to bus 625. Contactor 735 would also move right, its circuit extending from bus 614 through its right magnet, conductors 775, 776, right contacts of contactor 741, conductor 758, switch 747, conductor 759, switch 757, to bus 625. Right movement of contactor 741 would cause contactor 653 to drop, thus breaking the circuit for valve 655 and stopping the ram. Right movement of contactor 735 would break the circuit for valve 738, reversing the mandrel. If switch 747 opens normally no such circuits are closed and the cycle proceeds normally.

Means is provided for automatically limiting the extent of this preliminary stroke of the main ram and in constructions embodying the invention to the best advantage the stroke is limited by a given main line pressure being attained, whereby the ram will not upset the billet sufficiently to extrude the same. As here shown as an example, associated with the main water line is a valve chest 510 (Figs. 62, 63) its valve chamber 511 being connected through an inlet 512 with the water line. Working in the valve chamber is a piston rod 513 which abuts a crosshead 515 sliding on rods 516, 517. Extending upwardly from the crosshead is a rod 518 carrying an arm 519 normally engaging spring-held, switch-operating lever 520. Movement of the piston rod 513 is opposed by a spring 521 confined between crosshead 515 and an adjustable abutment 515*a*. By adjustment of the latter the opposing force of spring 521 may be given various predetermined values. Lever 520 controls switches 743, 744 in such manner that when the lever is held up by its spring, switch 743 is closed and switch 744 is open. Switch 743 is in a series interlock with switch 746 controlling the centering tool withdrawal and switch 744 is in a parallel interlock with switch 659 controlling the main ram inlet valve. As soon as inlet valve 655 of the main ram unit is opened, as described, to advance the ram, the hydraulic pressure in the main line drops. As a result, rod 518 is moved down by spring 521, arm 519 actuating switch lever 520 to open switch 743 and close switch 744. As the ram reaches the point where it starts to upset the billet, the resistance starts to build up the main line pressure. When this pressure reaches a predetermined point, piston rod 513 raises crosshead 515 and rod 518 against the pressure of spring 521, thus permitting switch lever 520 to reverse. This closes switch 743 and opens switch 744. Switch 659 having been opened by the ram in passing the circuit previously traced for inlet valve 655 is broken. The closing of switch 744, however, closed a supplemental circuit comprising a loop between conductors 660 and 658 and passing through switch 744, conductor 720 and left contacts of contactor 705. This circuit is broken by the opening of switch 744 just referred to, whereby valve 655 closes. Consequently the ram stops. It does not withdraw, however, because its exhaust valve is still closed.

This movement of the ram also closes switch 746 and opens switch 757.

This movement and stopping of the ram effects the withdrawal of the mandrel centering tool, the mandrel now being held in centered position by the upset metal. To this end, closing of switch 743, as just described, causes contactor 705 to move to the right by closing a circuit extending from one side of the line on conductor 616, through the right magnet of contactor 705, conductor 760, contacts of switch 746, which closes immediately before the billet is upset, conductor 745, contacts of switch 743, to the other side of the line on conductors 624, 625. Contactor 705, upon moving to the right, breaks the circuit controlling valve 707, causing this valve to open, and breaks the circuit to valve 709 causing this valve to close. This reverses cylinder 241 and the centering tool is withdrawn from centering position. This right movement of contactor 705 will stop the ram by breaking the supplemental circuit for valve 655 in the event that switch 744 should fail to open.

With a valve control at each end of cylinder 241 two objects are accomplished. By placing the cylinder under exhaust for withdrawal of the centering tool a quicker withdrawal is effected than if the cylinder were under constant return pressure. This insures removal of the centering tool before any extrusion can take place. Also, by having the cylinder at exhaust when the centering tool is in centering position there is provided a strong net pressure to resist any tendency of the centering tool to be pushed away during upsetting of the billet.

Withdrawal of the centering tool effects reverse swing of carrier 233 to move the tool out of line and put guide conduit 235 in line. To this end, the centering tool, upon its back

stroke, passes and closes switch 761 which causes contactor 612 to move to the right by closing a circuit extending from conductor 616, right magnet of contactor 612, conductor 762, switch 761, to the other side of the line on conductors 763 and 625. This movement of contactor 612 closes a circuit for valve 694 extending from conductor 641, conductor 696, coil of valve 694, conductor 764, right contacts of contactor 612, to bus 645. Thereupon valve 694 closes and carrier 233 is given a reverse swing under constant pressure in cylinder 234 to place guide conduit 235 in line. It is noted that this unit is one of those, elsewhere referred to, in which a closed circuit closes the valve rather than opens it.

Closing of switch 761 and the subsequent movement of contactor 612 to the right also opens valve 709 by closing a circuit extending from conductors 641 and 710, through contacts of switches 711 and 712, conductor 713, closed switch 714, conductor 715, closed switches 716, 717, conductor 718, the coil of valve 709, conductor 719, right contacts of contactor 612, to bus 645. Upon opening of valve 709, pressure fluid is admitted to the right end of cylinder 241 (as viewed in Fig. 33) for advancing the centering tool in the next cycle. It is meanwhile ineffective against the pressure in the other end of the cylinder, valve 707 being still open.

Switch 761 is opened by the continued withdrawal stroke of the centering tool.

The swing of carrier 233 just described effects the advance of the main ram for the extrusion operation. To this end, the carrier, in the movement referred to, opens switch 704 and at the end of its movement closes switches 702, 703.

The closure of switch 703 forms another supplemental loop between conductors 658, 660 and so closes a circuit for inlet valve 655 and the ram starts forward again on its extrusion stroke.

In the present embodiment, the above described operations are carried out under relatively low water pressure. For the extrusion stroke of the ram, however, relatively high water pressure is utilized. The pressure control is here indicated diagrammatically but is more fully shown and described in the copending application referred to. Referring more particularly to Figs. 58 and 66, leading from the pressure side of a pump unit 500 is the main water pressure line 501. Associated with the main line is a piston-like relief valve 502 controlling a port 503 in a pipe 504 leading to the exhaust line 509. Also associated with the main line is a second relief valve 506 controlling a port 505 in a pipe 504. Between these two relief valves is a valve 507 controlling flow through pipe 504. Relief valve 502 is set to open upon an excess main line pressure above a high maximum and relief valve 506 is set to open upon an excess over a low maximum. When the system is under low pressure, control valve 507 is open. If the low maximum is exceeded relief valve 506 opens and the main line is thus opened to exhaust via pipe 504. To place the system at high pressure, valve 507 is closed, thus cutting off port 505 from exhaust even though relief valve 506 may open. If the maximum high pressure is exceeded, relief valve 502 opens to connect the main line with exhaust.

Valve 507 is operated by a fluid pressure unit controlled by a magnetic valve unit 768. This valve is energized to open and admit pressure to the cylinder to close valve 507 upon opening of valve 655 to start the ram. To this end, the movement of inlet valve unit 655 in opening closes switch 765 causing contactor 766 to move from its normal right hand position to the left. The circuit for this contactor extends from conductors 613, 614, left magnet of contactor 766, upper right contacts of contactor 612, conductor 767, contacts of switch 765, to conductor 625. The closure of contactor 766 to the left completes the circuit for energizing valve 768, the circuit extending from conductor 639, uppermost contacts of contactor 640, normally in its left hand position, conductor 901, operating coil of valve 768, conductors 772, 773, contacts of contactor 766, upper left contacts of contactor 735, to bus 645.

The ram now completes its advance under high pressure and extrudes the billet through the die into the form of a tube which passes out through guide conduit 235 as above described.

The completion of the extrusion stroke of the ram effects cutting off the high pressure, the return of the mandrel and the return of the ram itself. To this end, the ram, at the end of its stroke closes switch 774. This moves contactor 735 to the right, its circuit extending from conductor 614 through its right magnet, conductors 775, 776, switch 774, to conductor 625.

Contactor 735, upon breaking its left contacts, breaks the circuit controlling valve 768. As a result, valve 507 is opened to place the system under low pressure. This movement of the valve closes switch 622, previously referred to as being closed when the system is under low pressure. Upon closing of this switch contactor 741 moves to the right, the circuit extending from conductor 614, through the right magnet of contactor 741, conductors 758, 777, right contacts of contactor 735, left contacts of contactor 766, conductor 621, contacts of switch 622, to the other side of the line on conductors 623, 624, 625. If the pressure during the extrusion operation exceeds the predetermined value, the high pressure relief valve 502 opens to relieve the pressure and, in opening, closes

switch 778 before switch 774 closes. In such case the circuit for the right magnet of contactor 735 is traceable over conductors 775, 776, 779, contacts of switch 778 to conductors 624, 625.

Upon moving to the right, contactor 735 opens the circuit for valve 738, which reverses the condition of cylinders 393, 394, whereupon the mandrel unit starts back.

The right movement of contactor 741 opens the circuit for contactor 653 which drops. This breaks the circuit for valve 655, which closes, and remakes the circuit for valve 656, which opens, whereupon the ram also starts back under the constant pressure in cylinders 116, 117. Switch 774 is opened by the start of the ram withdrawal.

Withdrawal of the main ram effects operation of the pointing tools. To this end, as the ram moves back it passes and closes switch 780, which, in turn, moves contactor 781 from its normal right hand position to the left, the circuit for this contactor extending from conductor 614 through its left magnet, conductor 782, right contacts of contactor 741, conductor 783, contacts of switch 780 to conductor 625. This closes a circuit from conductors 641, 696, contacts of switch 702, conductors 784, 785, operating coil of valve 786, conductor 787, left contacts of contactor 781, to bus 645. The valve 786, being opened admits fluid pressure to cylinders 280, whereby the gripping tools 263 are advanced to grip the extruded tube, as before described.

Tools 263, upon moving inwardly, close switches 788 and 789 and these switches, upon closing, complete a circuit to open valve 790, which circuit extends from conductor 641, conductor 696, through the contacts of switch 702, conductors 784, 785, operating coil of valve 790, conductors 791, 792, left contacts of contactor 781, conductor 793, contacts of switches 789 and 788, conductor 794, to conductor 646. Valve 790, upon opening, causes the pointers 253 to move toward the extruded tube to indent its walls. The movement of the pointers 253 causes switches 717, 716, 712, 711, to open to prevent any possibility of the centering tool moving in during the pointing operation. When the pointers 253 have reached the end of their stroke, switches 795 and 796 are closed, causing contactor 797 to move to the left, this circuit extending from conductor 614 through its left magnet, conductor 798, switches 796 and 795 to conductors 652, 625.

The movement of contactor 797 to the left prepares the circuit for opening valve 799 for cylinders 265, 266, of the crushing tools 263, and cylinder 271 of the shears 268. The circuit for valve 799 extends from conductors 641, 696, contacts of switch 702, conductor 784, operating coil of valve 799, conductors 800, 801, left contacts of contactor 797, left contacts of contactor 781, conductor 793, contacts of switches 789 and 788, conductor 794 to conductor 646. Upon opening of valve 799 tools 263 are further moved in under pressure in their main cylinders to perform their crushing operation and shears 268 move down to cut off the finished tube from the stump.

This movement effects the withdrawal of the pointing tools and the withdrawal of the container unit away from the die by closing switch 802, whereupon contactor 803 is raised to close its contacts in a circuit extending from conductor 616, through the magnet of contactor 803, conductor 804, contacts of switch 802, to conductors 805, 625. Contactor 687 now moves to the right, its circuit being completed from conductor 616, right magnet of the contactor, through the closed contacts of contactor 803 to conductors 806, 625, whereupon valve 680 is opened and valve 681 is closed starting the movement of the container away from the die under the control of rods 283, 284, in cylinders 281 and 282. The circuit for energizing the operating coil of valve 680 extends from conductor 646 through the right contacts of contactor 687, conductor 807, operating coil of inlet valve 680, contacts of switch 753, contacts of switch 756 to conductors 642, 641; and the circuit to exhaust valve 681 which was traced through the left contacts of contactor 687 is broken. Switch 693 is opened by the movement of the container away from the die, causing the magnet of contactor 691 to become deenergized, opening its upper contacts and closing its lower contacts.

At the same time that contactor 803 causes contactor 687 to swing to the right, the closing of its contacts also energizes the magnet of contactor 781, causing it to move to the right, the circuit for this contactor extending from bus 614 and its magnet through the upper contacts of contactor 803 and conductor 806 to conductor 625. Thereupon the circuit controlling valves 786, 790, 799 is opened, closing these valves, whereupon the pointers and shears withdraw. The shears unit, in retracting, closes switch 714 and opens switch 802 causing contactor 803 to become de-energized. Switches 788, 789 and 795, 796 are also opened and switches 717, 716, 712 and 711 are closed.

The container unit in moving away from the die passes and closes switch 689, completing an energizing circuit for contactor 797 which causes this contactor to be moved to the right. This circuit extends from conductor 614, right magnet of contactor 797, through the right contacts of contactor 682, conductor 690, the contacts of switch 689 to bus 625. The movement of contactor 797 to right closes a circuit for reopening valve 768. This circuit extends from conductor 639 through the valve to left contacts of contactor 766 as previously traced, thence through left contacts of

contactor 797, right contacts of contactor 687, to bus 646. Opening of valve 768 causes pressure control valve 507 to close and build up the high pressure for the purpose of ejecting the stump from the container on the next cycle, as above described.

Upon continued withdrawal of the container, switch 689 is opened and switches 638 and 673 are closed, whereupon contactor 766 moves to the right, by a circuit extending from conductor 614, right magnet of contactor 766, upper right contacts of contactor 661, conductor 674, switch 673 to bus 625. This breaks the circuit for valve 768 which closes, opening pressure control valve 507, to put the system under low pressure control for the next cycle.

Switch 638 is used as an interlock for the start of the succeeding cycles. Upon its closing, contactor 632 is moved left by the closing of the circuit previously described. This movement of contactor 632 depends on the preliminary steps originally initiated by the closing of hand switch 610. These steps are repeated in subsequent cycles as follows: When contactor 741 goes right, as above described, at the end of the extrusion stroke, contactor 612 goes left by a supplemental circuit extending from bus 616, through the left magnet of the contactor, conductors 617, 618, hand switch 610, conductor 619, lower right contacts of contactor 620, lower left contacts of contactor 766, right contacts of contactor 735, conductor 777, lower right contacts of contactor 741, conductor 776, switch 774, to bus 625. As the ram is withdrawn switches 628 and 631 are closed, whereupon contactor 626 lifts and contactor 636 goes left, the circuits being those described. Thus conditions are ready for contactor 632 to move left as soon as switch 638 closes.

In the above description of the automatic press cycle the mandrel exchange device was omitted. This device may be included in the automatic cycle or not, as may be desired. If it is cut out, the same mandrel is used over and over. If it is to be included, the controlling circuits are cut in by moving a double-throw hand switch 810 (Fig. 66) to the upper of its two positions. Thereafter the exchange unit is controlled by the mandrel unit. As the latter withdraws after an extrusion operation, it passes and closes switch 811, completing a circuit from conductors 625, 624, cutout switch 812, conductor 813, contacts of switch 811, contacts of switch 814 which is closed at this time, conductor 815, left magnet of contactor 816 to conductor 614. Contactor 816 now swings to the left, closing its left contacts to prepare a circuit for the exchange apparatus.

By this time the mandrel unit has closed switch 817, whereupon a circuit is completed for closing the valve 818 controlling cylinder 343, this being another instance of a closed circuit closing the valve. This circuit extends from conductors 641, 642, operating coil of valve 818, contacts of switch 817, conductors 819, 820, left contacts of contactor 816 to conductor 646. Valve 818 is thereupon closed to put cylinder 343 under constant pressure and piston rod 339 is operated to swing bell crank 324, 330, thus removing the hot mandrel unit from press position to the position of Fig. 39. This stroke of piston rod 339 opens switches 814 and 821, preventing further operation of the mandrel control until the new mandrel is in place. At the same time, switch 822 is closed by the piston rod, completing a circuit for lifting contactor 823 which extends from conductors 625, 652, contacts of switch 822, conductor 824, left contacts of contactor 816, magnet of contactor 823, to conductor 614. Contactor 823 closes, through its own contacts, a holding circuit for itself which circuit extends from its magnet through its upper closed contacts, conductor 825, contacts of switch 826 to conductor 652.

As the piston rod reaches the end of its stroke, switch 827 is closed, whereupon a circuit is established from conductors 625, 624, contacts of hand switch 810, conductor 828, contacts of switch 827, conductor 829, other contacts of switch 810, conductor 830, contacts of switch 831, conductor 832, upper contacts of contactor 823, left magnet of contactor 833 to conductor 614. Contactor 833 is energized in this circuit and swings to the left, establishing a circuit extending from conductor 641, operating coil of valve 834, conductor 835, upper contacts of hand switch 810, conductor 836, left contacts of contactor 833 to conductor 646. Valve 834 being thus opened, admits pressure to cylinder 357 and the advance of piston rod 355 draws the mandrel into the cooling chamber. During this movement, switches 831 and 826 are opened and at the end of the stroke switch 838 is closed and switch 826 is closed. The momentary opening of switch 826 breaks the holding circuit for contactor 823, which drops and the closing of switch 838 prepares a circuit for raising or lowering the cooling housing, depending on which chamber the cool mandrel is in.

The direction of movement depends upon the position of contactor 837, valve 839 or 840 being operated, as the contactor is to the right or left respectively. Let it be assumed that contactor 837 is in the right hand position, that is, that the cool mandrel is in the lower chamber. It is, therefore, necessary to raise the housing. With contactor 837 to the right and contactor 833 to the left, the closure of switch 838 establishes a circuit extending from direct current on conductor 642, operating coil of valve 839, conductor 841, contacts of hand switch 810, conductor 842, right contacts of contactor 837, left con-

tacts of contactor 833, conductors 843, 844, contacts of switch 838, conductor 845, contacts of hand switch 810 to conductors 846, 645. Pressure fluid is thereupon admitted to the left end of elevating cylinder 390 as viewed in Fig. 42 and the housing is raised, as hereinbefore described. As soon as the housing is completely raised, switch 847 is closed, establishing a circuit for contactor 837 for moving this contactor to the left so that, upon the completion of the next extrusion operation, the housing may be lowered to bring the upper mandrel into position. This circuit is traced from conductor 652, contacts of switch 847, conductor 848, contacts of double-throw switch 852, controlled from contactor 837, operating magnet of contactor 837, right magnet of contactor 833 to conductor 614. This circuit also causes contactor 833 to move to the right. It is noted that contactor 837 has but one magnet and is arranged to move back and forth upon successive energizations of the magnet.

Upon the next cycle contactor 837 is thus left and the circuit closed by the closing of switch 838 closes a circuit for opening valve 840, whereupon pressure is admitted to the other end of cylinder 390 and the housing is moved downwardly. This circuit extends from conductors 641, 642, coil of valve 840, conductor 849, contacts of switch 810, conductor 850, left contacts of contactor 837, left contacts of contactor 833, conductors 843, 844, contacts of switch 838, conductor 845, contacts of switch 810 to conductors 846, 645. When the housing has been completely lowered, switch 851 is closed, moving contactor 837 to the right for the next cycle. The energizing circuit for this contactor extends from conductors 625, 652, contacts of switch 851, conductor 848a, contacts of double-throw switch 852, controlled from contactor 837, magnet of contactor 837, right magnet of contactor 833, to conductor 614. This circuit also causes contactor 833 to move right.

Since contactor 833 moves right upon the housing movement regardless of direction, and since the circuits for both valves 839, 840 pass through the left side of this contactor, the movement closes whichever valve was open. The housing remains in position, however, because these D-slide valves are of the stay-put type previously described.

This right movement of contactor 833 also breaks the circuit for valve 834 so that piston rod 355 reverses, under constant pressure in cylinder 357, to push the cool mandrel out of the cooling chamber into its block. This movement closes switch 831, completing a circuit through the right magnet of contactor 816. This circuit extends from conductor 614, right magnet of contactor 816, lower contacts of contactor 823, conductor 832, contacts of switch 831, conductor 830, contacts of hand switch 810, conductor 829, contacts of switch 827, conductor 828, contacts of hand switch 810, to conductor 624. Contactor 816 swings to the right upon energization in this circuit and opens, at its left contacts, the energizing circuit for the operating coil of special type valve 818, which valve opens, whereupon piston rod 339 reverses under pressure admitted to cylinder 343 to reverse bell crank 330, 324 and insert the cool mandrel in the press.

As soon as the mandrel is positioned, switch 821 is closed, completing a circuit extending from conductor 641, through operating coil of valve 853, above referred to, contacts of switch 821, conductor 854, contacts of hand switch 810, conductor 855, right contacts of contactor 816 to conductor 646. Valve 853 being opened, the mandrel is ready to move forward at the proper time as previously described.

Provision is made for manually controlling the various operations. To this end, for each magnetic valve there is provided a hand switch connected in circuit with the operating coil of the valve.

For example, the following hand switches are connected through a bus 857, conductor 858 and left contacts of contactor 770, with the main line. The other poles of the respective switches are connected by the conductor listed with the coils of the respective valves. It will be apparent that the continuation of the circuits beyond the valve coils are the same as for the automatic operation:

Hand switches	Conductors	Valves
866	787	786
867	791	790
868	800	799
869	688	681
870	871, 807	680
872	873, 697	695
874	725	724
875	731	730
876	739	738
878	764	694
879	719	709
880	881, 644	611
882	809, 662	655
883	884, 672	656

Double pole switch 877 controls valve 768, the circuit extending from left contacts of current control contactor 770, through conductor 858, one side of the switch, the coil of the valve, the other side of the switch, conductor 771, back to contactor 770. Switch 885 also controls valve 768, the circuit extending from bus 645 through conductor 846, the switch, conductor 772, the coil of the valve, conductor 901 to bus 641.

For manual operation of the mandrel exchange, hand switch 812 is opened and double-throw hand switch 810 is moved down. Valve 818 is controlled by hand switch 856 connected to bus 857, the circuit leading to

the coil of the valve through conductor 819 and switch 817, which is closed with the mandrel in the press. Valve 834 is controlled by hand switch 859, connected to bus 857, the circuit extending through conductor 860, hand switch 810, switch 827, which is closed by the withdrawal of the mandrel, conductor 829, switch 810, conductors 835 to the coil of the valve. Valves 839 and 840 are controlled by the right or left position of double throw hand switch 861. The circuit for valve 839 extends from bus 857 through conductor 864, hand switch 810, conductor 845, switch 838, which is closed by the movement of the hot mandrel into the housing, conductor 844, switch 861 right, conductor 862, switch 810, conductor 841 to the coil of the valve. The circuit for the valve 840 is the same through conductor 844, thence switch 861 left, conductor 864[a], switch 810, conductor 849, to the coil of the valve.

The movement of the housing may be controlled by any suitable stop.

Valve 853 is controlled by switch 865 connected to bus 857, the circuit extending through switch 810, conductor 854, switch 821, which is closed by the replacement of the cool mandrel, to the coil of the valve.

The control board also contains hand switches 886, 887 for moving contactor 684 left and right respectively. The circuit for the left magnet extends from line 607, through the left magnet, conductor 1114, switch 886 to line 605. The other circuit extends from line 607, through the right magnet, conductor 1112, switch 807 to line 605. It is noted that switch 886 is closed at the start and contactor 684 remains to the left throughout.

Hand switches 888 and 889 control the right and left movements of A. C. circuit controlling contactor 770. Both magnets connect to A. C. line 607. The right magnet is connected through conductor 890 and switch 888, to line 605. The left magnet is connected through conductor 891 and switch 889 to line 605. This contactor 770 is moved left at the start and so remains.

D. C. current controlling contactor 640 is moved right or left by switches 892, 893 respectively. Both magnets connect to A. C. line 607. The circuit for the right magnet extends through conductor 894 and switch 892 to line 605; that for the left magnet through conductors 895 and switch 893, to line 605. This contactor is moved left at the start and so remains. Hand switch 665 is an emergency switch controlling the circuit for the ram inlet valve 655 and is normally closed.

Hand switch 726 controls the circuits for the valves of the feed slides and is normally closed.

Hand switch 812 controls the mandrel exchange and is normally closed for automatic operation of the latter.

There is provided indicating means for showing various circuit conditions. In the present embodiment a series of pilot lamps are located at the switchboard. Lamp 898 indicates the fact that contactor 770 is in its left hand or "current on" position. The circuit for lamp 898 is traced from conductors 639 and 769, top left contacts of contactor 770, conductor 771, lamp 898, conductor 858, next to the top left contacts of contactor 770 to conductor 647. Therefore, when contactor 770 has closed its current feeding contacts, lamp 898 is illuminated.

Lamp 899 indicating the left hand position of alternating current controlling contactor 609 is illuminated in a circuit extending from conductor 605, lamp 899, conductors 616, 615, 614, 613, top left contacts of contactor 609 to conductor 607.

In like manner, lamp 900 is lighted when contactor 640 closes its left contacts, the circuit for this lamp being traceable from conductor 645, lamp 900, over conductors 901 and 641 to the top left contacts of contactor 640 thence to conductor 639.

In the press above described, the billet was formed previous to use with a central bore for passage of the mandrel. With a slight modification of the control mechanism and wiring, the press may be used with solid billets, i. e. billets not previously pierced. In such cases, the mandrel centering tool is not used and to get greater power for the mandrel the mandrel fluid pressure unit is connected into the water line instead of being operated by air. The controlling circuits are so modified that the cycle is as follows:—

The billet slide and dummy block slide operate as above described to position the dummy block and the billet. The mandrel is advanced sufficiently to thread through the dummy block and thereafter the mandrel and ram advance together, the end of the mandrel being kept flush with the face of the dummy block. This pushes the billet into the container and pushes the dummy block off the dummy block slide onto the billet slide whereupon the dummy block slide is withdrawn out of the way. Continued movement pushes the dummy block into the container whereupon the billet slide is withdrawn out of the way. This movement is continued until the billet has been upset sufficiently to cause it to fill the container chamber. Then the ram is stopped and the mandrel advanced alone, and pushed through the hot metal of the billet until its forward end enters the mouth of the die. By this preliminary upset of the metal the billet is so held that the mandrel passes through it on the center line. Thereafter the extrusion is the same as above described.

In the foregoing description of the automatic cycle, it is noted that the various switches and contactors are at some stage of

the operation returned to their original settings to be ready for the next cycle, although such resetting is not, in all cases, referred to specifically.

It is noted also that, except in certain instances, no reference is made to the control of the length of stroke of the various pressure units. It will be apparent that where stops are required to limit the stroke of a unit, any suitable form of stop may be provided. In the present embodiment, the container unit has no stop other than the die unit. On reverse it goes to the end of the piston's stroke. The ram has no stop for its forward stroke. All the other units have suitable stops for positively limiting the piston strokes.

What I claim is:

1. In an extrusion press, and in combination, a main ram having an extruding plunger, a container having a billet-receiving chamber, a die, an extrusion mandrel, means for positioning a pierced billet outside of the container chamber in alignment therewith, means for advancing the mandrel through the billet to support the same and further to insert its end in the mouth of the die, and means for advancing the main ram to enter the billet into the container chamber and further to extrude the billet into the form of a tube.

2. In an extrusion press, and in combination, a main ram having an extruding plunger, a container having a billet-receiving chamber, a die, an extrusion mandrel, means for positioning a pierced billet outside of the container chamber and in axial alignment therewith, means for positioning a pierced dummy block behind the billet, means for advancing the mandrel through the billet and dummy block to support the same and further to insert its ends in the mouth of the die, and means for advancing the main ram to enter the billet and dummy block into the container chamber and further to extrude the billet into the form of a tube.

3. In an extrusion press, and in combination, a container having a billet-receiving chamber, a die, a main ram having an extrusion plunger, an extrusion mandrel movable to have its forward end enter the mouth of the die, means for giving the ram a preliminary advance to upset the metal of the billet in said chamber sufficiently to grip the mandrel and center the same, means for positively centering the mandrel prior to said upset, and devices for bringing said mandrel entering means into and out of cooperative engagement with said mandrel.

4. In an extrusion press, and in combination, a container having a billet-receiving chamber, a die, a main ram having an extrusion plunger, an extrusion mandrel movable to have its forward end enter the mouth of the die, a mandrel centering tool movable axially of the die and having its end formed with a recess for receiving the end of the mandrel to center the same, means for giving the ram a preliminary advance to upset the metal of the billet in said chamber sufficiently to grip the mandrel and centering the same, and means for removing said centering tool subsequent to said preliminary ram advance.

5. In an extrusion press, and in combination, a container having a billet-receiving chamber, a die, a main ram having an extrusion plunger, an extrusion mandrel movable to have its forward end enter the mouth of the die, a mandrel centering tool movable axially of the die and having its end formed with a recess for receiving the end of the mandrel to center the same, a guide conduit for receiving the extruded product, a carrier on which said centering tool and guide conduit are mounted and movable across the axis of the die, means for giving the ram an interrupted advance to cause, upon its preliminary movement, an upset of the metal of the billet sufficient to grip the mandrel and center the same and thereafter to extrude the billet into the form of a tube, and means for moving said carrier during said interruption to remove the centering tool and substitute the guide conduit in line with the axis of the die.

6. In an extrusion press, and in combination, a billet container, a die, a main ram, having an extrusion plunger, an extrusion mandrel slidable in said plunger, means for moving the main ram, means including a fluid pressure cylinder and piston moving with the ram for giving the mandrel an independent movement, and means including a stationary conduit and a telescoping conduit carried by the ram for conveying fluid pressure to said cylinder.

7. In an extrusion press, and in combination, a billet container, a die, a main ram having a tubular extrusion plunger, an extrusion mandrel carried by the main ram and slidable in said plunger, means for advancing the mandrel independently of the ram movement, and means independent of the mandrel advancing means for withdrawing the mandrel independently of the ram movement, and auxiliary mechanism associated therewith for freeing the mandrel from a stump in the billet container.

8. In an extrusion press, and in combination, a movable billet container, a die, a main ram having an extrusion plunger, a fluid pressure cylinder in which part of said ram operates as a piston, valve-controlled means for supplying pressure fluid to said cylinder, and a fluid pressure unit including a cylinder carried by the main ram and a piston rod arranged to abut the container, for advancing the container and withdrawing the ram.

9. In an extrusion press, and in combination, a movable billet container, a die, a main

ram having an extrusion plunger, a fluid pressure cylinder in which part of said ram operates as a piston, valve-controlled means for supplying pressure fluid to said cylinder, a fluid pressure unit including a cylinder carried by the main ram and a piston rod arranged to abut the container, for advancing the container and withdrawing the ram, and means including a stationary conduit and a telescoping conduit carried by the ram for conveying pressure fluid to the last named cylinder.

10. In an extrusion press, and in combination, a movable billet container, a die, a main ram having an extrusion plunger, a fluid pressure cylinder in which part of said ram operates as a piston, valve-controlled means for supplying pressure fluid to said cylinder, a fluid pressure unit including a cylinder carried by the main ram and a piston rod arranged to abut the container, for advancing the container and withdrawing the ram, and means for moving the container in the reverse direction.

11. In combination with means for extruding a tube, including a die, means for crushing the wall of a portion of the extruded tube while the trailing end thereof is in the die, and means for severing the tube between the die and the crushed portion, thereby to provide a tube pointed for subsequent threading into a draw die.

12. In an extrusion press for forming tubes, and in combination a pair of oppositely disposed gripping and crushing tools, means for giving said tools a preliminary advance to grip the extruded tube, a pair of oppositely disposed indenting tools, located substantially 90° from the first named tools, means for advancing the second named tools to indent the tube while so gripped, and means for further advancing the first named tools to crush the tube.

13. In an extrusion press, and in combination, a container having a chamber for receiving a billet and a dummy block, a die, a main ram having an extrusion plunger, means for advancing the main ram to extrude the billet, means for cutting off the extruded product from the stump, means for withdrawing the ram, means for moving the container away from the die to withdraw the stump and to carry the dummy block against the withdrawn plunger to eject the stump beyond the face of the container, and means for separating the stump from the dummy block.

14. In an extrusion press, and in combination, a container having a chamber for receiving a billet and a dummy block, a die, a main ram having an extrusion plunger, means for advancing the main ram to extrude the billet, means for cutting off the extruded product from the stump, means for withdrawing the ram, means for moving the container away from the die to withdraw the stump and to carry the dummy block against the withdrawn plunger to eject the stump, means for adjustably fixing the relative position of the ram and container when withdrawn, whereby the trailing end of the stump upon ejection is substantially flush with the face of the container, a slide movable across the face of the container, and a knife-like element on said slide for separating the stump from the dummy block.

15. In an extrusion press, and in combination, a container having a chamber for receiving a billet and a dummy block, a die, a main ram having an extrusion plunger, means for advancing the main ram to extrude the billet, means for cutting off the extruded product from the stump, means for withdrawing the ram, means for moving the container away from the die to effect ejection of the stump and dummy block by the plunger, a dummy block trimming device, a slide movable across the axis of the withdrawn container to receive the ejected dummy block and carry it to a point adjacent said trimming device, and means for forcing the dummy block through said trimming device.

16. In an extrusion press, and in combination, a container having a chamber for receiving a billet and a dummy block, a slide for carrying the dummy block into line with the container chamber, a dummy block trimming device, means for moving the dummy block to and through said trimming device following an extrusion operation, and a chute leading from said trimming device to the withdrawn slide.

17. In an extrusion press, and in combination, a movable billet container, a die, an extrusion ram, a slide carried by the container and movable with respect thereto means for moving said slide including a fluid press cylinder carried by the container, and means including a stationary conduit and a telescoping conduit carried by the container, for conveying pressure fluid to said cylinder.

18. In an extrusion press, and in combination, a movable billet container, a die, an extrusion ram, a slide carried by the container for positioning a dummy block in a position to be inserted in the container chamber, means including a fluid pressure cylinder for operating said slide, and means including a stationary conduit and a telescoping conduit carried by the container for conducting pressure fluid to said cylinder.

19. In an extrusion press, and in combination, a die, a main ram having a tubular extrusion plunger, an extrusion mandrel slidable in said plunger, a mandrel-reciprocating device carried by the main ram, a detachable connection between the mandrel and its reciprocating device, and mandrel handling mechanism for removing the mandrel from operative position in the press and inserting a mandrel in operative position.

20. In an extrusion press, and in combination, a main ram having a tubular extrusion plunger, an extrusion mandrel slidable in said plunger, a mandrel-reciprocating device carried by the main ram, a connection between the mandrel and its reciprocating means for causing the mandrel to move with said device on the axis of the die but permitting independent sidewise movement of the mandrel, mandrel transfer means for removing the mandrel sidewise from the press position, spring-pressed latch means for normally holding the mandrel against sidewise movement.

21. In an extrusion press, and in combination, a die, an extruding ram, a plurality of interchangeable extrusion mandrels, and means for moving said mandrels successively into and out of operative position in the press.

22. In an extrusion press, and in combination a die, an extruding ram, a plurality of interchangeable extrusion mandrels, a housing having a plurality of cooling chambers, mandrel transfer means for moving a mandrel between said housing and press position, means for moving a mandrel into and out of said chambers, and means for giving said housing an indexing movement to position the desired chamber in operative relation with said last named means and the transfer means.

23. In an extrusion press, and in combination, a die, a main ram having an extrusion plunger, a mandrel-reciprocating device carried by the ram, a plurality of interchangeable extrusion mandrels, any one of which may be detachably connected with said reciprocating device, a mandrel exchange device pivotally mounted on the ram, means on said exchange device for removing one mandrel from press position and substituting another, and means for causing said exchange device to be moved into active position as the mandrel-reciprocating device moves back to withdraw a mandrel from the die and into an inactive position as the reciprocating device moves forward.

24. In an extrusion press, and in combination, a die, a main ram having an extrusion plunger, an extrusion mandrel, a housing having a cooling chamber, means for withdrawing the mandrel from press position and inserting it in said cooling chamber, a removable plug in the end of said chamber having tong-like elements for grasping part of the mandrel whereby the mandrel may be removed from the chamber upon removal of the plug, and a handle on said plug.

25. In an extrusion press, and in combination, a billet container, a die, a ram, means for moving the ram, means for causing relative movement between the container and die, and mechanism actuated by said first named means for setting in action said last named means.

26. In an extrusion press, and in combination, a plurality of movable press elements, fluid pressure units for moving said elements, and means for causing said fluid pressure units to operate automatically through a given cycle, the operation of one fluid pressure unit to move its corresponding press element being dependent on the relative position of another press element.

27. In an extrusion press, and in combination, a plurality of movable press elements, fluid pressure units for moving said elements, means including electric circuits for controlling the operation of said fluid pressure units, and means dependent on the relative position of one of said press elements for creating circuit conditions to cause operation of the fluid pressure unit for another of said elements and to prevent operation of the fluid pressure units for other of said elements.

28. In an extrusion press, and in combination, a plurality of press elements, fluid pressure units for moving said elements, means including electric circuits for controlling the operation of said fluid pressure units, means for effecting circuit conditions to cause the fluid pressure units to operate the press elements through a predetermined cycle, switch means for rendering said circuits ineffective, substitute circuits for the pressure unit controlling means, and hand switches for controlling said substitute circuits.

29. In an extrusion press, and in combination, an extrusion ram, a die, a billet container, a billet-supplying slide, a dummy-block-supplying slide, means to move said slides to position a billet and a dummy block for reception in the container, an extrusion mandrel, and automatic means controlled by the positioning movement of said slides for advancing the mandrel through the pierced billet and dummy block and into the mouth of the die.

30. In an extrusion press, and in combination, an extrusion ram, a die, a billet container, a billet-supplying slide, a dummy-block-supplying slide, means to move said slides to position a billet and a dummy block for reception in the container, an extrusion mandrel, automatic means controlled by the positioning movement of said slides for advancing the mandrel through the pierced billet and dummy block and into the mouth of the die, and automatic means controlled by the advance of the mandrel for advancing the ram.

31. In an extrusion press, and in combination, an extrusion ram, a die, a billet container, a billet-supplying slide, a dummy-block-supplying slide, means to move said slides to position a billet and a dummy block for reception in the container, an extrusion mandrel, automatic means controlled by the positioning movement of said slides for advancing the mandrel through the pierced

billet and dummy block and into the mouth of the die, automatic means controlled by the advance of the mandrel for advancing the ram, and automatic means for stopping the ram in case of failure of the mandrel to make a predetermined advance.

32. In an extrusion press, and in combination, an extrusion ram, a die, a billet container, a billet-supplying slide, a dummy-block-supplying slide, means to move said slides to position a billet and a dummy block for reception in the container, an extrusion mandrel, automatic means controlled by the positioning movement of said slides for advancing the mandrel through the pierced billet and dummy block and into the mouth of the die, automatic means controlled by the advance of the mandrel for advancing the ram, and automatic means controlled by the advance of the ram to withdraw said slides.

33. In an extrusion press, and in combination, an extrusion ram, a die, a billet container, a billet supplying slide, a dummy-block-supplying slide, means to move said slides to position a billet and a dummy block for reception in the container, an extrusion mandrel, automatic means controlled by the positioning movement of said slides for advancing the mandrel through the pierced billet and dummy block and into the mouth of the die, automatic means controlled by the advance of the mandrel for advancing the ram, automatic means for stopping the ram in case of failure of the mandrel to make a predetermined advance, automatic means controlled by the advance of the ram to withdraw said slides, and automatic means for stopping said ram in case said slides fail to make a predetermined withdrawal.

34. In an extrusion press, and in combination, a die, a billet container, an extrusion ram, an extruson mandrel, means for supplying a pierced billet to a position between the ram and the container, automatically controlled means for advancing the mandrel through the billet and into the mouth of the die, automatically controlled means including a fluid pressure unit for advancing the ram to insert the billet in the container and upset the billet sufficiently to grip the mandrel and center the same, and means dependent on the pressure in said fluid pressure unit for automatically stopping the ram.

35. In an extrusion press, and in combination, a die, a billet container, an extrusion ram, an extrusion mandrel, a mandrel-centering tool movable on the axis of the die, means for moving the mandrel into operative relation with the die and centering tool, means including a fluid pressure unit for advancing the ram to upset the metal of the billet sufficiently to grip the mandrel and center the same, automatic pressure-controlled means for stopping the ram, and automatic means controlled by said last named means for withdrawing the centering tool.

36. In an extrusion press, and in combination, a die, a billet container, an extrusion ram, an extrusion mandrel, a mandrel-centering tool movable on the axis of the die, a carrier movable across the axis of the die and on which the centering tool is mounted, a guiding conduit also mounted on said carrier, means for advancing the mandrel into operative position with respect to the die and centering tool, means for giving the ram a preliminary advance, means for withdrawing the centering tool, and automatic means controlled by the withdrawal of the centering tool for moving said carrier to remove the centering tool and substitute the guide conduit on the axis of the die.

37. In an extrusion press, and in combination, a die, a billet container, an extrusion ram, an extrusion mandrel, a mandrel-centering tool movable on the axis of the die, a carrier movable across the axis of the die and on which the centering tool is mounted, a guiding conduit also mounted on said carrier, means for advancing the mandrel into operative position with respect to the die and centering tool, means for giving the ram a preliminary advance, means for withdrawing the centering tool, means for moving the carrier to remove the centering tool and substitute the guide conduit on the axis of the press, and automatic means controlled by such movement of the carrier for advancing the ram to extrude the billet.

38. In an extrusion press, and in combination, a die, a billet container, extrusion ram, an extrusion mandrel, means for advancing the mandrel into operative position with respect to the die, means for advancing the ram to extrude the billet, and automatic means controlled by the completion of the extruding stroke of the ram for withdrawing the ram and the mandrel.

39. In an extrusion press, and in combination, means for extruding a tube, tools for pointing or crushing the trailing end of the tube, and operating mechanism therefor called into action by operation of said extrusion press after the completion of the extrusion.

40. In an extrusion press, and in combination, means for extruding a tube, and severing mechanism called into action thereby upon the completion of the extruding operation for cutting the tube from the stump.

41. In an extrusion press, and in combination, a die, a movable billet container, an extrusion ram, means for advancing the ram to extrude the billet and to withdraw the same, cutting means for severing the extruded product from the stump, and automatic means controlled by the operation of said cutting means for moving the container back toward the withdrawn ram.

42. In an extrusion press, and in combina-

tion, a container having a chamber for receiving a billet and a dummy block, a die, a reciprocating extrusion ram, cutting means for severing the extruded product from the stump, means for moving the container back towards the withdrawn ram to eject the stump beyond the face of the container, a slide movable across the axis of the container chamber, a knife-like element on said slide for separating the stump from the dummy block, and automatic means controlled by the back movement of the container for moving said slide.

43. In an extrusion press, and in combination, a container having a chamber for receiving a billet and a dummy block, a die, an extrusion ram, means for moving the container back toward the withdrawn ram after extrusion to eject the stump beyond the face of the container, a slide movable across the axis of the container, a knife-like element on said slide for separating the stump from the dummy block, means for advancing the slide, and automatic means controlled by the movement of the slide for advancing the ram to eject the dummy block from the container.

44. In an extrusion press, and in combination, a container for receiving a billet and a dummy block, a die, an extrusion ram, means for moving the container back toward the withdrawn ram after extrusion, means for advancing the ram to eject the dummy block, and automatic means controlled by the movement of the ram for causing withdrawal of the ram.

45. In an extrusion press, and in combination, a container for receiving a billet and a dummy block, a die, an extrusion ram, means for moving the container back toward the withdrawn ram after extrusion to eject the stump beyond the face of the container, a slide movable across the axis of the container, a knife-like element on said slide for separating the stump from the dummy block, means for advancing the slide, means for advancing the ram to eject the dummy block and for withdrawing the ram, and automatic means controlled by the ram withdrawal for causing reverse movement of the slide.

46. In an extrusion press, and in combination, a container for receiving a billet and a dummy block, a die, an extrusion ram, means for moving the container back toward the withdrawn ram after extrusion, means to advance the ram to eject the dummy block and to withdraw the ram, a slide movable across the face of the container and having a receiver for the ejected dummy block, a dummy block trimming device, and automatic means controlled by said withdrawal of the ram for moving the slide to carry the dummy block to said trimming device.

47. In an extrusion press, and in combination, a container for receiving a billet and a dummy block, a die, an extrusion ram, means for moving the container back toward the withdrawn ram after extrusion to eject the stump beyond the face of the container, a slide movable across the axis of the container, a knife-like element on said slide for separating the stump from the dummy block, means for advancing the slide, means for advancing the ram to eject the dummy block and for withdrawing the ram, means for reversing the slide, and automatic means controlled by said reverse movement of the slide for causing return movement of the container to a position adjacent the die.

48. In an extrusion press, and in combination, a container for receiving a billet and a dummy block, a die, an extrusion ram, means for moving the ram and container to effect ejectment of the dummy block, a dummy block trimming device, means for receiving the dummy block and carrying it to the trimming device, means for moving the container forward to a position adjacent the die, and automatic means controlled by said forward movement of the container for moving the dummy block past the trimming device.

49. In an extrusion press, and in combination, a billet container, a die, an extrusion ram, an extrusion mandrel, a mandrel-centering tool, a carrier for moving said centering tool into and out of line with the axis of the die, means for moving the ram and container after extrusion to effect ejectment of the stump and dummy block, means for returning the container to a position adjacent the die, and automatic means controlled by said return movement of the container for moving said carrier to place the centering tool in line with the axis of the die.

50. In an extrusion press, and in combination, a billet container, a die, an extrusion ram, an extrusion mandrel, a mandrel-centering tool, a carrier for moving said centering tool into and out of line with the axis of the die, means for moving the ram and container after extrusion to effect ejectment of the stump and dummy block, means for returning the container to a position adjacent the die, means for moving the carrier to place the centering tool in line with the axis of the die, and automatic means controlled by such movement of the carrier for advancing the centering tool to centering position.

51. In an extrusion press, and in combination, a billet container, a die, an extrusion ram, an extrusion mandrel, means for reciprocating the mandrel, a detachable connection between the mandrel and its reciprocating means, and automatic means controlled by the withdrawal of the mandrel from the die for moving the mandrel out of press position.

52. In an extrusion press, and in combination, a billet container, a die, an extrusion ram, a plurality of interchangeable mandrels, means for reciprocating a mandrel on

the axis of the die, and automatic means controlled by the withdrawing movement of said reciprocating means for removing one mandrel from press position and substituting another.

53. In an extrusion press, and in combination, a billet container, a die, an extrusion ram, an extrusion mandrel, a mandrel-cooling housing, means for transferring a mandrel from press position, automatic means controlled by the movement of said removing means for drawing the mandrel into said cooling housing, and automatic means controlled by the reverse movement of said drawing means for reversing the transfer means to replace a mandrel in press position.

54. In an extrusion press, and in combination, a billet container, a die, an extrusion ram, a plurality of interchangeable extrusion mandrels, a housing having a plurality of cooling chambers, transfer means for moving mandrels between press position and the housing, the housing being movable with respect to the transfer means, means for sliding a mandrel into the housing, and automatic means controlled by the movement of said sliding means to insert a mandrel in the housing and for moving said housing to bring another cooling chamber in line with the transfer means.

55. In an extrusion press, and in combination, a billet container, a plurality of interchangeable extrusion mandrels, a housing having a plurality of cooling chambers, transfer means for moving mandrels between press position and the housing, the housing being movable with respect to the transfer means, means for sliding a mandrel into the housing, and automatic means controlled by the movement of said sliding means to insert a mandrel in the housing, for moving said housing to bring another cooling chamber in line with the transfer means and for reversing said sliding means and then reversing said transfer means, thereby to substitute a cool mandrel in press position.

56. In an extrusion press, and in combination, a billet container, a die, an extrusion ram, a plurality of interchangeable extrusion mandrels, means for reciprocating a mandrel on the axis of the die, means for removing one mandrel from operative position in respect to said reciprocating means and substituting another, and automatic means controlled by the insertion of a mandrel for operating said reciprocating means to advance the inserted mandrel into the mouth of the die.

57. In an extrusion press, and in combination, automatic means for causing the press parts to operate through a given cycle, a plurality of interchangeable mandrels, means for removing one mandrel and substituting another in press position, and means controlled by the movement of said last named means for preventing further operation of the press parts from the time one mandrel is removed from press position, until another is substituted.

In testimony whereof, I have hereunto set my hand.

DAVID L. SUMMEY.