

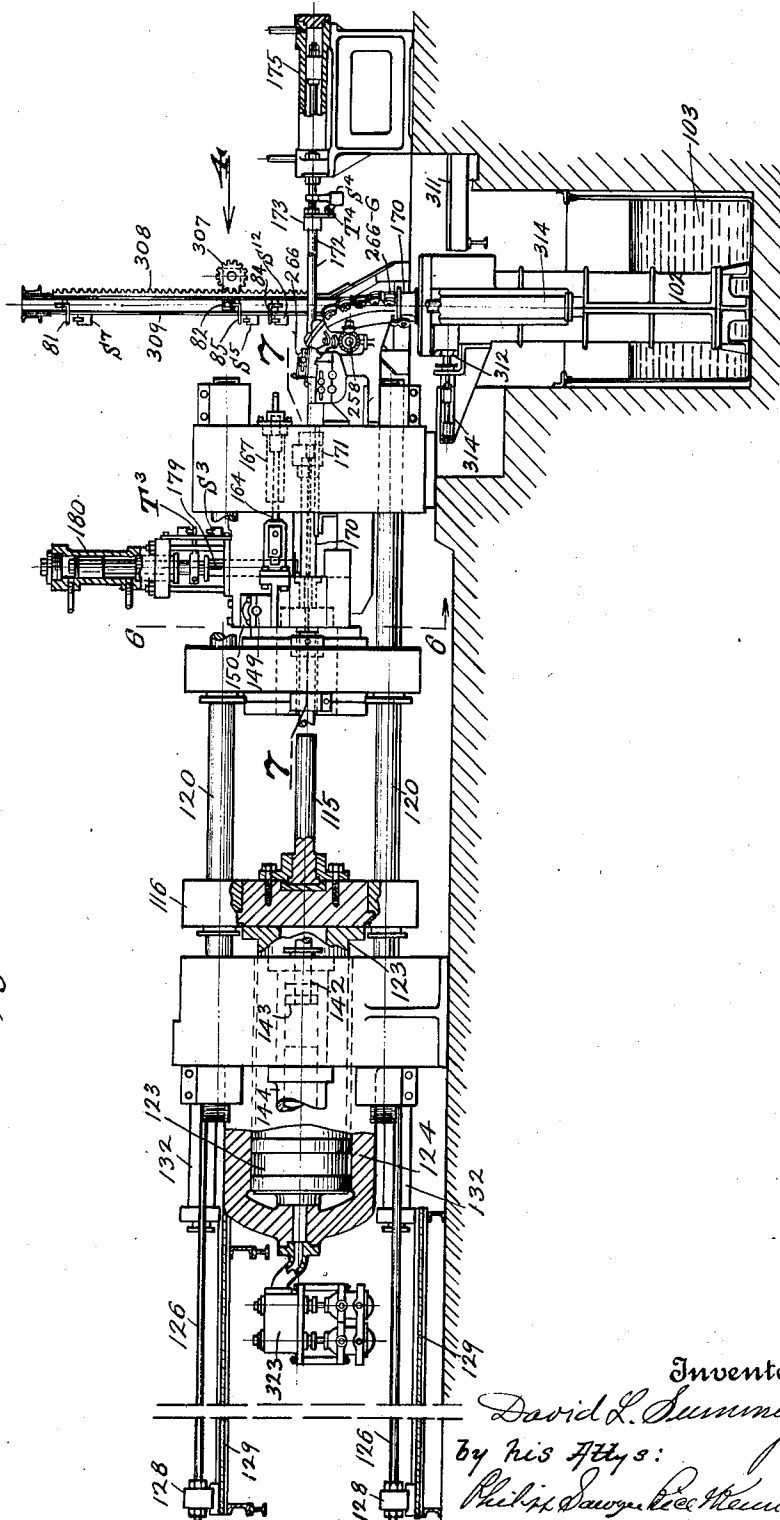
March 8, 1932.

D. L. SUMMEY
 APPARATUS FOR EXTRUDING AND COILING RODS AND
 CONTROLLING MEANS APPLICABLE THERETO
 Filed March 12, 1926

1,849,044

20 Sheets-Sheet 1

Fig. 1.



Inventor
 David L. Summey
 by his Attys:
 Philip Dawson, Esq. & Kenneth

March 8, 1932.

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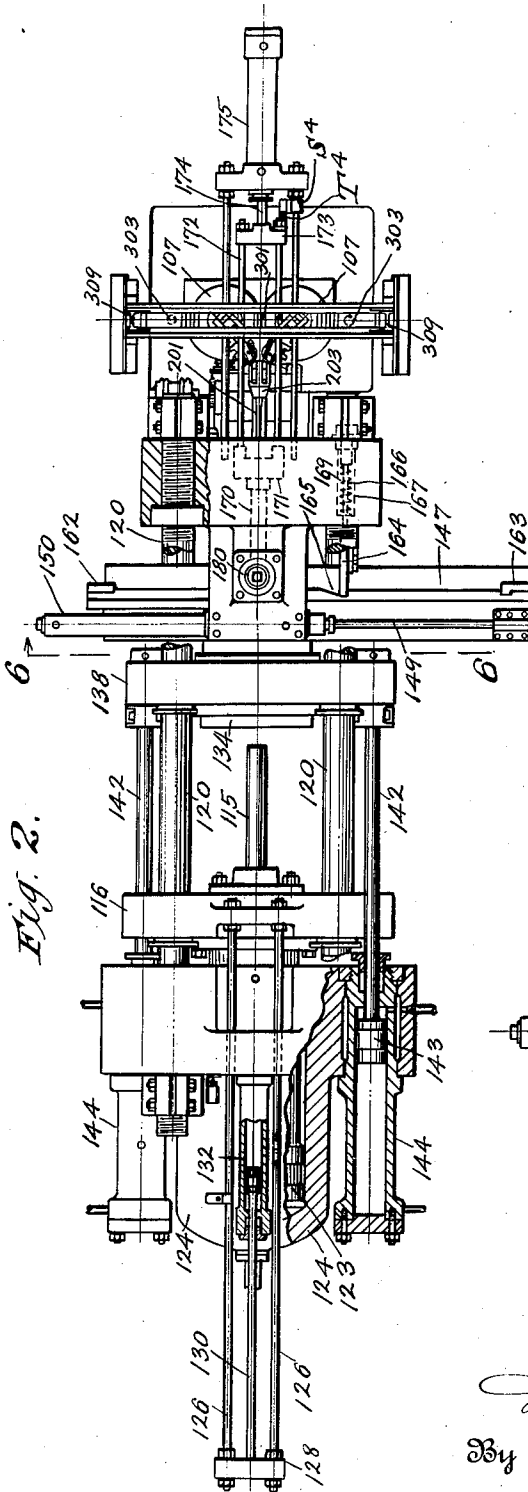


Fig. 2.

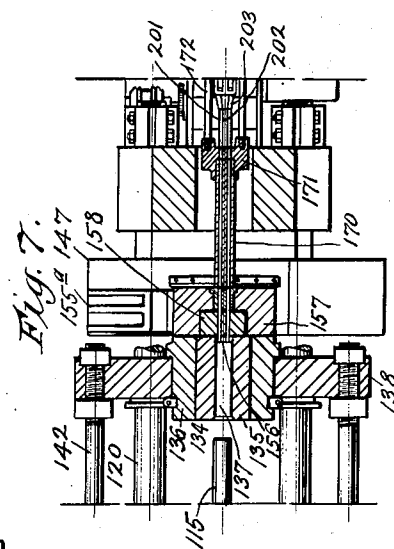


Fig. 7.

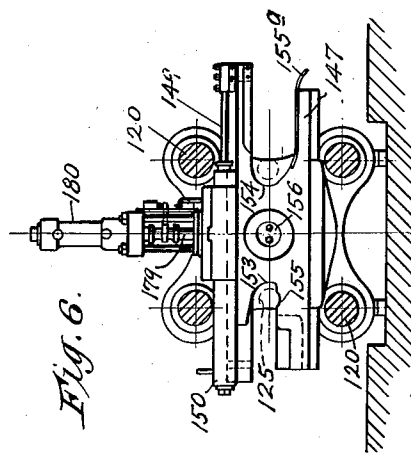


Fig. 6.

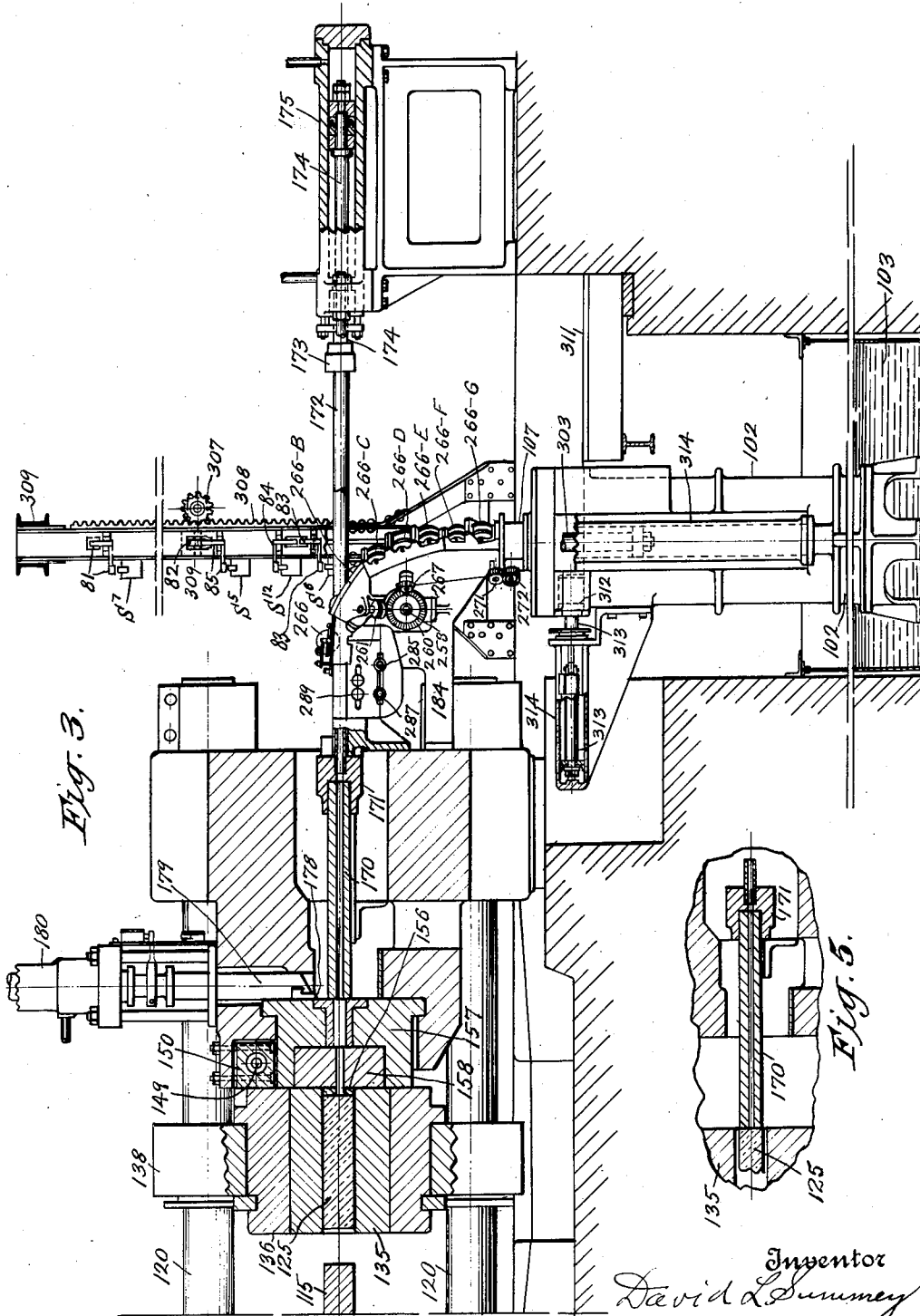
Inventor
David L. Summey
 By his Attorneys
Philip S. Sumner & Co. Kennedy

March 8, 1932.

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Inventor
David L. Summey
By his Attorneys
Philip S. Summey & Kennedy

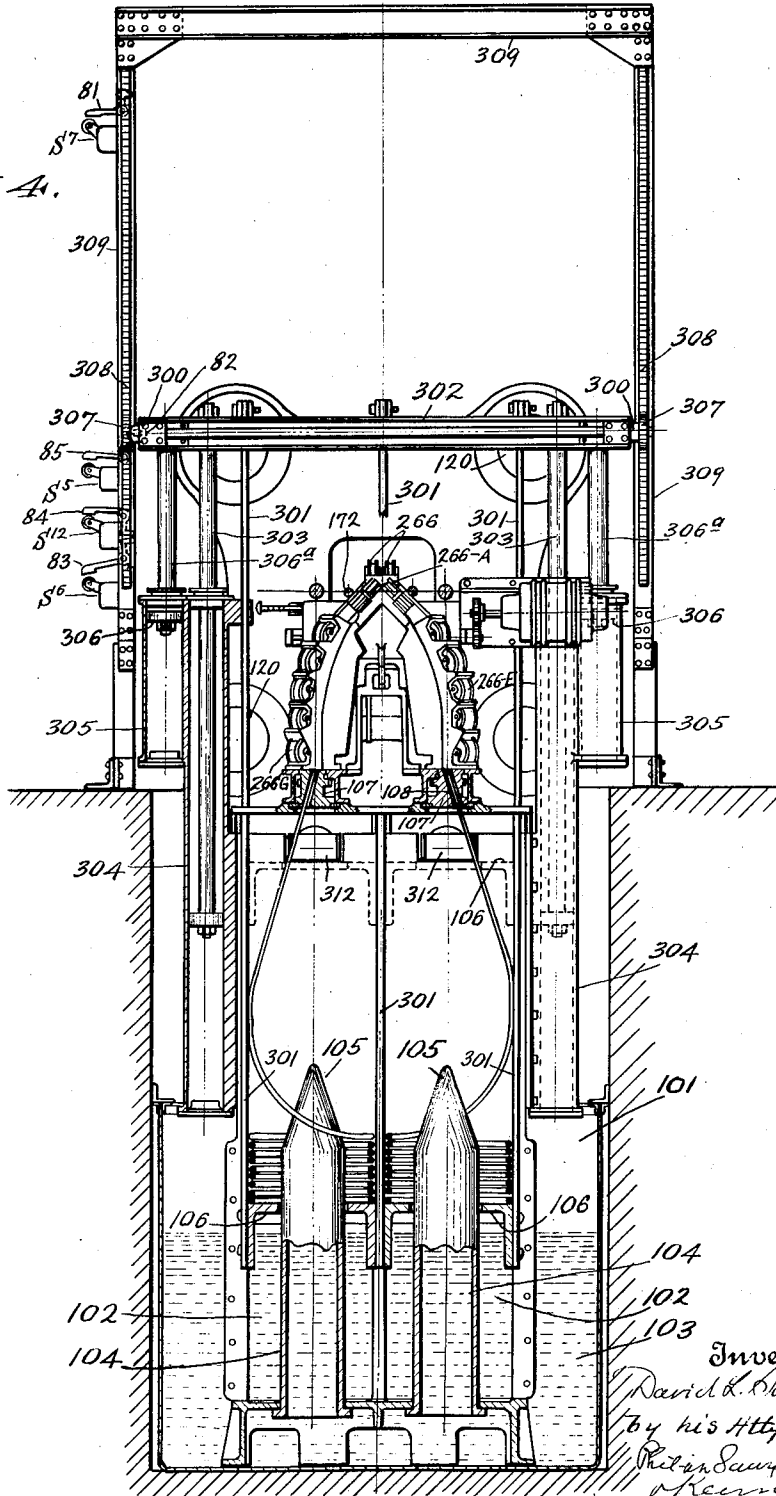
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Fig. 4.



Inventor
 David L. Summey
 by his Attys:
 R. L. Sawyer & Co.
 Attorneys

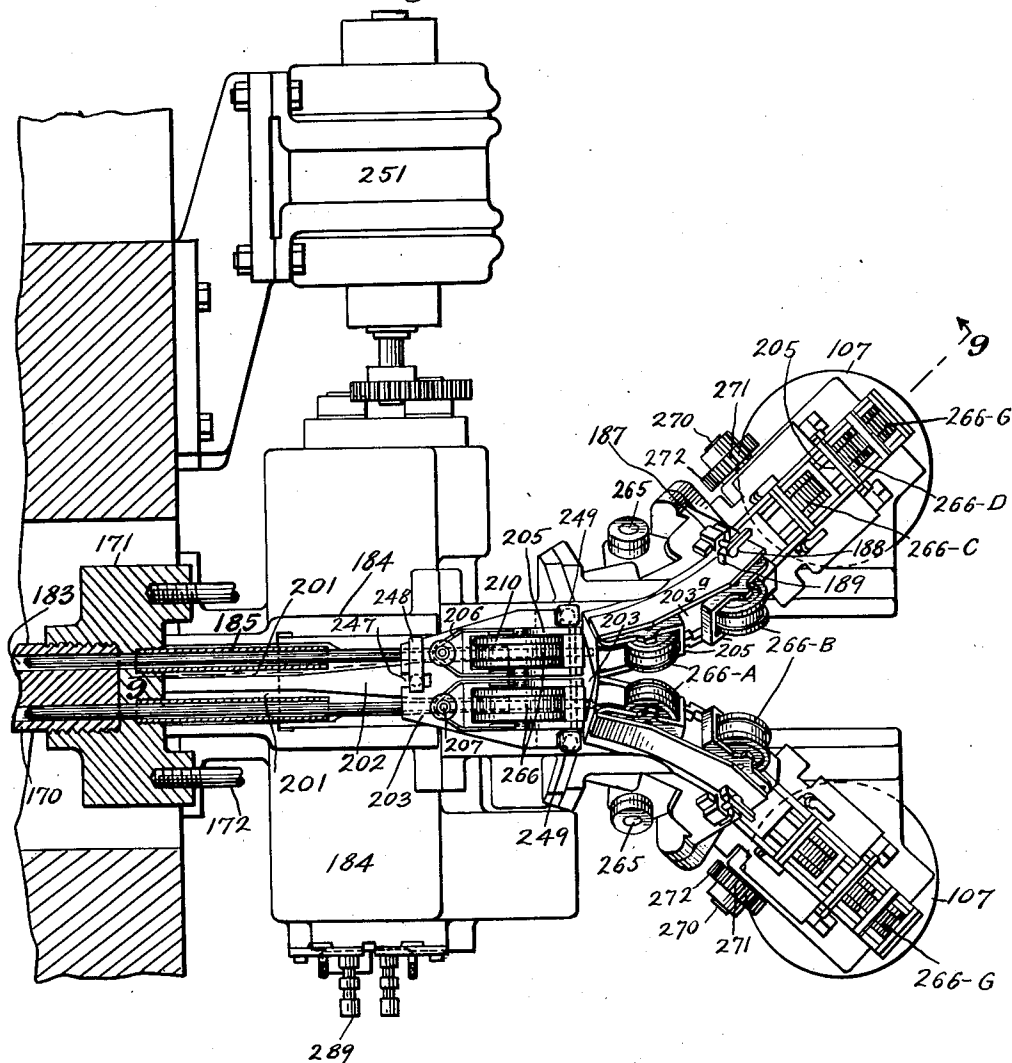
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Fig. 8.



Inventor
David L. Summey
By his Attorneys
Philip Sawyer Rice & Kennedy

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Fig. 10.



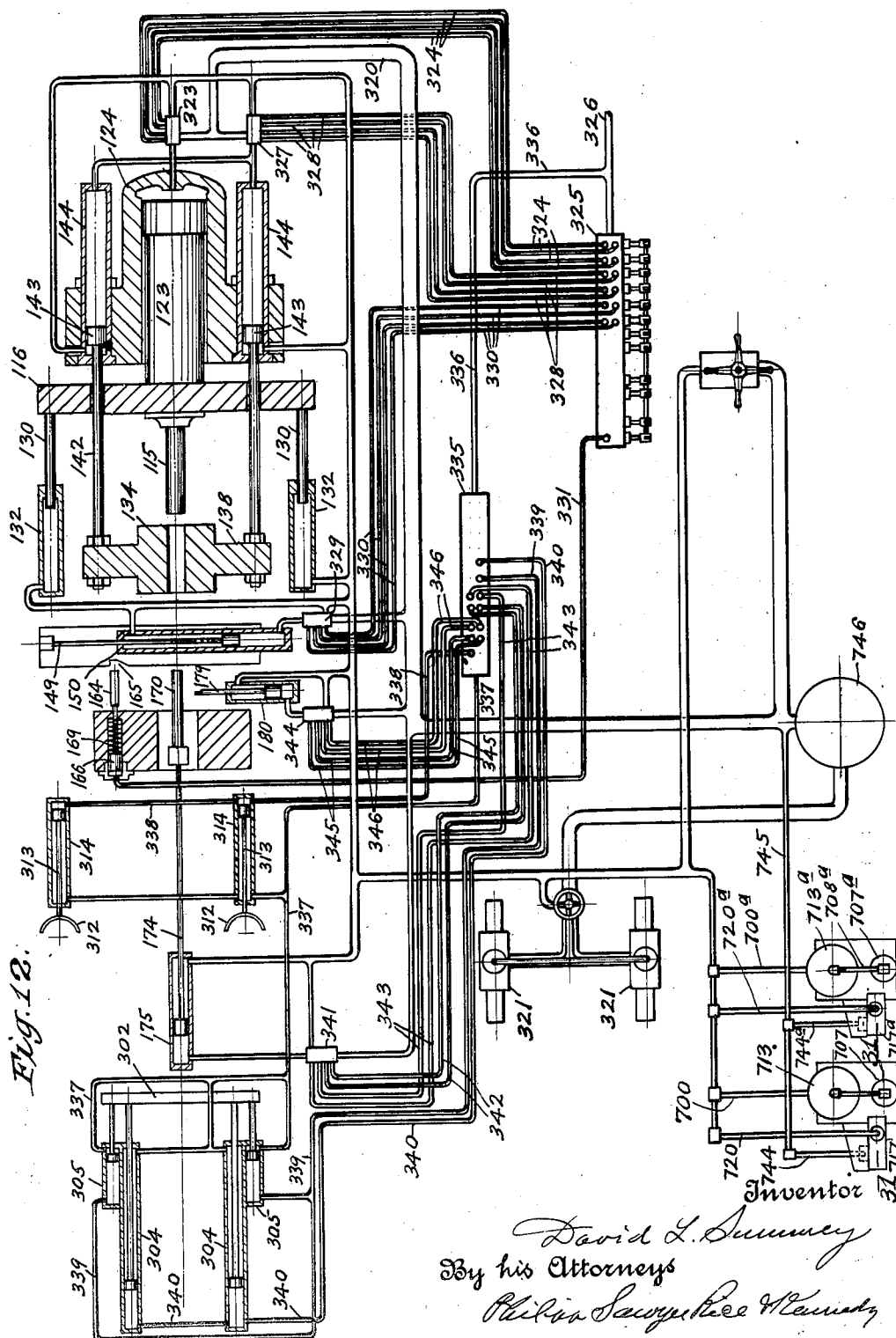
266^d 268^d 266^e 266^f 266^g Inventor
David L. Summey
By his Attorneys
Philip Summey & Co. Attorneys

March 8, 1932.

D. L. SUMMEY
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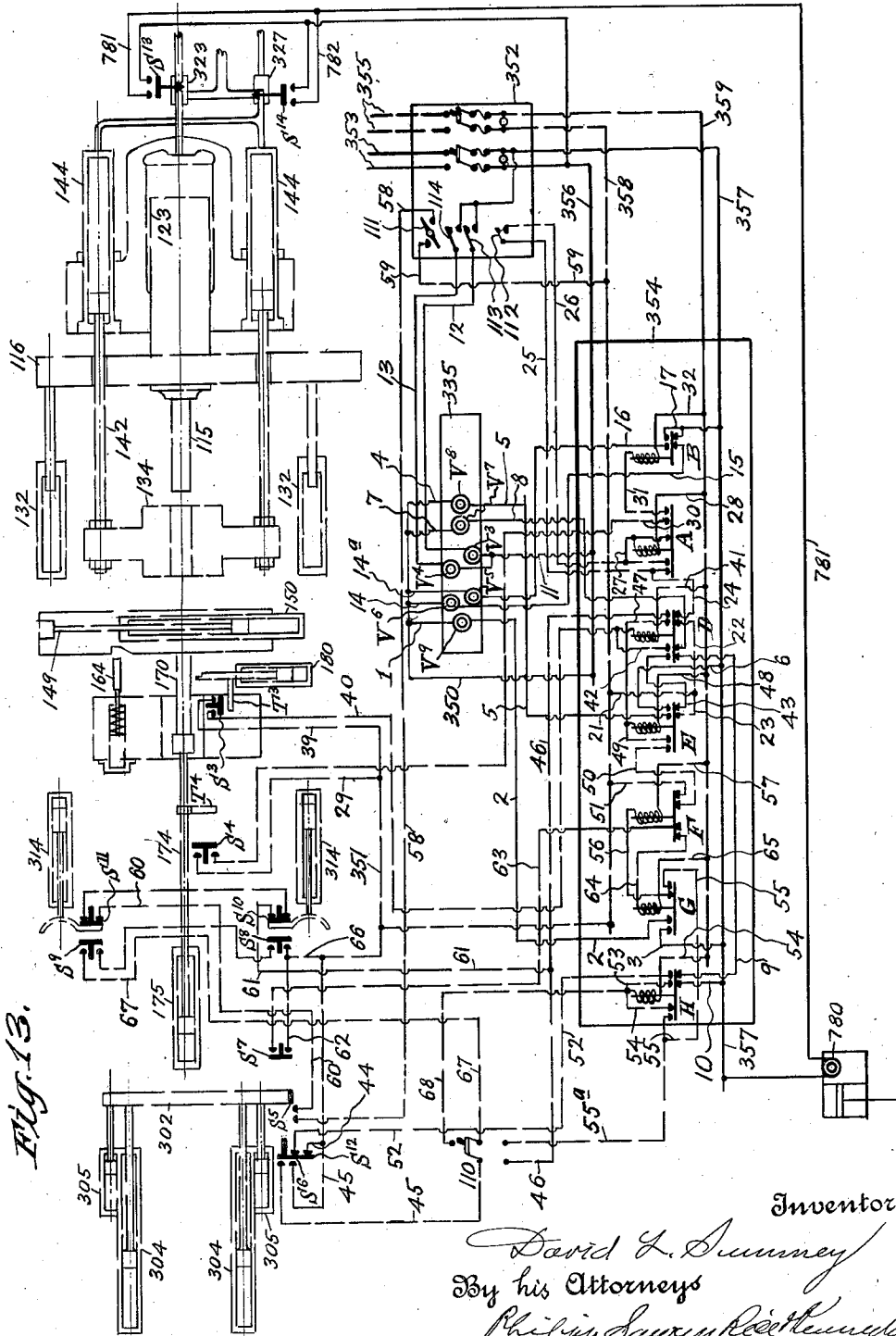


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Inventor

David L. Summey
By his Attorneys
Philip Saxe and Robert Kennedy

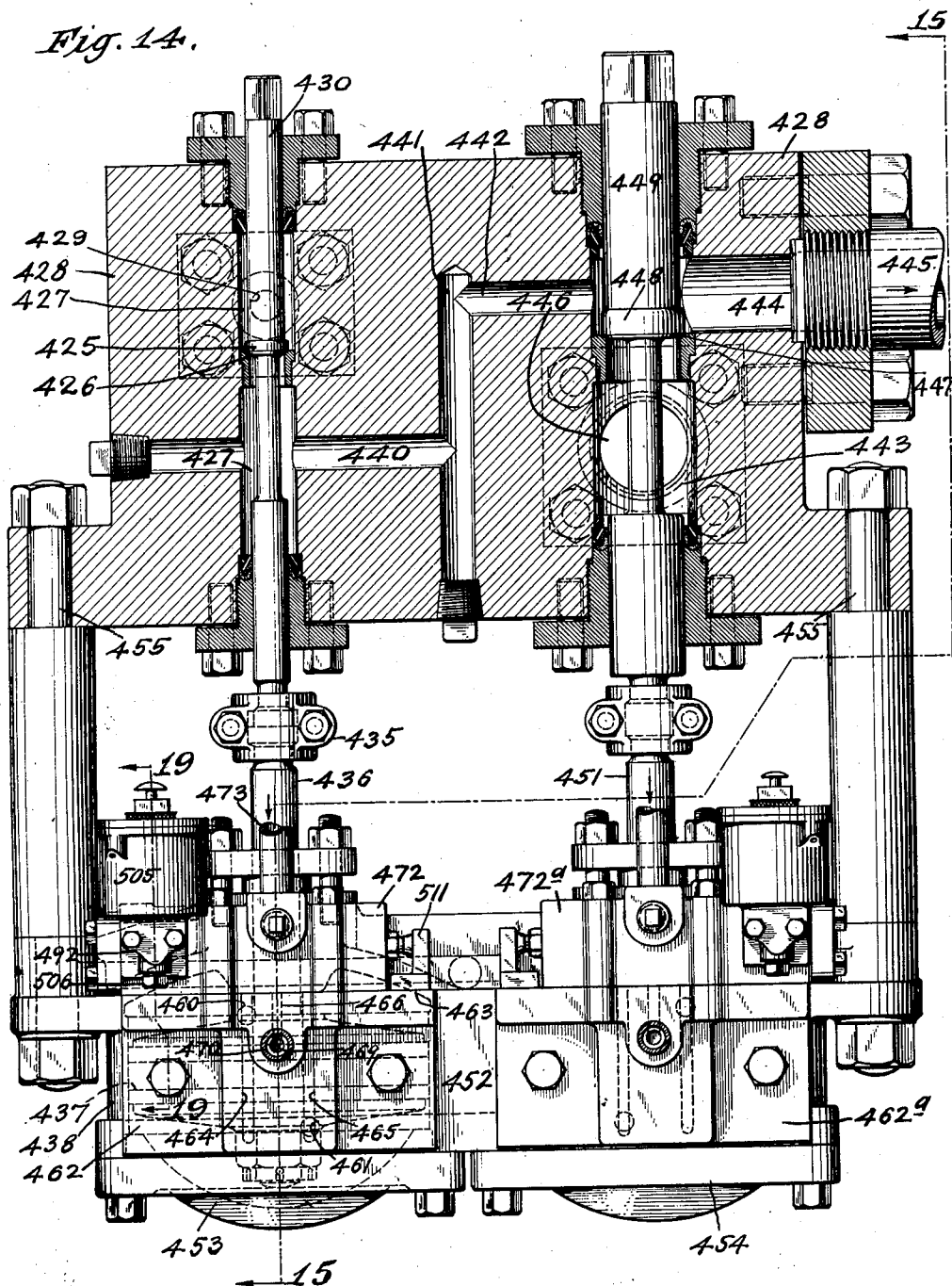
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Fig. 14.



INVENTOR
David L. Summey
 BY
Philip Sawyer & Co. Attorneys
 HIS ATTORNEYS

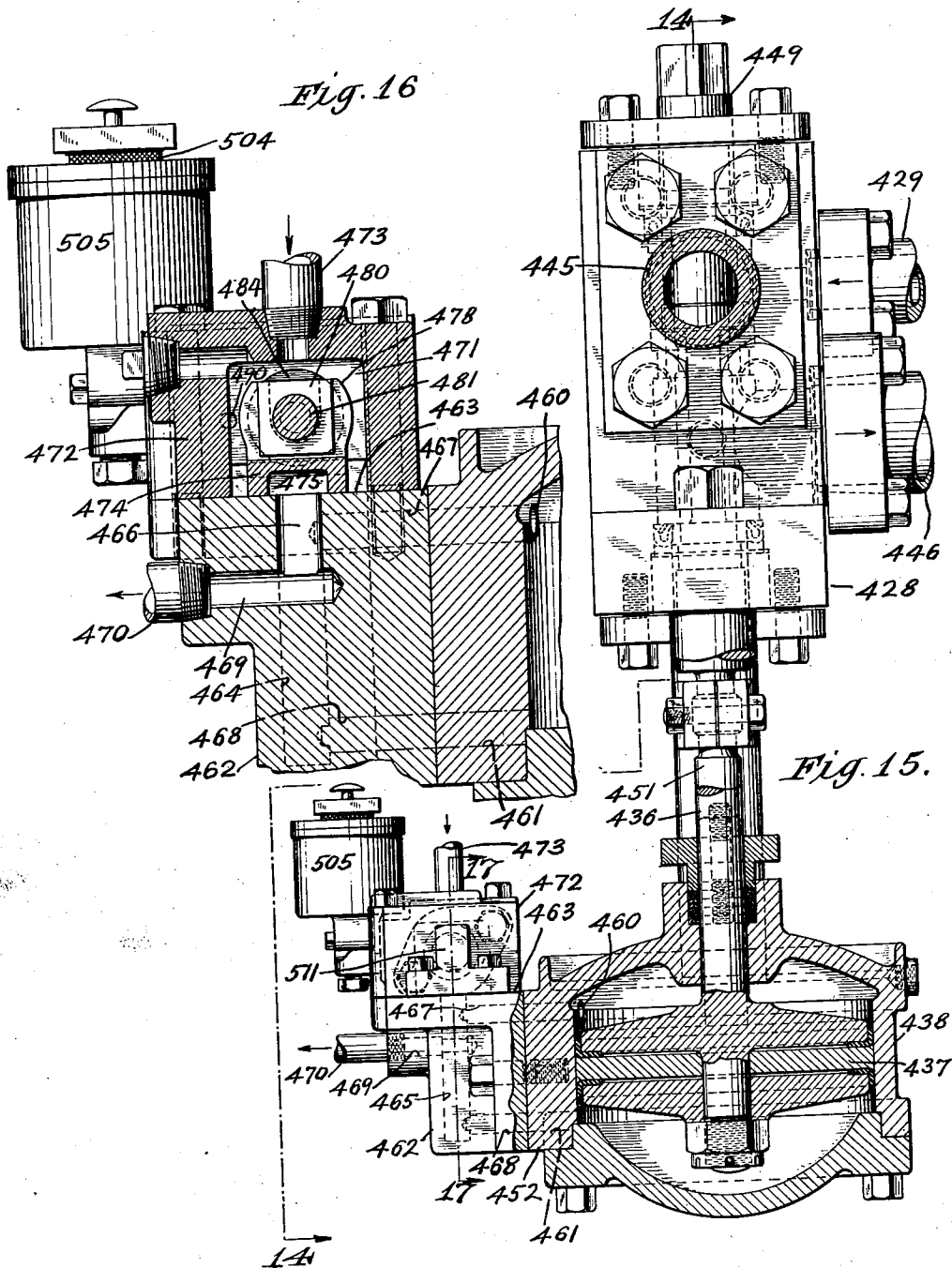
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CONTROLLING MEANS APPLICABLE THERETO

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INVENTOR
David L. Summey
BY
Philip Sawynuk & Co.
HIS ATTORNEYS

March 8, 1932.

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Fig. 17.

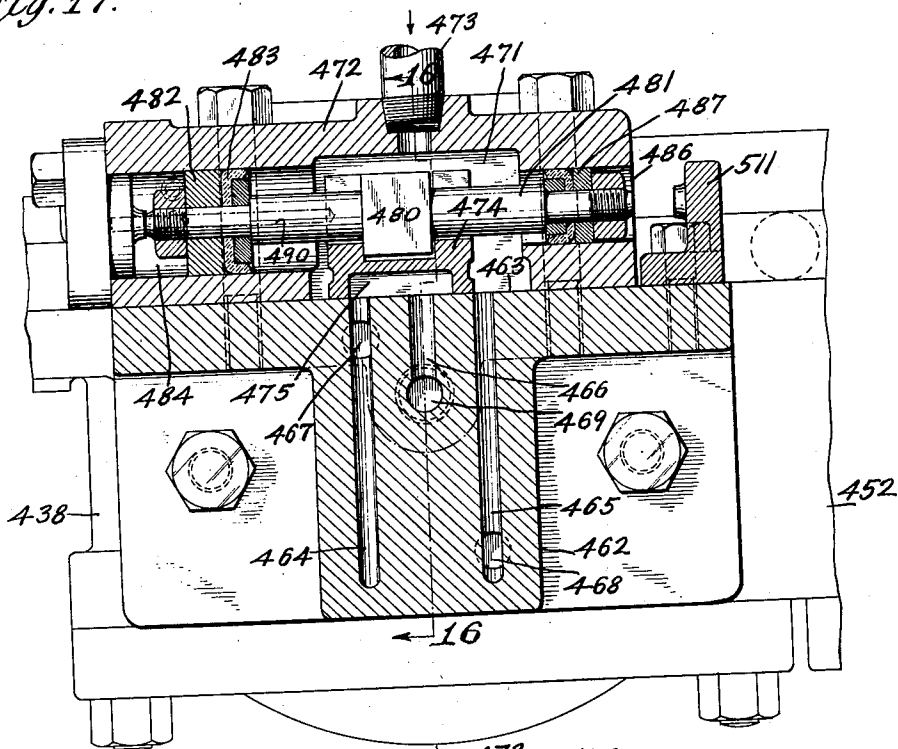
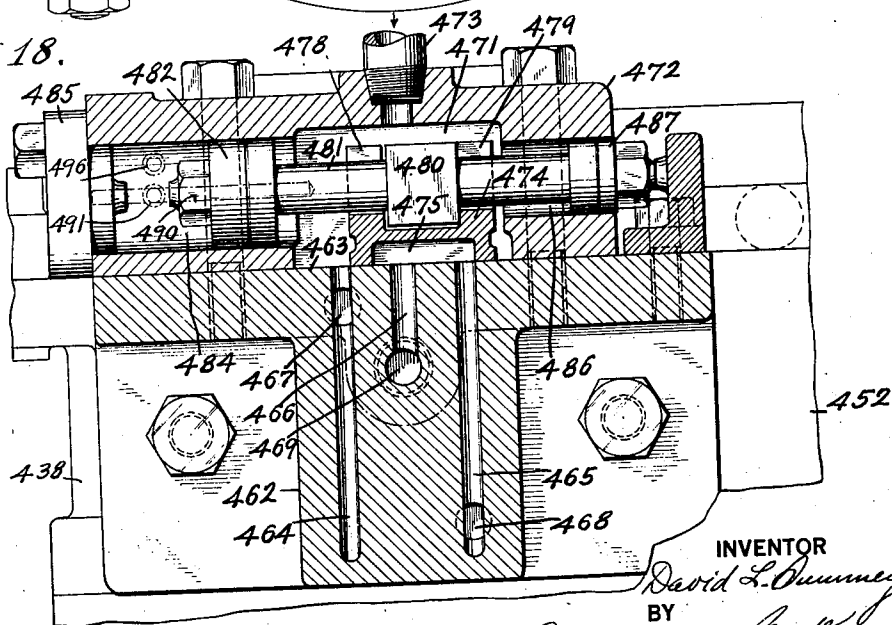


Fig. 18.



INVENTOR

David L. Summey

BY

Philip S. Thompson

HIS ATTORNEYS

March 8, 1932.

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Fig. 19.

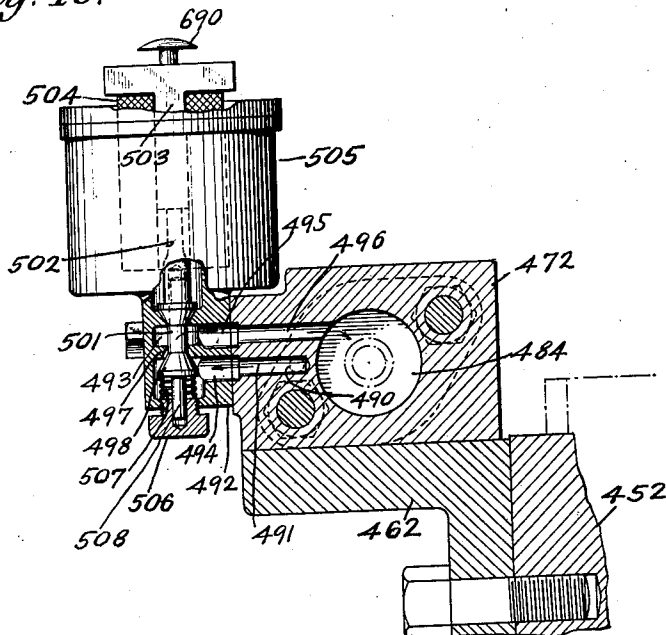
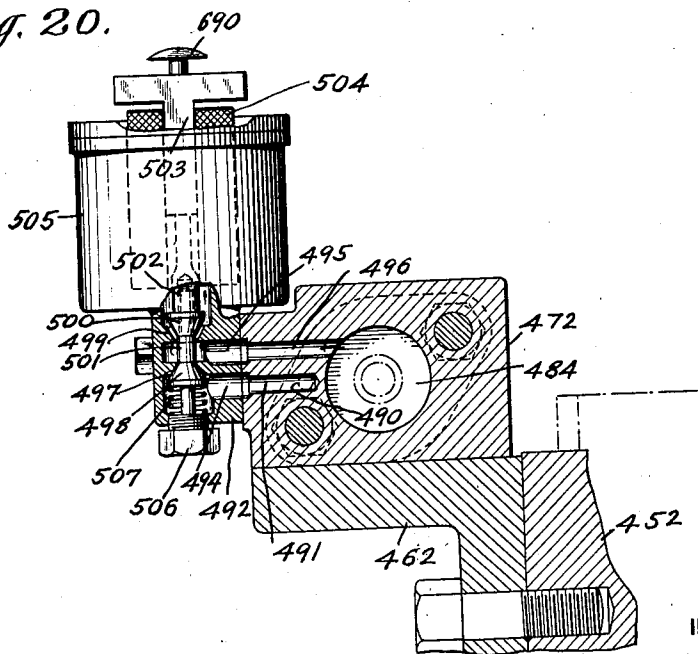


Fig. 20.



INVENTOR

David L. Summey
BY
Philip Lawrence Summey
HIS ATTORNEYS

March 8, 1932.

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 CONTROLLING MEANS APPLICABLE THERETO
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Fig. 22.

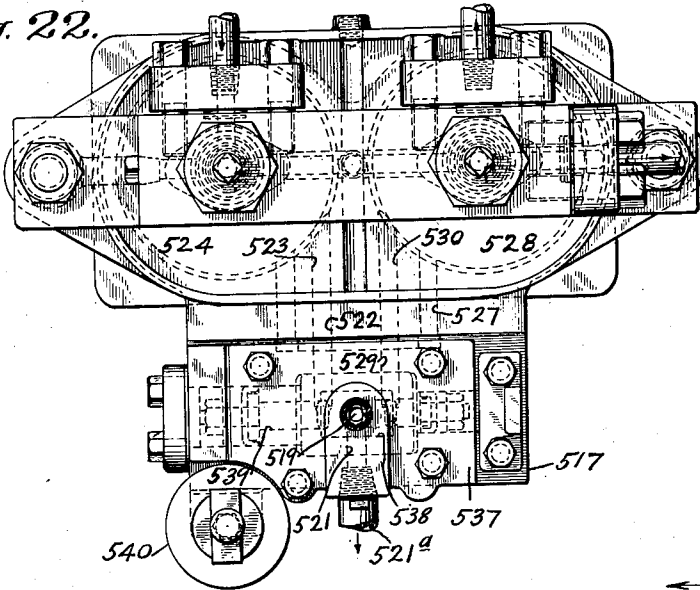
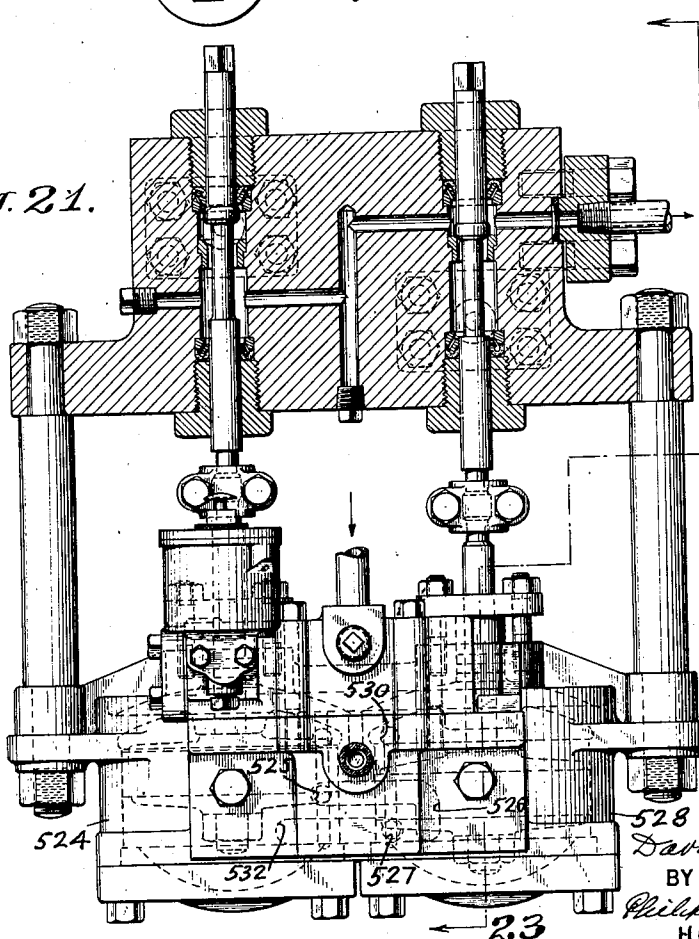


Fig. 21.



INVENTOR
David L. Summey
 BY
Philip S. Sawyer Rice & Sumner
 HIS ATTORNEYS

March 8, 1932.

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Fig. 23.

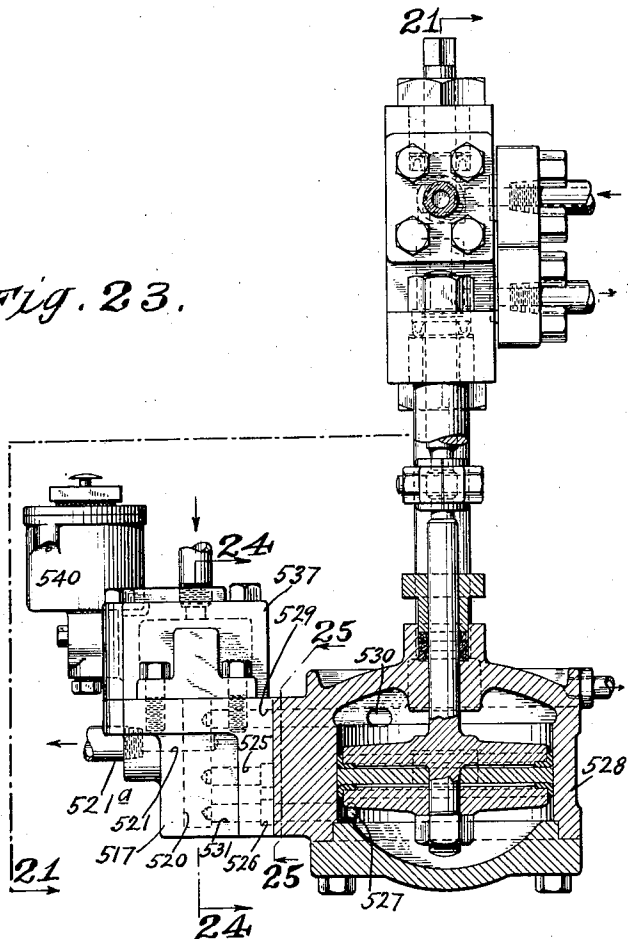
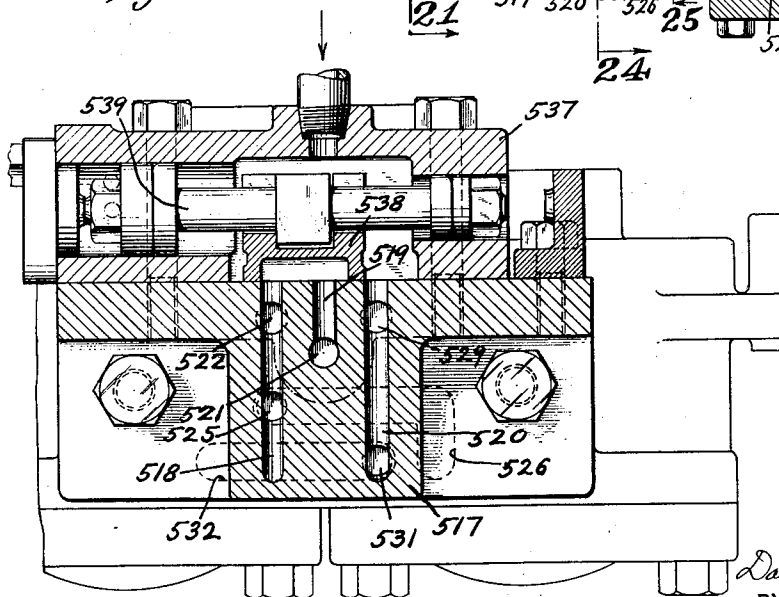


Fig. 24.



INVENTOR

David L. Summey

BY

Philip S. Summey & Co.
HIS ATTORNEYS

March 8, 1932.

D. L. SUMMEY
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Fig. 25.

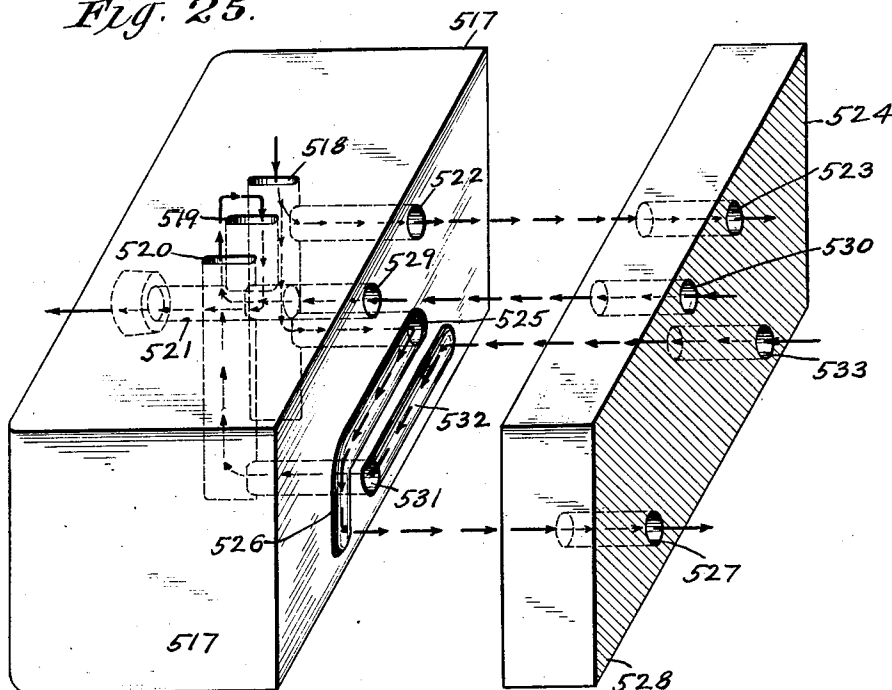
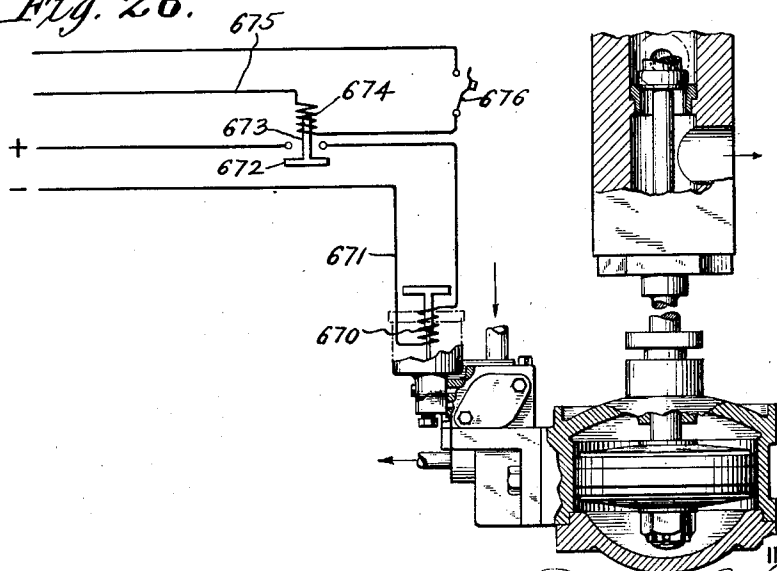


Fig. 26.



INVENTOR

David L. Summey

BY HIS

Philip Lucian Rice & Co. ATTORNEYS

March 8, 1932.

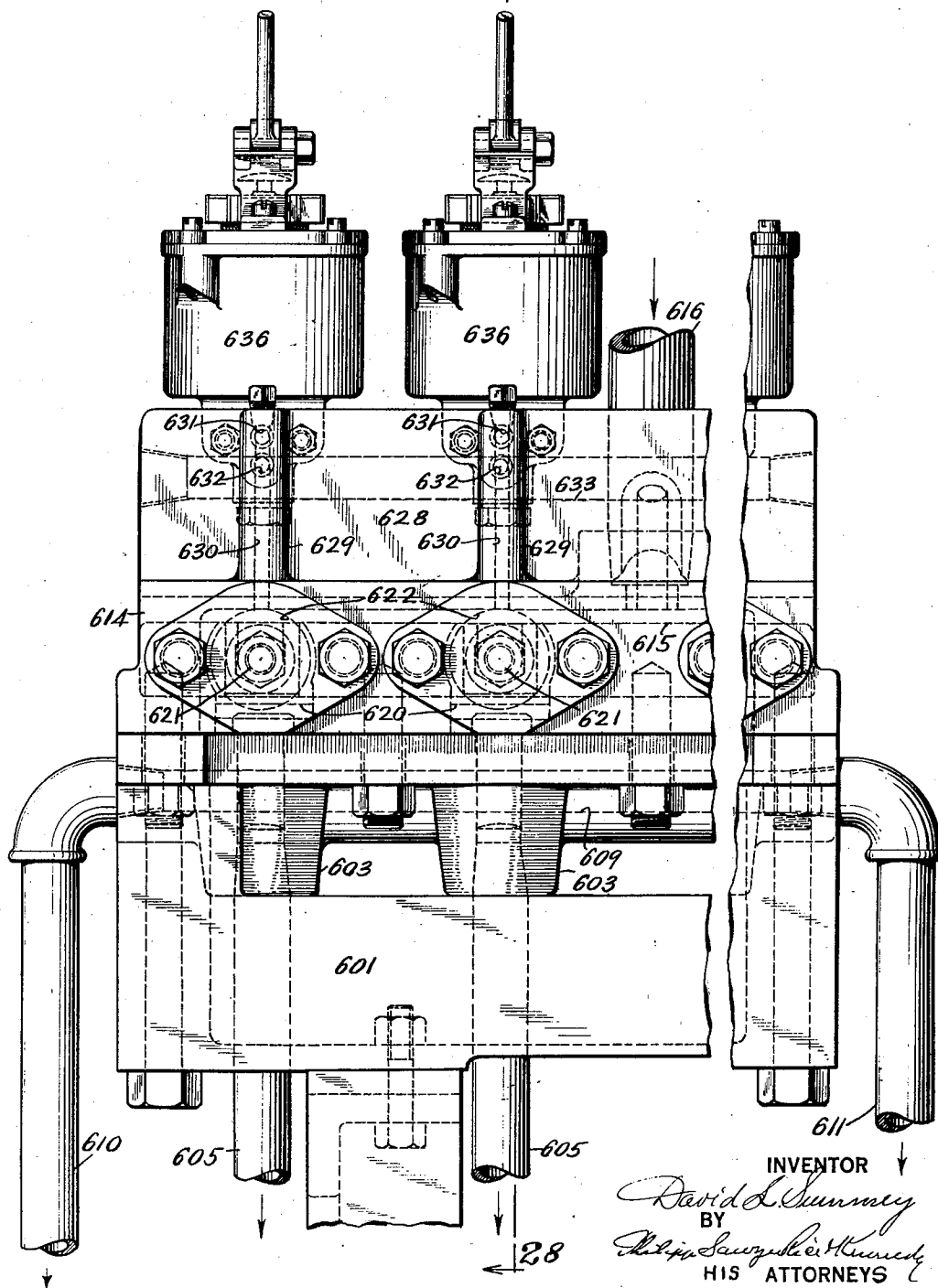
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Fig. 27. 28



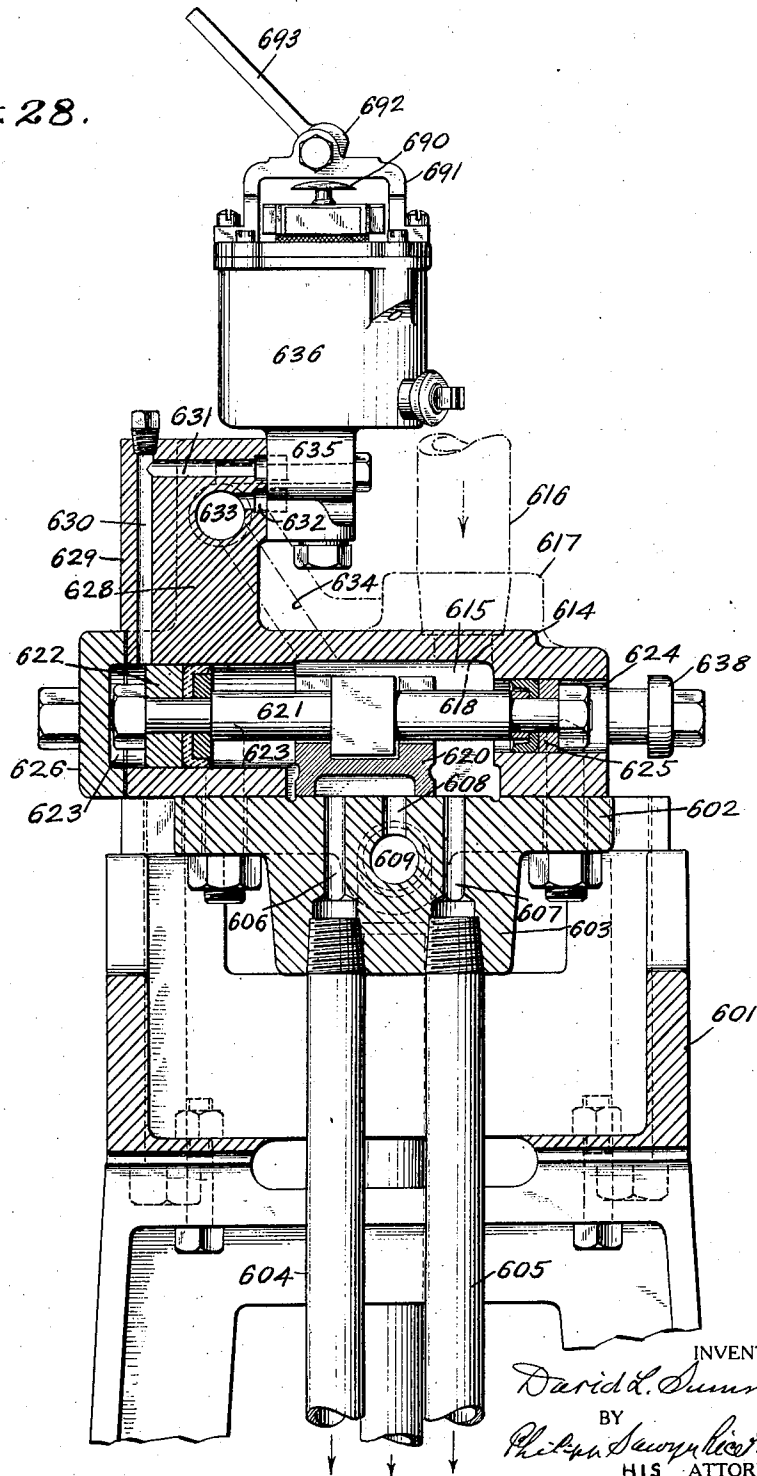
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 Filed March 12, 1926

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Fig. 28.



INVENTOR
David L. Summey
 BY
Philip S. Sawyer & Co.
 HIS ATTORNEYS

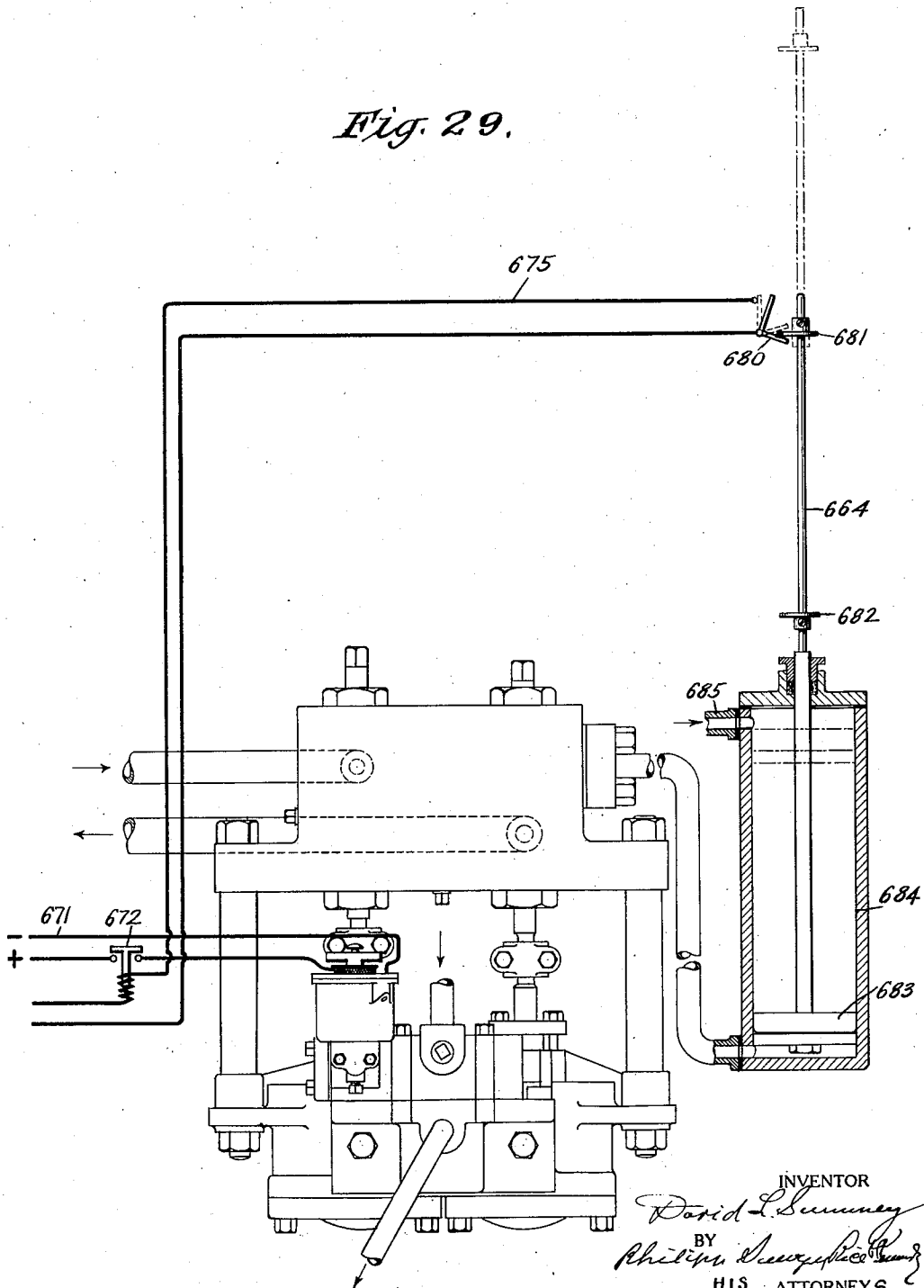
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Fig. 29.



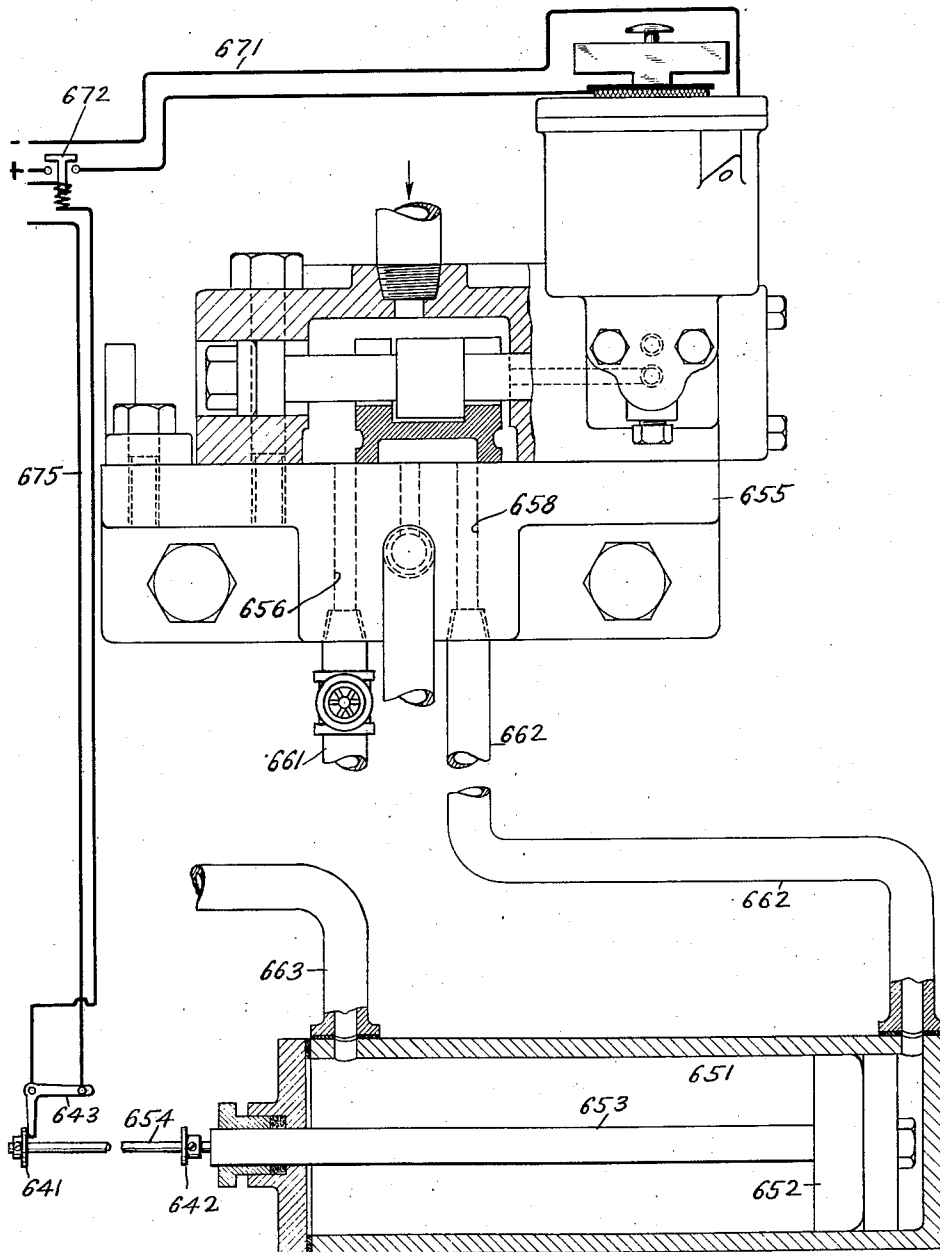
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Fig. 30.



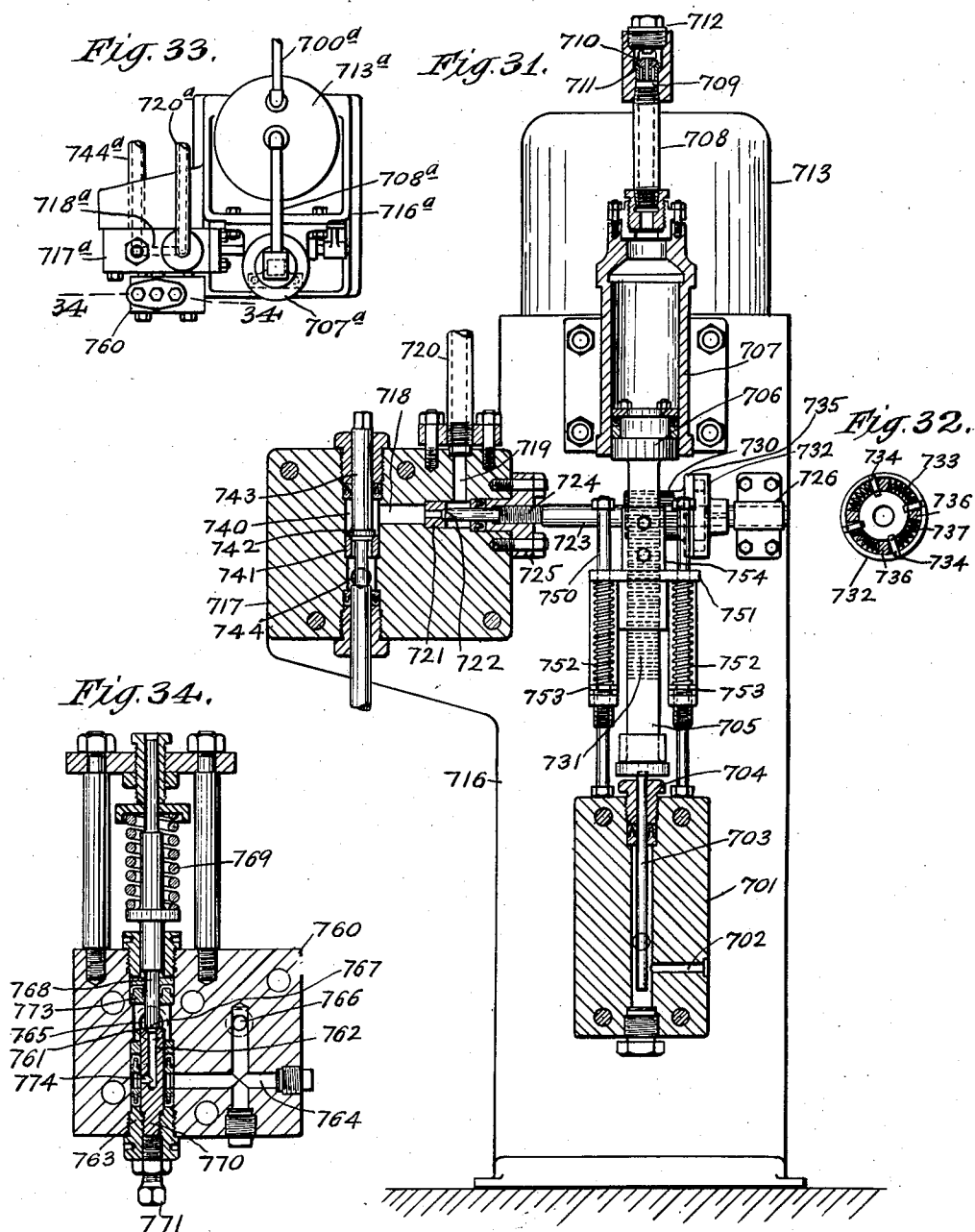
INVENTOR
David C. Summey
BY
Philip Sawyer & Co. Attorneys
HIS ATTORNEYS

March 8, 1932.

D. L. SUMMEY
 APPARATUS FOR EXTRUDING AND COILING RODS AND
 CONTROLLING MEANS APPLICABLE THERETO
 Filed March 12, 1926

1,849,044

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Inventor

David L. Summey
 By his Attorneys
 Philip M. Sawyer & Co. Kennedy

UNITED STATES PATENT OFFICE

DAVID L. SUMMEY, OF WATERBURY, CONNECTICUT

APPARATUS FOR EXTRUDING AND COILING RODS AND CONTROLLING MEANS
APPLICABLE THERETO

Application filed March 12, 1926. Serial No. 94,334.

This invention relates to apparatus for extruding and coiling rods and to controlling means applicable thereto.

In extruding rods, according to known practice, as the rods emerge from the extruding die they are grasped by suitable tongs in the hands of workmen who walk away from the press as the rods advance and guide them in a more or less straight path along a receiving table or the like. Later the rods are usually coiled for facility in handling. Owing to the fact that the speed of emergence is inversely proportional to the size of the rod extruded, the size of rods produced under this practice is limited. If it is attempted to extrude small size rods, the rods emerge so fast that the workmen cannot keep up with them. As a result, when small size rods are desired, a medium size, say $\frac{1}{2}$ ", is extruded and this rod is drawn down to desired size by repeated drawing operations.

It is an object of the invention to provide apparatus capable of producing small as well as large size rods and avoiding the separate step of rod coiling. More particularly it is an object of the invention to provide apparatus in which the extruded rod is automatically coiled as it emerges from the extruding die.

It is a further object of the invention to provide a combined extrusion press and coiler in which the various operating elements operate through at least part of their cycle automatically, the operation of one element being dependent on the operation of some other element.

It is another object of the invention to provide means for the automatic control of pressure fluid power units in general.

It is still another object of the invention to provide automatic means for limiting the pressure of a fluid pressure system and for automatically changing from one critical pressure to another.

With these general objects, and others not

specifically mentioned, 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 view, partly in side elevation and partly in vertical section, of a combined extrusion press and coiler constructed in accordance with the invention;

Figure 2 is a top plan view of the same with parts in horizontal section;

Figure 3 is an enlarged view of the coiler end, partly in side elevation and partly in section, showing the parts just prior to the extrusion of a billet;

Figure 4 is an end view (enlarged), partly in vertical section, looking in the direction of arrow of Fig. 1;

Figure 5 is a detail view showing part of Fig. 3 in a different position of the parts;

Figure 6 is a vertical sectional view taken on the line 6—6 of Figs. 1 and 2;

Figure 7 is a detail view showing, in horizontal section, the parts in the position of Fig. 3;

Figure 8 is a plan view, with parts in section and parts omitted, of the rod-feeding mechanism;

Figure 9 is an explanatory sectional view of the rod-feeding mechanism, the section being taken on the irregular line 9—9 of Fig. 8;

Figure 10 is a detail view showing part of the rod-feeding mechanism in end elevation;

Figure 11 is a gearing diagram for the rod-feeding and coiling mechanism;

Figure 12 is a piping diagram;

Figure 13 is a wiring diagram;

Figure 14 is a sectional view, taken on the broken line 14—14 of Fig. 15, of controlling mechanism constructed in accordance with the invention;

Figure 15 is a sectional view, with parts in

end elevation, taken on the broken line 15—15 of Fig. 14;

Figure 16 is a sectional view taken on the line 16—16 of Fig. 17;

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

Figure 18 is a similar view showing the parts in a different position;

Figure 19 is a sectional view, partly in elevation, taken on the line 19—19 of Fig. 14;

Figure 20 is a similar view showing a different position of the parts;

Figure 21 is a sectional view, taken on the broken line 21—21 of Fig. 23, showing a modified construction;

Figure 22 is a top plan view of the same;

Figure 23 is a sectional view, with parts in elevation, taken on the broken line 23—23 of Fig. 21;

Figure 24 is a sectional view taken on the line 24—24 of Fig. 23;

Figure 25 is a schematic view supposedly taken at the line 25—25 of Fig. 23;

Figure 26 is a diagrammatic view of a typical fluid pressure unit with a wiring diagram;

Figure 27 is a view in side elevation of a modified construction;

Figure 28 is a vertical sectional view thereof, with parts in elevation;

Figure 29 is a diagrammatic view of a hydraulic unit with a wiring diagram;

Figure 30 is a similar view for an air-operated power unit;

Figure 31 is a view in vertical section, with parts in elevation, of part of a pressure-limiting device, the section being taken on the line 31—31 of Fig. 12;

Figure 32 is a sectional detail view;

Figure 33 is a top plan view of another part of the pressure-limiting device; and,

Figure 34 is a vertical sectional view (enlarged), taken on the line 34—34 of Fig. 33.

Referring to the drawings, in the embodiment illustrated, the billet 125 is extruded by a ram 115 mounted on a crosshead 116 which slides on horizontal columns or tie rods 120. Crosshead 116 is moved to drive the ram forward by a hydraulic plunger 123 which is secured to part of the crosshead. This plunger operates in a large hydraulic cylinder 124 to which pressure water is admitted as later described. The plunger 123 is advanced to operate the ram by the pressure fluid and is withdrawn by means of two pair of draft rods 126 located above and below the ram cylinder. Each pair of rods is connected with the crosshead 116, the other ends of each pair being secured to a yoke 128 sliding on a track 129 and secured to a piston 130. These pistons operate in relatively small pull-back cylinders 132 which are directly connected with the main water supply. Being under constant, i. e. continuous, pump pressure, their tendency is to move the crosshead backward but because

of their relatively small size they are effective only when pressure is removed from the large cylinder 124.

The billet is held by a container 134 which, in the present embodiment, comprises two concentric cylindrical sleeves 135, 136, having a billet chamber 137. This container is mounted on a crosshead 138 which slides on the tie rods 120. Movement of the container crosshead 138 is effected by piston rods 142 to which the crosshead is connected and on which are pistons 143 operating in hydraulic cylinders 144. The crosshead 138 is moved in one direction, namely, toward the left as viewed in Fig. 12; by valve-controlled pressure fluid on pistons 143, as later described. They are moved in the opposite direction by constant return pressure received from a direct connection with the main water supply. As this constant return pressure operates on a smaller piston area, it becomes effective only when the valve-controlled pressure is relieved.

In this connection it may be noted that throughout this specification when constant return pressure is referred to, either in the case of water or air, it means continuous, direct connected main line pressure acting on smaller piston area. When variable pressure is referred to, either water or air, it means main line pressure that is put on or off and acts on greater piston area.

Movable across the axis of the container chamber and ram is a reciprocating die-carrying slide 147. This slide is moved by a piston rod 149 to which it is secured and which operates in a hydraulic cylinder 150. This unit is operated in the same way as the container crosshead, namely, by variable pressure, controlled as later described, and constant return pressure. Slide 147 is also used in inserting the billet. To render the billet chamber accessible for the insertion of a billet and for the removal of the stump, the slide is cut away at each end to form deep offsets 153, 154 (Fig. 6). These are so positioned that when the slide reaches either end of its stroke the end of the billet chamber is exposed. Adjacent offset 153 is a cradle 155 for a billet and leading away from offset 154 is a discharge runway 155a for the stump. The slide 147 takes an intermediate position to position a die in line with the axis of the container chamber. The die 156 here shown as an example has twin extruding bores, illustrated in Figs. 6 and 7, so that two rods are formed simultaneously from a single billet. Different dies may be substituted, having bores of different diameters, the die being hung on the carrier slide.

The backing for the extrusion force is provided by the die carrier. To this end, the central portion of the carrier is a thick heavy block 157. Set in the block behind the die is a cylinder 158 substantially larger in diameter than the die. This cylinder and the block

have passages therethrough (Fig. 7) in line with the die bores for the passage of the extruded rods.

To control the several positions of the slide during the cycle of operations, automatic stops are provided. At the billet-carrying end of the slide is a stop 162 which makes contact with the frame to stop the carrier in billet-inserting position. At the other end is a similar stop 163 which makes contact with the frame to stop the carrier at the other end of its stroke in a position for expulsion of the stump. This stop, however, is an emergency one as later described. For the die centering positions, a latch 164 is provided which enters a notch 165 formed in the slide. The latch is attached to the end of a piston rod 166 working in an air cylinder 167, the air supply of which is controlled as later described. The air pressure normally holds the latch advanced to a position to enter the notch. The latch is withdrawn by a coil spring 169 bearing against the face of the piston and effective upon release of the air pressure. One side of the notch is abrupt and the other side sloping so that after a billet has been placed on the cradle the carrier slide moves to billet-inserting position regardless of the latch which merely rides up the slopes. But when the carrier slide moves back for die-centering the latch slips into a notch and by its contact with the abrupt face stops the slide in extruding position.

To insert a billet into the container after the slide has positioned the billet, there is provided a billet pusher. As here shown as an example, this billet pusher is in the form of a tube 170. This tube has a second function, that of serving as a conduit for the extruding rods, as later described. Tube 170 is mounted in a head 171 connected by draft rods 172 with a crosshead 173. The latter is mounted on the end of a piston rod 174 having a piston working in a hydraulic cylinder 175 that receives variable pressure as later described and is under constant return pressure.

To sever the extruded stock from the sprue, a cutter is provided in the form of drop-bar shears. As shown, a cutting plate 178 is mounted on a vertically disposed piston rod 179 having its piston operating in a hydraulic power cylinder 180. This cylinder receives variable water pressure through a valve unit to be described and is under constant return pressure. When variable water pressure is admitted, the cutter is forced downward to cut the stock. When this variable pressure is relieved the constant return pressure becomes effective and withdraws the cutter. The cutter is so located that it operates in close proximity to the back of the die-carrier so that, after cutting, there is left only a short stump representing extruded metal in the die and the die-carrier.

The cycle of operation of the parts so far

described starts with the billet pusher back, the ram back, the cutter back, the container near the slide and the slide in the position of Fig. 6. A billet is placed on the cradle and the slide moved over until stopped by stop 162 with the billet in line with the container. The billet pusher is then advanced to push the billet into the container. The pusher is withdrawn and the slide moved across the container mouth until its notch is engaged by latch 164. This positions the die in line with the ram (Fig. 6). The container is then moved up until its mouth takes over the die (Fig. 7) and the billet pusher is moved up to abut the slide and function as a conduit for the emerging rods. The main ram is now advanced against the billet and the metal is extruded through the die bores into the form of rods, the disposition of the extruded stock being later described. When all but a short dead end is extruded the ram is stopped and withdrawn and the pusher is withdrawn. The cutter is advanced to sever the rods and the container is moved back to withdraw the stump. Continued back movement of the container brings the sprue against the end of the withdrawn ram for expulsion.

In case a sprue or billet becomes frozen in the container, latch 164 is released and the slide moved over to the extreme left (Fig. 6) until stopped by stop 163, to expose the container chamber. The ram is then advanced against the sprue or billet and the latter is ejected by the full force of the ram unit. If this emergency operation takes place the resulting slide position may be considered billet-receiving position as it is really an overthrow beyond initial position.

Disregarding the control, so much of the apparatus as has been described is substantially like that of applicant's Patent #1,317,238, except that the billet pusher is different in construction, though performing the same pushing operation, and the die has twin bores.

The invention in its entirety includes means for coiling the extruded rods as they emerge from the press and in structures embodying the invention to the best advantage the rods will be laid in stationary coils. As here shown as an example, beyond the press is a pit 101 containing two cylindrical coiling tanks 102, the lower ends of which seat in a water tank 103 and have perforated bottoms to let in water. In each coiling tank is a stationary hollow central post 104 having a conical top 105 and a bottom open to the water. Between the wall of each tank and its central post is a normally stationary platform 106 for receiving the coils. Mounted above the mouth of each tank and centrally thereof is a whipping block 107 rotating on a vertical axis and having an oblique bore 108. The upper mouth of the bore is coaxial with the

block and is in line with the vertical path of the rod stock as it comes from the feeding rolls, to be described. Block 107 is rotated, as later described, at substantially the normal speed of emergence of the rod and the rod, passing through the oblique bore, is whipped into loops (Fig. 4), which fall down about the conical post and are laid in stationary coils on the platform. The tank walls and coiling posts form an annular receiving channel and the whipping block coils the rod in this channel in much the same way as a rope is coiled down by hand. The size of the loops, except as limited by the diameter of the tank, depends upon the speed of emergence of the rod and the speed of rotation of the whipping block.

The invention in its entirety includes means for feeding a rod from an extrusion press to a coiling device and in structures embodying the invention to the best advantage the rod will be placed under tension throughout its course from the press to the coiler. With apparatus of the type described, since the rod emerges from the die in a horizontal path and enters the whipping block in a vertical path, the feeding means also serves to direct the rod from the horizontal to the vertical. Moreover, with machines producing two rods, since the centers of the coiling tanks are separated more widely than the die bores, the two paths diverge and the feeding means serves to direct the rods along diverging as well as down-turning paths. In the embodiment here illustrated, therefore, the path of each rod includes a horizontal portion as the rod emerges from the die and a vertical portion just prior to its being taken by the whipping block. Between the horizontal and vertical portions the path follows a compound curve which may be described as being made up of the arcs of two circles of substantially the same radius, their centers being located in different planes which may be at about right angles to each other, the two arcs joining at a point of common tangency. Such a path is void of any break in its regular continuity.

While the feeding and guiding means may vary, it may include, for each rod, a series of pairs of cooperating rolls, connected by guiding throats, the passes of the successive pairs of rollers and the intermediate throats substantially following paths of the kind just described. In structures embodying the invention to the best advantage, the feeding means will be capable of some slippage to accommodate changes in the speed of rod emergence and complete stoppage of the stock during cutting. This may be accomplished by yieldably mounting one roll of each pair and a convenient construction embodies a frictional drive for the yieldable rod.

Although capable of various construction,

in that here shown as an example, at the start of extrusion the billet pusher 170 is advanced to abut the carrier slide (Figs. 3 and 7), its twin passages 183 registering with the passages through the slide to serve as conduits for the rods. These passages 183 are continued through crosshead 171 as will be apparent from Fig. 7. Beyond the crosshead 171 is a frame 184 for the feeding mechanism. This frame is formed with two parallel grooves 201, separated by a Y-shaped tongue or partition 202, in line with the passages 183. When the billet pusher is in withdrawn position (Fig. 6) crosshead 171 abuts frame 184. But when the pusher is advanced, as above referred to, there is a gap between the crosshead and grooves 201. This gap is bridged, as here shown, by twin tubes 185 secured in the crosshead 171 to form continuations of passages 183 and telescoping into grooves 201. The emerging rods advance, under the force of extrusion, through the passages 183 and tubes 185 into grooves 201, where they are guided by tongue 202 into the bite of the first pairs of rolls. From there on they are taken by the succeeding rolls and fed forward under tension. When the billet pusher is withdrawn (Fig. 8), the tubes move up the grooves, simply shortening the distance to be traversed by the rods between the tubes and the first rolls.

As above stated, the feeding means comprises successive pairs of rolls, one roll of each pair being positively driven. As here shown as an example, throughout the series the lower or inner rolls are the positively driven ones and they are mounted on suitable shafts carried by stationary frame 184. The first rolls of the two sets are parallel and the top rolls are carried by a removable frame 203. Each of these upper rolls 266 is rotatably mounted in a yoke 205 which is pivotally connected with frame 203. This permits each upper roll to move toward and away from the lower roll 266. The upper roll is yieldably pressed toward the lower roll by means of a two-armed spring 206. The loop of this spring is fulcrumed under an adjustable abutment 207 carried by frame 203 and the ends are mounted in the yoke 205. The upper and lower rolls of each pair have cooperating flanges 210 and the spring 206 normally holds the upper roll with its flanges in contact with the flanges of the lower roll. When the lower roll is driven, therefore, as later described, the upper roll, no rod being present, is driven frictionally by the contact of its flanges with those of the lower roll. The bite of the roll treads, however, is such that when an emerging rod is received the upper roll is forced outwardly against its spring, separating the flanges, and thereafter the upper roll is driven frictionally through the rod itself from the lower roll. Beyond the tangential point of each

initial pair of rolls the stationary frame and the frame 203 enclose a throat 204 for guiding the rod towards the next pair of rolls. The passes of the initial pairs of rolls are parallel and in line with the horizontal paths of the emerging rods but beyond these passes the paths start on an outward and downward curve, i. e. the first arc of the compound curve above referred to. It is to be understood that the throat 204, and subsequent throats to be referred to, are bounded by substantially flat walls, but the successive roll passes lie in the compound curve referred to and this curve is embraced by the throats so that the rods, in effect, follow such curve.

Beyond the frame 203, the two sets of feeding and guiding means are reverse hand duplicates and a description of one set is sufficient. Abutting frame 203 is a removable frame 203a which carries the second and third upper rolls 266A, 266B. These rolls are mounted on yokes similar to yoke 205 and are spring-pressed toward the lower rolls by springs like those described. Between the frame 203a and the stationary frame is a throat 204a that forms a continuation of throat 204 approaching the second pair of rolls 266A, 266a; that connects the latter rolls with the third pair 266B, 266b; and that extends beyond the latter (Fig. 9). Its end here registers with the end of a throat 204b formed between the stationary frame and a third removable frame piece 203b which abuts frame piece 203a. This third piece carries the upper rolls 266C, 266D, 266E of the fourth, fifth and sixth pair. These rolls are mounted in a manner similar to that already described. The throat 204b forms a continuation of throat 204a in approaching the fourth pair of rolls 266C, 266c; connects the passes of the latter rolls with the fifth pair 266D, 266d; connects these with the sixth pair 266E, 266e; and extends beyond the latter. Its end here registers with the end of a throat 204c formed between the stationary frame and another removable frame piece 203c, which abuts frame 203b. This latter carries the upper rolls 266F and 266G of the seventh and eighth pair. These rolls are mounted as the others are. The throat 204c forms a continuation of throat 204b in approaching the seventh pair of rolls 266F, 266f; connects the latter with the final pair of rolls 266G, 266g and extends beyond the latter to register with the upper end of bore 108 of whipping block 107. In the embodiment described, the first arc of the compound curve referred to joins the second arc at the junction of the throats 204a, and 204b. The second arc continues to the pass of rolls 266F, 266f and from there on the path is substantially straight to the whipping block.

While the means for driving the various lower rolls may vary, in the embodiment here illustrated as an example, an electric motor

251 drives, through a change-speed train later described, a gear 252. This gear is on a shaft 253 carrying a pinion 254 which drives, through intervening pinions 255, 256, a gear 257 on a common cross shaft 258. From here on the two units are reverse hand duplicates (Fig. 11) and the description of one will suffice. On the end of shaft 258 are two pinions 259, 260. The former meshes with a gear 261 on a stub shaft 262 having a pinion 263 meshing with opposing gears 264, 264a. Gear 264 is mounted on a shaft 265 which carries inner or lower roller 266a of the second pair, the first pair being driven as later described. Pinion 260 meshes with a gear 267 on a shaft carrying a pinion 268 analogous to pinion 263. Through opposing gears 264c, 264d and shafts like those described, the succeeding lower rolls 266c and 266d are driven. From this point on, the remaining three lower rolls are driven by a simple train of gears, an intermediate pinion being interposed between each two roll gears, as will be obvious from Figs. 11 and 9.

Referring to the first pair of rolls of each set, the lower rolls 266a are mounted on a common shaft 279 which has a gear 280 meshing with pinion 254.

There is provided means for readily effecting a considerable variety of speed changes in the lower rolls. Although capable of various constructions, in that here shown as an example, motor 251 drives, through suitable gearing, a shaft 285 having three pinions 290, 291, 292 thereon of different sizes. In line with shaft 285 but separate therefrom is a like shaft 286 carrying three pinions 293, 294, 295 of different sizes, the middle pinion meshing with gear 252 from which all the roller gears derive power. Paralleling shafts 285, 286 is a shaft 287 having slidably keyed thereon two sets of three gears each, of different sizes. One gear of the first set meshes with one of the pinions on shaft 285 so that shaft 287 is driven from the latter. Thus, in Fig. 11 the middle gear of the first sliding set is in mesh with pinion 291. One gear of the second set meshes with one of the pinions on shaft 286 so that the latter is driven from shaft 287. Thus, in Fig. 11 the middle gear of the second set is in mesh with pinion 294. To vary the speed of the roll drive the sliding gears are shifted. One set is shifted by a gear shaft lever 288 operated by a push-pull rod 289. A similar device shifts the other unit. By shifting one or the other set of sliding gears, or both sets, a great variety of roller speeds may be obtained. It will be understood that extruded rods of different sizes emerge at different speeds. The roll driving mechanism is arranged to give a roll speed that is 30 or 40% higher than the normal speed of emergence and when different size rods are extruded, the roll speed may be changed accordingly.

While the means for rotating the whipping blocks 107 may vary, this is conveniently accomplished by connecting them with the gearing trains of the feeding rolls. As here shown as an example, each whipping block 5 has formed thereon a worm gear 275 meshing with a worm 274 on a shaft 273. The latter has a gear 272 meshing with a gear 271 on a shaft 270 which is driven 10 by the gear of the final lower roll 266g. Gears 271, 272 are change-speed gears that may be removed for the substitution of other gears to adjust the speed of rotation of the whipping block to various 15 speeds of emergence, the block being rotated at substantially the normal speed of rod emergence.

The rod feeding rolls and whipping block, in the embodiment illustrated, are continuously rotated during a run, the upper rolls being driven frictionally by the flange contact with the lower rolls. When a billet is extruded the emerging rods pass to the first pair of rolls as above described. Here the 25 rods are taken by the rolls which, rotating at a peripheral speed considerably faster than the speed of emergence, place the rods under tension and feed them forward. Guided by throats 204, 204a the rods pass 30 to the next pair of rolls and are fed and guided forward in the paths described by the succeeding rolls and throats. Finally, the last pair of rolls 266G, 266g, feeds the rods into the bore of whipping blocks 107. 35 As a rod is taken by each pair of rolls, the upper roll is forced back slightly against its spring, thereafter being driven frictionally through the passing rod.

With the construction described the rods 40 are fed forward under tension direct from the press to the coiler so that the whole operation is automatic. The rolls do not exert a sufficient grip on the rod to deform the same to any substantial extent but are capable 45 of slip with respect to the rod by the yield of the upper rolls. This takes care of any slowing down in speed of emergence and stoppage of the rod for cutting. As the feeding rolls are continuously rotated, the rod, 50 even when stopped, is under tension. As a result, when the cutter operates, the trailing ends of the rods are immediately fed forward and coiled. As the emerging rods are laid in stationary coils, stoppage or slowing down 55 of the rods does not interfere with the coiling.

In the present embodiment, as above stated, the frame pieces that carry the upper or 60 outer rolls are removable to give access to the interior and to permit substitution of rolls having different channels for different size rods. Means is provided for releasably retaining these frame pieces in position. To 65 this end, as here shown as an example, frame piece 203 for the initial rolls has corner tongues taking under lugs or heads 249 on

stationary frame 184 (Fig. 8). At the other end of the frame is a notch 247 above which is a latch 248 carried by the stationary frame. When the latch is in the position of Fig. 8 the frame piece is held down. When latch 70 248 is turned to coincide with the notch the end of the frame piece may be raised and the tongues withdrawn from lugs 249. Frame piece 203a that carries the second and third pair of rolls, has a tongue and lug connection 75 with frame piece 203 and is latched at the far end. To this end, on the stationary frame is a block 187 in which is the threaded stem of a latch 188. This latch has a flat edge and a curved edge. When in the position of 80 Fig. 8 the curved edge lies in the path of a lug 189 on the box-like side of frame piece 203a so that the end of the frame piece cannot be moved out. To release this holding device the latch 85 is rotated through an arc of 180° or thereabouts so that its flat edge is presented to lug 189, whereby the lug can clear the latch. At the same time, the latch is cammed outwardly by its screw thread to relieve any 90 pressure on lug 189.

Frame piece 203c which carries the last two rolls has a tongue and lug connection with 95 frame 184 like that of frame piece 203 and latches like those described. Frame piece 203b which carries the fourth, fifth and sixth rolls, and which is conveniently assembled 100 last, has a tongue and lug connected with frame piece 203c and latches, at the upper end, like those described.

The invention in its entirety includes a part 105 to be moved between two extremes and an intermediate position and means, including a fluid pressure unit, for moving such part without the necessity of stopping such unit in the course of its stroke by control of its 110 fluid pressure. This may be accomplished by connecting the part to be moved with the piston rod of a fluid pressure unit capable of a stroke equal to the extreme range of movement of the part to be moved and associating 115 with this unit an auxiliary fluid pressure unit having a piston rod unconnected with the part to be moved but capable of abutting the latter, such auxiliary piston rod having a stroke equal to the movement of the part to 120 be moved from one extreme position to intermediate position. In connection with the coiling means there is provided elevator means for moving the coil platforms 106 to 125 a cooling position below initial or coil-receiving position and to a coil-discharging position above initial position. This movement may conveniently be accomplished by the two-part fluid pressure device just referred to, the elevator being the part to be 130 moved above mentioned.

Although capable of various constructions, in that here shown as an example, the platforms 106 have a sliding bearing in the coiling tanks and are connected by three draft 135

rods 301 with a crosshead 302. The draft rods slide in grooves in the tank walls, the central rod being common to both units, so as to present a flush surface to the whipping loops of the coiling stock. Bolted to the crosshead 302 are two piston rods 303 the pistons of which work in air cylinders 304 that are long enough to permit the necessary range of movement of the elevator unit above and below initial position. At the upper ends of the two cylinders 304 are two relatively short auxiliary air cylinders 305 in which work auxiliary pistons 306 having piston rods 306a, the outer ends of which can abut the bottom of crosshead 302 but which are not connected thereto. The auxiliary power units are so positioned and have such stroke that when their pistons are fully advanced the piston rod ends abut the crosshead 302 when the latter is in initial position and when withdrawn, they permit descent of the elevator to cooling position. To steady the movement of the elevator unit the crosshead 302 has a bolster 300 which carries pinions 307 running on racks 308 located on the outer face of a frame element 309 formed by channel irons. In the embodiment shown, the two sets of power units are air operated. Admission of variable air to the lower ends of the cylinders, to advance or raise the pistons, is valve controlled as later described, and the other ends are under constant return pressure for downward or withdrawing movement. In initial or coil-receiving position of the elevator unit, the crosshead is held up by the auxiliary power units, the main pistons being under return pressure which is ineffective against the variable pressure on the auxiliary pistons.

The embodiment described is capable of at least two different cycles, depending on how the power units are operated. In one type of elevator cycle, the elevator is moved from initial position downward to cool the extruded stock, then clear up to discharge position and finally part way down to initial position. In the other type of cycle, the extruded stock is not cooled. Consequently, following coiling, the elevator is moved up to discharge position, then clear down to cool the platforms, and finally part way up to initial position.

Referring to the first type of cycle, to lower the elevator from initial position, the auxiliary pistons are withdrawn. As the main pistons are already under return pressure, for which gravity might be substituted, the elevator moves down to immerse the platforms and coils into the water bath. To raise the elevator, the main pistons are advanced the full length of their stroke and this moves the elevator up past initial position to discharge position. In such movement, of course, crosshead 302 simply draws away from the unconnected auxiliary pistons. After the coils are discharged, as later described, the

elevator is returned to initial position by allowing the main pistons to descend under return pressure and using the auxiliary piston rods as positioning stops. To this end, the auxiliary pistons are returned to and held in initial position by variable pressure. When the descending crosshead strikes the ends of the auxiliary piston rods it is stopped in its down movement because the return pressure on the main line pistons is ineffective against the auxiliary pistons. The parts are now ready for the next extrusion.

In the second type of cycle, the elevator, after completion of the coiling operation, is raised to discharge position by putting variable pressure on the main pistons, the crosshead drawing away from the auxiliary pistons. After discharge of the coils, the elevator is moved to cooling position, for platform cooling, by placing the auxiliary pistons under return pressure to get them out of the way, and putting the main pistons under return pressure to carry the elevator from extreme up position to extreme down position. To return the elevator to initial position the main pistons are left under return pressure and the elevator is raised by putting the auxiliary pistons under variable pressure. The return pressure is ineffective against the variable pressure and the auxiliary piston rods, abutting the crosshead, raise the elevator to initial position. This position is, of course, automatically attained because it is governed by the stroke of the auxiliary pistons. This again places the parts for the next extrusion.

With the construction described the elevator may be stopped in a position intermediate its extreme range without the necessity of stopping the long power unit in the middle of a power stroke.

There is provided means for discharging the coils from the coiling platforms. This may be accomplished, in connection with the elevator just described, by transverse pushers. Although capable of various constructions, in that here shown as an example, substantially level with the tops of the coiling tanks (Fig. 3) is a discharge platform 311. Opposite this platform are twin discharge pushers, one for each coil. Each pusher comprises an arcuate coil-engaging element 312 mounted on a piston 313 working in a power cylinder 314. One end receives variable air pressure as later described and the other end is under constant return pressure. When the platforms are elevated to discharge position, as above described, they are substantially flush with the platform 311. Pistons 313 are advanced by variable pressure and pushers 312 shove the two coils onto the discharge platform. From here the coils may be removed in any suitable manner. Following discharge the pushers are withdrawn by return pressure.

As later described in detail, the invention

in its entirety includes means whereby the operation of various steps in the cycle of rod production is automatically controlled by some preceding step. In the embodiment here illustrated, the cycle is manually controlled up to the completion of the extruded rod and the cutting, cooling and discharging steps are automatically controlled. While the controlling means for the ram, the container and the slide may vary, the drawings illustrate, by way of example, a control like that described in the patent referred to. That is, from suitable high pressure pumps 321 (Fig. 12) a main water line 322 leads to a hydraulic valve unit indicated by 323 and having connection with an exhaust water line 320 leading back to the pumps. This hydraulic valve unit is like the one described in the patent referred to but a similar unit is described hereinafter. Briefly, it comprises water inlet and exhaust valves each operated by a piston working in an air cylinder. Each piston is operated by air pressure delivered to one end or the other of the corresponding cylinder. Fig. 12 shows a group of four air pipes 324, one pair for each cylinder, leading to suitable pilot valves at a manual control station 325 connected by a pipe 326 with a source of compressed air. By operation of these pilot valves the movement of the pistons referred to is controlled to open or close the hydraulic valves. The container unit is operated in the same way, that is, its cylinders 144 are connected through a valve unit 327, like unit 323, with the main line and exhaust and connected by a group of four pipes 328 with pilot valves at the manual control station. Similarly the slide unit has a valve unit 329 with four air pipes 330 leading to the manual control station. The manual control station also has a pilot valve controlling the air, through a pipe 331, to the latch unit. Normally the latch cylinder is under air pressure but the air may be cut off to withdraw the latch for the emergency expelling step above described.

While the automatic control may vary, in structures embodying the invention to the best advantage, it will include electrically operated elements for controlling the actuating air for the various power units, whether the air acts as a motive force directly or to actuate a hydraulic valve that controls water pressure. This may be accomplished by selective valves for controlling air flow, the valve actuation being controlled by a solenoid. In the case of hydraulic power units, e. g. the cutter unit, the selective valve may control the air that operates the hydraulic valves. In the case of air power units, e. g. elevator units, the selective valve may control the variable pressure air that actuates the units. Examples of such electrically controlled, selective valves are hereinafter described in detail. For the present, they

are referred to as magnetic valves, it being assumed that such magnetic valves include a solenoid element. It is assumed, further, for the present, that, in the case of magnetic valves controlling hydraulic units, the hydraulic valve, be it inlet or exhaust, is open when the magnetic valve is "on" i. e. when its solenoid is energized, and closed when the magnetic valve is "off", i. e. when its solenoid is in an open circuit. Also, it is assumed that, in the case of air pressure power units, the piston is under variable pressure when the magnetic valve is "on" and under constant return pressure when the magnetic valve is "off".

While the magnetic valves and their connections may be arranged in various ways, in the present embodiment they are collected at an automatic control station later referred to in more detail. Such a station is indicated by 335 in Figs. 12 and 13. This station is connected with the air supply pipe by a branch pipe 336 and from the station a pipe 337 serves to supply constant return pressure to the discharge and elevator cylinders, as will be apparent from Fig. 12. At the automatic control station is a magnetic valve V9 which controls variable pressure through pipe 338 leading to the coil ejector cylinders 314. Similar magnetic valves V7, V8, control variable pressure through pipes 339, 340, with the auxiliary elevator cylinders 305 and main elevator cylinders 304 respectively. In the case of the shears and billet pusher, which are operated by hydraulic power units, the magnetic valves control the air pressure for operating the hydraulic valves. The billet pusher has a hydraulic valve unit indicated in Fig. 12 by 341. This is like unit 323. But the two air pipes 342 for its exhaust valve lead to a magnetic valve V3 and the two pipes 343 for the inlet valve lead to a magnetic valve V4.

A similar arrangement is provided for the cutter. To this end, water to the cutter cylinder is controlled by a hydraulic valve unit 344 like unit 341. The two air pipes 345 for the inlet valve lead to a magnetic valve V5 and the two pipes 346 for the exhaust valve lead to a magnetic valve V6.

There is provided electrical means for controlling the status of the various magnetic valves and in structures embodying the invention to the best advantage, the solenoids of the magnetic valves will be included in circuits of a D. C. system and these circuits will be controlled by suitable make-and-break devices. In the embodiment here illustrated, the circuits for magnetic valves V3, V4 of the billet pusher are controlled by hand switches and the circuits for the remaining magnetic valves are controlled by relays or contactors, the solenoid coils of which are included in the wiring of an A. C. system. As here shown as an example, and

referring to Fig. 13 particularly, the D. C. system (shown in full lines) comprises main line wires 353 connected with bus bars 356, 357, carried by a panel 354, and a supplemental bus 350. Magnetic valve V3 for the exhaust valve of the billet pusher power unit is in a circuit controlled by a hand switch 113 on a panel 352 and magnetic valve V4 for the inlet valve of the billet pusher unit is in a circuit controlled by a hand switch 114 on panel 352. Magnetic valves V5, V6 for the inlet and exhaust valves of the cutter unit are in circuits controlled by a contactor B on panel 354. This contactor, as well as the others later referred to, comprises a contact bar, a core and a coil and may be of any suitable description to include the various contact terminals hereinafter mentioned. Magnetic valve V7 for the auxiliary elevator cylinders is in a circuit controlled by a contactor D and magnetic valve V8 for the main elevator cylinders is in a circuit controlled by a contactor E. Magnetic valve V9 is in a circuit controlled by a contactor G. The panel carries further contactors A, F and H later referred to.

The coils of the several contactors are included in circuits in an A. C. system (represented in the wiring diagram by broken lines) and including main line wires 355, bus bars 358, 359, and supplemental bus 351. As later described in detail, the circuits of the contactor coils are controlled by switches automatically operated by moving mechanical elements.

The following table shows the status of the several magnetic valves and the resulting starting position of the controlled parts—

V9—Off—Discharge pushers withdrawn under return pressure.	
V3—On—Exhaust valve of billet pusher open	Billet pusher withdrawn under return pressure
V4—Off—Inlet valve of billet pusher closed	
V5—Off—Inlet valve of cutter closed	Cutter withdrawn under return pressure
V6—On—Exhaust valve of cutter open	
V7—On—Auxiliary elevator units under v. p.	Elevator held in intermediate position by auxiliary units against return pressure on main units
V8—Off—Main elevator units under c. p.	

This is accomplished by so arranging the circuits and contactors or other switches that the magnetic valves have the status stated.

The following table shows the initial circuit arrangements, all the contactors, as later referred to, being down, i. e., open,—

V3—On—Bus 357, hand switch 113 closed, wires 12, 11, bus 356.	
V4—Off—Bus 356, wires 11, 13, open switch 114.	
V5—Off—Bus 356, supplemental bus 350, wires 14a, 16, open break at contactor B.	
V6—On—Bus 356, supplemental bus 350, wires 14, 15, bar of contactor B, wire 17, bus 357.	
V7—On—Bus 356, supplemental bus 350, wires 7, 8, bar of contactor D, wire 9, bar of contactor H, wire 10, bus 357.	
V8—Off—Bus 356, supplemental bus 350, wires 4, 5, open break at contactor E.	
V9—Off—Bus 356, supplemental bus 350, wires 1, 2, open break at contactor G.	

In the above table it was assumed that the contactors were all down. The following table gives the initial circuit arrangements resulting in this condition—

Contactors A. Coil in circuit containing hand switch 112 later referred to and now assumed to be open.	70
Contactors B. Coil in a circuit broken at contactor A which must be up before B can lift.	
Contactors D. Coil in a circuit including open switch S3.	
Contactors E. Coil in circuit broken at contactor D which must be up before E can lift.	
Contactors F. Coil in circuit broken at contactor G which must be up before F can lift.	
Contactors G. Coil in a circuit including open switch S7.	75
Contactors H. Coil in a circuit including open switches S8, S9.	

At the start of an extruding operation, the magnetic valves and associated parts having the initial status and position described, it is assumed that the manual pilot valves have been operated so that the ram is back, the container nearly at the end of its forward stroke, i. e. toward the carrier slide, and the slide in billet-feeding position. A billet being in place on the cradle, the operator opens switch 113 and closes switch 114. This reverses solenoids V3, V4, from initial position and so opens the inlet hydraulic valve and closes the exhaust valve of unit 341 whereby the pusher is advanced to push the billet into the container. To withdraw the pusher again, the operator opens switch 114 and closes switch 113, which replaces the parts into initial position. By the manual pilot-valve control the slide is moved over and is stopped by latch 164 entering notch 165, which positions the slide with its die in line with the container chamber. The container is similarly caused to move forward until its mouth embraces the die (Fig. 7). The billet pusher is now advanced to abut the slide (Fig. 7) to function as a conduit for the extruded rods. This is accomplished by a repetition of its former advance movement, namely, by opening switch 113 and closing 114. The parts are now ready for the advance of the main ram for extrusion.

As later described, the withdrawing movement of the billet pusher actuates a switch S4 that controls the cutter movement. But since the pusher makes a withdrawing movement following billet insertion, provision is made whereby the mechanical operation of such switch is normally without effect but may be made effective at the option of the operator. In the present embodiment this is accomplished by making the electric control system effective only to maintain the parts in initial position until a preparatory circuit rearrangement is made by the operator. The switch S4 is in a circuit that controls the coil of contactor B. As shown, contactor B is rendered ineffective, even when switch S4 is closed by including in its circuit contactor A. The preparatory step, therefore, consists in causing contactor A to lift so that contactor B may function at the proper time. As shown, this is accomplished by a hand switch 112, which is a momentary contact switch of

any suitable description and which is in the circuit controlling the coil of contactor A. While the preparatory rearrangement of the system may be effected at any time prior to the withdrawal of the billet pusher to permit rod cutting, it is most conveniently done at the stage above mentioned, i. e. with the parts ready for extrusion. Just before the ram is advanced, therefore, the switch 112 is actuated and, by its momentary closing, contactor A is raised by circuit: bus 358, wires 21, 22, contactor D (down), wires 24, 25, 26, 27, 28, bus 359. Since switch 112 immediately reopens, provision is made for holding contactor A up. This is accomplished, as shown, by circuit: bus 358, wires 21, 22, contactor D (down) wires 24, 27, 28, bus 359. While the actuation of preparing switch 112 rearranges the circuits, it has no other immediate effect than to prepare the system for later automatic operation.

By means of the manual pilot valves the main ram is now advanced and the billet is extruded through the die bores into two rods which are fed to the coiling means and coiled as above described. When all but a short dead end of the billet is extruded the ram is stopped and withdrawn. To give the cutter access to the rods, the pusher-conduit is withdrawn. This is accomplished, as before, by closing switch 113 and opening switch 114. It may be noted that this terminates the operation of these hand switches for the cycle and leaves them in initial position for the next cycle. In the present embodiment, following the final actuation of these hand switches, the succeeding steps up to and including the discharge of the coils are automatic.

There is provided means for automatically causing operation of the cutter upon withdrawal of the billet pusher. This may be accomplished by causing magnetic valves V5, V6, to be reversed. As here shown as an example, located on crosshead 173 (Fig. 2) is an arm T4 arranged to close a normally open switch S4 when the pusher is withdrawn. This switch is of any suitable construction to be spring-held in normal position, as is the case with the other automatically operated switches later referred to. Switch S4 is in the following A. C. circuit: bus 358, supplemental bus 351, wires 29, 30, contactor A (up), wires 31, 32 bus 359. This circuit includes the coil of contactor B which, by S4 closing, is raised. The above assumes, of course, the up position of contactor A, which was raised by the preparatory closing of switch 112. Switch S4 was mechanically closed by the first withdrawal of the pusher but at that time contactor A was down. Raising contactor B reverses magnetic valves V5 and V6 to advance the cutter. V6 which was "on" was in a circuit involving down position of contactor B. This circuit being broken, V6 is "off" and the cutter exhaust valve is closed. V5

is now "on" by circuit: bus 356, supplemental bus 350, wires 14a, 16, contactor B (up), wire 17, bus 357, and the cutter inlet valve is opened. By the resulting advance of the cutter the extruded rods are cut off at the rear of the slide and the trailing ends pass on to the coilers.

Means is provided for causing automatic operation of the coil elevator upon operation of the cutter. As above described, the elevator is capable of two types of cycles, one cooling the extruded coils and then discharging them, the other discharging the coils and then cooling the platforms. The invention in its entirety, therefore, includes alternative circuit arrangements by which either type of elevator cycle may be carried out automatically. In the present embodiment, the election of cycles is effected by a double-throw knife switch 110 and a switch 111 on panel 352. Switch 110 in up closed position connects wires 67, 68 together and connects wire 45 to a dead terminal; in down closed position it connects wires 45, 46 together and wires 67, 55a together. The effect of these different arrangements will hereafter be explained. Switch 111 either connects or disconnects wires 58, 59 with results later described.

In structures embodying the invention to the best advantage, operation of the cutter will cause the elevator to start down, e. g. by reversing magnetic valve V7 to place the auxiliary elevator pistons, normally holding the elevator up, under return pressure. In the coil-cooling cycle it will continue down but in the other cycle it will reverse and move up to discharge position without immersing the coils. While this common initial downward elevator movement may be effected in various ways, as here shown as an example, on the cutter piston rod is an arm T3 (Fig. 1) arranged to close a normally open switch S3 as the cutter reaches the end of its advance stroke. Switch S3 is in the following A. C. circuit: bus 358, supplemental bus 351, wires 39, 40, 41, bus 359. As this circuit includes the coil of contactor D, closing of switch S3 causes contactor D to be raised. Since switch S3 opens again upon return of the cutter, to be referred to, provision is made for holding contactor D up. This is accomplished by circuit: bus 358, wires 21, 23, contactor E (down), wires 43, 42, 41, bus 359. The lift of contactor D breaks wires 9, 8, in the circuit of solenoid V7. The latter now being de-energized, the auxiliary elevator pistons are placed under return pressure and, withdrawing, allow the elevator to descend. The main elevator pistons, it will be recalled, were initially under return pressure.

Leaving the elevator movement for the moment, means is provided for causing automatic return of the cutter upon completion

of the cutting stroke, and this may conveniently be accomplished partly in common with the elevator movement just described, i. e. by the closing of switch S3 and consequent lift of contactor D. As here shown as an example, by the lift of contactor D wires 22, 24 are broken. As these are in the circuit holding contactor A up, the latter now drops. The up position of contactor B was, in turn, dependent on the up position of contactor A and when the latter drops the break between wires 30, 31, causes B to drop, even though switch S4 remains closed. As raising contactor B put magnetic valve V5 "on" and V6 "off" to advance the cutter, so dropping contactor B reverses these magnetic valves back to initial position and the cutter is thereby withdrawn under its constant return pressure. It is noted, moreover, that this step returns contactors A and B to initial position ready for the next cycle.

Returning now to the elevator movement, the second type of elevator cycle, i. e. discharging the coils without cooling, will first be described. For this type it is assumed that elective switch 111 is closed and elective switch 110 is in up closed position. Means is provided for causing automatic rise of the elevator without dropping far enough to immerse the coils. This may be accomplished by reversing magnetic valve V8 upon the slight downward movement of the elevator just described. As here shown as an example, a momentary contact switch S5, operated as later described, is located to be actuated upon a slight down movement of the elevator and its actuation closes the following circuit: bus bar 358, wire 59, elective switch 111, wires 58, 60, 61, 46, contactor D (up), wires 47, 48, bus 359. The circuit described, it will be noted from Fig. 13, includes two switches S10, S11 which are later referred to, but for the present it is assumed that these are closed. As this circuit includes the coil of contactor E, closing of the circuit by switch S5 raises the bar of this contactor. Since switch S5 is a momentary contact switch provision is made for holding contactor E up after switch S5 reopens. This is accomplished by circuit: bus 358, wire 51, contactor F (down), wires 50, 49, 48, bus 359. Contactor E being up, a circuit is closed through the coil of magnetic valve V8, as follows: bus 356, supplemental bus 350, wires 4, 5, 6, bus 357. This energizing of valve V8 causes variable pressure to be admitted to the main elevator cylinders and the elevator is raised thereby to discharge position. A further result of raising contactor E is a break between wires 23, 43. These being in the circuit which held contactor D up, the latter drops, and is thus returned to initial position. By the drop of contactor D to initial position, magnetic valve V7 is reversed to initial status by its initial circuit, whereby the auxiliary pistons are advanced.

Means is provided for causing automatic operation of the discharge pushers or ejectors dependent upon the elevator reaching discharge position. As here shown as an example, a normally open switch S7 is located to be closed, as later described, when the elevator reaches discharge position. This causes contactor G to be raised by closing circuit: bus 358, supplemental bus 351, wires 66, 62, 63, contactor F (down), wires 64, 65, bus 359. Raising of contactor G closes a circuit through the coil of magnetic valve V9, whereby variable pressure is delivered to the cylinders 314 of the discharge pushers to advance the latter and eject the extruded coils, as previously described. This circuit is: bus 356, supplemental bus 350, wires 1, 2, contactor G (up), wire 3, bus 357.

Means is provided for automatically causing return of the discharge pushers upon completion of their stroke. As here shown as an example, associated with the respective units are normally open switches S8, S9, arranged to be closed, as later described, when the pushers complete their ejecting strokes. These switches are in series in the following circuit: bus 358, supplemental bus 351, wires 66, 67, elective switch 110, wires 68, 54, bus 359. As this circuit includes the coil of contactor H the latter is raised by its closing. As switches S8, S9, reopen provision is made for holding contactor H up. This is accomplished by circuit: bus 358, supplemental bus 351, wire 44, switch S12 (later referred to and assumed to be normally closed), wires 52, 53, 54, bus 359. Contactor H in lifting closes a circuit: bus 358, supplemental bus 351, wires 66, 67, switch 110 (up), wires 68, 54, contactor H (up), wire 55, contactor G (up), wires 56, 57, bus 359. As this circuit includes the coil of contactor F, the latter is raised. This causes a break between wires 63, 64 in the circuit holding contactor G up. The latter now drops to initial position and by a break between wires 2, 3, magnetic valve V9 is reversed to initial "off" position, whereby the discharge pushers are withdrawn under return pressure.

Means is provided for automatically causing descent of the elevator following discharge of the coils and this may be accomplished partly in common with the means for causing withdrawal of the discharge pushers, i. e. the closing of switches S8, S9 and the consequent lift of contactor H. In the present type of elevator cycle the elevator is dropped clear down for cooling the platforms and the automatic control provides for putting both sets of power units under return pressure. As shown, by the lift of contactor H the circuit through magnetic valve V7 is broken by a break between wires 10, 9. Valve V7 being "off", the auxiliary elevator pistons move down under return pressure. The main elevator pistons also move down under return pressure because by the lift of contactor F

following the lift of contactor H, as above described, a break is caused between wires 50, 51 in the circuit holding up contactor E. The latter now drops to initial position and thereby causes a break between wires 6, 5, in the circuit energizing magnetic valve V8. Contactor F also drops back to initial position because of the drop of contactor G.

The descent of the elevator, in the present cycle, carries the platforms into the water tank to cool the same. Means is provided for automatically causing the elevator to return to initial position upon its reaching the end of its cooling stroke. This is accomplished by leaving the main elevator unit under return pressure and reversing magnetic valve V7 to initial "on" position, whereby the advance of the auxiliary pistons returns the elevator to initial position. As shown, this is accomplished by a normally closed switch S12 arranged to be opened, as later described, when the elevator reaches the end of its down movement. This causes a break between wires 44, 52 and so opens the circuit that was holding up contactor H which now drops to initial position. Being in initial position, circuit is made through the coil of magnetic valve V7 as in the initial circuit condition above tabled. This admits variable pressure to the auxiliary elevator cylinders and the elevator is raised to initial position and there held.

This completes the cycle as far as the extrusion of one billet is concerned and it is noted that all the power units are back in initial position and all the circuits are back in initial condition, ready for the next cycle. Before another cycle can begin the stump and sprue must be removed. This, as shown in the present embodiment, is accomplished as above described. That is, by operation of the manual pilot valves the container is caused to move back, withdrawing the stump from the die and kicking out the sprue by forcing it against the ram. The slide is then moved over to billet-receiving position and the container advanced to initial position, whereupon the parts are ready for another cycle. It will be apparent that these last manually controlled steps may be carried out during the coiling and discharge of the coils.

In the other type of elevator cycle, cooling the coils, the elevator starts down in the same way as before, namely, upon closing of switch S3 by the cutter. In this case, however, it goes to the bottom and means is provided for cutting out switch S5 which before started the elevator immediately upwardly. This is accomplished, as shown, by opening elective switch 111 in the circuit including the coil of contactor E. Consequently, when the elevator starts down, while switch S5 is mechanically actuated, it has no effect because contactor E cannot lift and so magnetic valves V7, V8, are not energized. The ele-

vator, therefore, continues down to the bottom of its stroke, thereby immersing platforms and coils in the water bath.

Means is provided for automatically causing the elevator to be moved from cooling position to discharge position. This may be accomplished by reversing magnetic valve V8, of the main elevator pistons. Since the auxiliary piston rods are later desired in advanced position, magnetic valve V7 may be conveniently reversed at the same time. It will be recalled that in the former cycle these magnetic valves were energized to raise the elevator by the lifting of contactor E due to closing switch S5. In the present cycle this lift of contactor E was prevented by cutting out switch S5. It may conveniently be effected at a different point in the cycle by cutting in a different circuit including a switch closed when the elevator reaches the bottom. As shown, elective switch 110 is shifted to down closed position. In wire 45, formerly connected to a dead end, is a normally open switch S6 arranged to be actuated, as later described, when the elevator reaches the bottom of its stroke. This switch was, of course, closed mechanically in the former cycle but without effect because it was cut out by elective switch 110. In the present cycle switch S12 is mechanically opened but without effect because, whereas in the former cycle it resulted in a drop of contactor H, in the present cycle the latter is still down and, in fact, remains down. When switch S6 closes, it closes the following circuit: bus 358, supplemental bus 351, wire 45, switch 110 (down), wire 46, contactor D (up), wires 47, 48, bus 359. As this circuit includes the coil of contactor E, the latter is raised. The result is as before, namely, magnetic valve V8 is energized to cause the main elevator power units to rise and by the consequent drop of contactor D magnetic valve V7 is energized, thereby causing the auxiliary elevator units to rise. The elevator is moved up, therefore, to discharge position.

Upon the elevator reaching discharge position, the discharge pushers are caused to function as before, namely, by the closing of switch S7, which raises contactor G to put magnetic valve V9 in circuit.

Means is provided for automatically causing the withdrawal of the discharge pushers and the return of the elevator to initial position after discharge of the coils. As shown, this is accomplished by the closing of switches S8, S9, as before, but by a different circuit arrangement. In the former cycle, the elevator, after discharge, was sent to the bottom, so that both main and auxiliary elevator units were placed under return pressure. In that cycle, magnetic valve V8 was de-energized by the dropping of contactor E which resulted from the drop of contactor G, which resulted, in turn, from the lift of con-

tactor F, and the latter resulted from the lift of contactor H. Magnetic valve V7 was de-energized directly by the lift of contactor H. In the present cycle, the elevator descends only to initial position and this is effected by placing the main power units under return pressure and holding the auxiliary units advanced. Magnetic valve V8, therefore, is de-energized but not magnetic valve V7. Consequently, this circuit arrangement is such that upon closing of switches S8, S9, contactor F will be raised but not contactor H. The latter is cut out by the shifted position of elective switch 110. When switches S8 and S9 close, upon the advance stroke of the ejectors, they close the following circuit: bus 358, supplemental bus 351, wires 66, 67, switch 110 (down), wires 55a, 55, contactor G (up), wires 56, 57, bus 359. As this circuit includes the coil of contactor F, the latter is raised. As in the former cycle, the lift of contactor F causes contactor G to drop, which causes contactor E to drop, and this, by a break between wires 6, 5, takes current off magnetic valve V8 thereby placing the main elevator units under return pressure. The elevator starts down, therefore, under return pressure but it goes down only to intermediate or initial position because the auxiliary elevator units being held up, act as stops against which the crosshead 302 strikes.

Also as in the former cycle, the dropping of contactor G, upon raising of contactor F, takes current off magnetic valve V9 whereby the ejectors withdraw under return pressure and the drop of contactor G drops contactor F.

This return of the elevator to initial position completes the automatic cycle of the second type and the return of the parts and circuits to initial condition.

There is provided interlock means for preventing operation of one mechanical element unless another mechanical element, which might interfere if improperly positioned, is properly positioned. For example, the elevator may be prevented from lifting to discharge position unless the ejectors are withdrawn. As here shown as an example, associated with the ejector units are two switches S10, S11, arranged to be held closed, as later described, when the ejectors are withdrawn. As above stated, and referring to the type of elevator cycle first described, the movement of the elevator upward to discharge position depends on the closing, by switch S5, of a circuit in which these interlock switches S10, S11 are included in series. In the above description it was merely assumed that they were closed. It will now be apparent, however, that unless both discharge pushers are withdrawn to close both of these switches S10, S11, the circuit for raising contactor E by actuation of switch S5 will not be closed.

Consequently, should an ejector happen to be advanced when switch S5 is closed, the elevator is prevented from moving up to any such position that might cause interference between the parts. Similar interlocking switches may be used in circuits controlling other mechanical elements.

Referring to the switches operated by the elevator, as here shown as an example, switch S7 is mounted on the frame 309 near the top. It is operated by a bell crank lever 81 one end of which extends through a suitable hole in the frame 309 in the path of a roller 82 carried by elevator crosshead 302. Switches S6, S12 are also mounted on frame 309 and have similar operating levers 83, 84 arranged to be actuated by the roller when the elevator is down. Switch S5 has a similar lever 85 positioned to be actuated by the roller when the elevator starts to move below initial position (Fig. 4). Switches S8, S9, S10, S11 are operated by a suitable connection from the discharge pusher units, for example, arms moving with the pushers.

The general features of the above described automatic cycle are applicable to other power units. That is, the invention in its entirety includes means of the general character described for effecting an automatic cycle of a plurality of fluid pressure power units.

The invention in its entirety includes means for automatically controlling the operation of pressure fluid units, that is, power units comprising a cylinder and piston, the piston serving to move some mechanical element or apparatus. Such power units include both hydraulic units and air pressure units. In the former, control may be effected by controlling the air which actuates pistons that open and close hydraulic valves; in the latter by controlling the air which actuates the power units directly.

Figures 14-20 illustrate an example of a hydraulic valve unit for controlling the inlet and exhaust of water pressure. This unit includes a valve chest 428, having a valve chamber 427 with which communicates an inlet pipe 429 for connection with a water pressure line. The valve chest has a second valve chamber 443 communicating with an exhaust pipe 446 for connection with the waste water line which may lead back to the suction side of the pumps. The inlet valve chamber 427 is connected with a pressure outlet pipe 445 by means of a transverse bore 440, a vertical bore 441, a second transverse bore 442, the exhaust chamber 443 and passage 444. The exhaust valve chamber is in communication with power outlet pipe 445 through passage 444. Below the inlet pipe in the inlet valve chamber is a tubular valve seat 426 on which seats an inlet valve 425. Below the exhaust outlet in the exhaust chamber is a tubular valve seat 447 on which seats an exhaust valve 448. The inlet valve is carried by a valve

stem 430 which is connected by a coupling 435 with a piston rod 436, the piston 437 of which works in an air cylinder 438. The piston is operated by pressure fluid, in this case compressed air, admitted, as later described, to one end or the other of the cylinder. When the piston is raised it opens inlet valve 425 and when lowered it returns the valve to its seat. The exhaust valve is carried by a valve stem 449 and is connected by a coupling, like coupling 435, with a piston rod 451. This latter is a duplicate of piston rod 436 and is actuated by a duplicating air cylinder unit. These duplicating parts are not shown in detail but the construction will be apparent from Figs. 14 and 15.

In the present embodiment, the two air cylinders are formed by a common cylinder block 452 with separate bottom closures 453, 454. The valve chest 428 and the common cylinder block 452 are connected together by bolts 455, the united structure being mounted in any suitable manner. When the exhaust valve 448 is closed and the inlet valve 425 open there is a flow of water from the main line through inlet pipe 429 to the power outlet pipe 445 and thence to the cylinder of the hydraulic power unit. When the inlet valve is closed and the exhaust valve open, the pressure water can exhaust back from the power unit through pipe 445 and out through exhaust pipe 446.

The construction just described may be considered a typical hydraulic valve unit, its basic features being known in the art. It corresponds to the hydraulic valve unit indicated by 323 in Fig. 12. and the other units above referred to as being like unit 323. It is noted, however, that in the case of valve units 323, 327 and 329, the air cylinders are piped to a manual control station. The present unit differs in that the air is delivered and controlled in a novel manner hereinafter described. Units 341 and 344 are different again in that their air cylinders are piped to an automatic control station, later referred to.

While the means for automatically controlling the flow of air to the air cylinders of the hydraulic unit may vary, in structures embodying the invention to the best advantage, such means will include electrically controlled selective valves. This may be accomplished by a D-slide valve for controlling the air flow and by electrically controlled means, e. g. means including a solenoid, for operating the D-valve.

While the air-controlling means and its relation with the ultimate destination of the controlled air may vary, in the embodiment illustrated in Figs. 14-20 the D-valve is located adjacent its air cylinders and piping is avoided. In the present exemplification, the front side of the cylinder block 452 has a flat face (Fig. 15). The cylinder 438 for

the inlet valve has an upper passage 460 leading from the flat face of the cylinder block to the interior of the cylinder above the piston, and a similar lower passage 461 leading to a point below the piston. Bolted to the flat face of the cylinder block is a block 462 having a flat top face 463. Opening out of this flat face (Figs. 17, 18) are three vertical bores or passages, 464, 465, 466, two of which communicate with the air cylinder, the third being an exhaust passage. To this end, as here shown, the block 462 has an upper transverse passage or bore 467 leading from vertical bore 464 and registering with cylinder passage 460 and a lower transverse passage 468 leading from vertical bore 465 and registering with cylinder passage 461. The block has a third transverse bore or passage 469, extending in a direction opposite to bores 467, 468, and leading from the middle vertical passage 466 to an exhaust pipe or outlet 470. In the embodiment illustrated, a valve chamber 471 is formed by the flat face 463 of the block 462 and an open sided valve housing 472 bolted to the block 462. With this construction, the three vertical passages 464, 465, 466 open directly into the valve chamber. In the top of the valve housing 472 is an inlet pipe 473 for connection with a source of pressure fluid, e. g. compressed air. Operating in the valve chamber 471 and sliding on the top face of block 462 above the three ports of the vertical passages, is a D-slide valve 474, its enclosed recess 475 being arranged to span the port of the middle passage (exhaust) and one or the other of the end ports, depending on the valve position.

When the D-valve is in the position of Fig. 17, end passage 465 is open to the valve chamber, thus placing the lower end of inlet valve cylinder 438 in communication with the pressure fluid. The D-valve spans the middle passage 466 and end passage 464, thus placing the upper end of cylinder 438 in communication with exhaust. The air passes from valve chamber 471 through passages 465, 468 and 461 to the cylinder and raises piston 437, thereby opening the hydraulic inlet valve 425. Meanwhile air above the piston exhausts via passages 460, 467, 464, valve recess 475, passages 466, 469 and pipe 470.

When the D-valve is moved, as later described, to the position of Fig. 18, the flow is reversed. That is, passage 464 is open to the valve chamber and the air passes via passages 467 and 460 to the upper part of cylinder piston 437, thus closing inlet valve 425. Meanwhile the air below the cylinder exhausts via passages 461, 468, 465, valve recess 475, passages 466, 469 to pipe 470.

While the electrically controlled means for operating the D-valve may vary, in structures embodying the invention to the best advantage, the D-valve will be moved by a piston operated by pressure fluid, e. g. air,

and the direction of piston movement will be controlled by automatic means for controlling the actuating air. This may be accomplished, for example, by a differential piston device on which the slide valve is mounted, the movement of this piston device being controlled by electrically operated means. Although capable of various constructions, in that here illustrated as an example, the D-valve 474 has two forked upright abutments 478, 479 between which is freely mounted a rectangular block 480 on a piston rod 481, the rod being cradled in the forks of the abutments. This forms a simple connection by which the D-valve is moved upon movement of the piston, the block 480 moving against one abutment or the other. It also permits the D-valve to adjust itself to its seat. On one end of the piston rod 481 is a relatively large piston 482 having a packing ring 483 and sliding in a cylindrical extension 484 of the valve chamber. The end of this extension is closed by a plug cap 485. At the other end of the valve chamber is a cylindrical extension 486 substantially smaller than extension 484 and open to atmosphere. In this extension 486 slides a relatively small piston 487 also mounted on the piston rod. This latter piston serves as a bearing support for the piston rod and a closure for the end of the valve chamber. The opposing inner faces of both piston heads are under valve chamber pressure but the inner area of piston 482 is larger than that of piston 487. Under normal conditions, therefore, and assuming the end of extension 484 to be open to exhaust, there is a constant effective force, measured by the air pressure on the excess of one piston area over the other, that moves the piston rod in one direction, i. e. to the left as viewed in Figs. 17, 18. When, however, air is admitted to the outer end of extension 484, and assuming it is air under substantially the same pressure as the valve chamber air, the force of this pressure on the outer face of piston 482 plus the force of the air pressure on the inner face of piston 487 is greater than the opposing force of the pressure on the inner face of piston 482. Consequently the piston rod is moved in the opposite direction, i. e. to the right as viewed in Figs. 17, 18.

While the end of extension 484 may be placed under pressure or exhaust in various ways, this may be conveniently accomplished by by-passing air from the valve chamber around piston 482, the by-pass line having an exhaust opening and this exhaust opening and the by-pass flow being governed by an electrically controlled valve. As here shown as an example, opening out of the valve chamber 471 (Figs. 19, 20) is a longitudinal passage 490 formed in the body of the casing 472 and communicating with a transverse bore or passage 491 which leads to the outer face of the casing. Bolted to this face of the casing is a valve casing 492 having a valve chamber 493 out of the lower end of which opens a transverse passage 494 registering with passage 491. Opening out of the upper end of valve chamber 493 is a second transverse passage 495 registering with a transverse passage 496 in casing 472 which leads to the outer end of extension 484 of the valve chamber 471, beyond the piston. Air from the valve chamber can, therefore, by-pass around piston 482 via passages 490, 491, 494, valve chamber 493, and passages 495, 496. The upper and lower portions of valve chamber 493 are separated by a conical valve seat 497 on which seats a conical control valve 498. When this valve is closed, the by-pass is shut off and the slide valve unit is under its normal effective pressure (Fig. 17). When, however, valve 498 is open, air by-passes from the valve chamber to the outer end of extension 484 to move the slide valve unit reversely (Fig. 18), as above described. To place extension 484 under exhaust, while valve 498 is closed, at the top of valve chamber 493 is an inverse conical valve seat 499 beyond which is a passage to atmosphere. On this valve seat seats an inverse conical valve 500. Both conical valves 498 and 500 are formed on a common valve stem 501 and are so arranged that when one valve is open the other is closed. Valve 500 is a bent valve controlling communication between the interior and exterior of valve casing 492. When valve 498 is open to by-pass actuating air, valve 500 is closed to seal the valve chamber 493. When control valve 498 is closed to shut off the by-pass, valve 500 is open, whereby air from the outer end of extension 484 exhausts via passages 496, 495 and valve chamber 493, as piston rod 481 moves under the force of normal pressure.

To operate the by-pass control valve, as here shown as an example, the upper end of the valve stem 501 is connected by a coupling 502 with the core 503 of a solenoid. This solenoid has a winding 504 and a housing 505 and is of any suitable construction. Between the bottom of valve 498 and a plug nut 506 is a return spring 507. The valve unit has a guiding tail-piece 508 sliding in nut 506. When the solenoid is energized the resulting core movement forces down the common valve stem 501 and thereby closes vent valve 500 and opens by-pass valve 498. This position is shown in Fig. 19 and corresponds to Fig. 18 in which the D-valve is moved to the right by the by-passing air. When the solenoid is de-energized, return spring 507 serves to reverse the common valve stem 501, thereby closing the by-pass valve 498 and opening vent valve 500. This position is shown in Fig. 20 and corresponds to Fig. 17 in which the D-valve is moved to the left by the normal

valve chamber pressure, the fluid previously by-passed exhausting as described.

Means is provided for limiting the D-valve piston movement in either direction. As here shown as an example, the piston movement to the right, as viewed in Figs. 14, 17, 18, is limited by a stop lug 511 for engagement by the end of the piston rod. At the other end the closure plug 485 serves as a stop for the other end of the piston rod to limit movement to the left. This stop construction avoids using the D-valve itself in stopping and so does not interfere with the adapting movement of the D-valve.

The construction described including the D-valve, its operating pistons, its air-actuating system, and the solenoid control valve, constitute one example of an air flow selective unit that may be termed a magnetic valve.

The above described features are those associated with the inlet valve of the hydraulic unit. A like control is associated with the exhaust valve and it is unnecessary to show or describe the same in detail. Fig. 14 shows a block 462a bolted to the common face of the cylinder casting 452 that is a reverse hand duplicate of block 462 and bears the same relation to the exhaust valve cylinder as block 462 does to the inlet valve cylinder. On the block 462a is a valve casing 472a that is a reverse hand duplicate of valve casing 472. It will be understood that this casing contains a D-valve, operating pistons, and associated features that are reverse hand duplicates of those described. Fig. 14 also shows a solenoid unit duplicating that described, as will be apparent. That is, the two operating valve units have independently operating controls so that the inlet valve and exhaust valve may be operated independently.

In the type of control described, the power-receiving element may be held for any given interval in its advanced position because, as the inlet and exhaust valves are independently operated, both may be closed. In this situation the power unit does not advance because there is no further inlet of variable pressure. On the other hand, it does not recede because the exhaust valve is closed. In some cases, however, it is not desired to hold the power unit advanced, but, on the contrary, it is desired to effect its return immediately following the completion of its advance. In such cases, therefore, as soon as the advance stroke is completed the inlet valve is closed and the exhaust valve opened. The drawings illustrate a modification of the control described, in which the inlet and exhaust valves of the hydraulic unit are simultaneously but inversely operated. That is, when one is opened the other is closed, and vice versa.

Referring to Figs. 21-24, there is shown a

hydraulic valve unit that is like the unit described except that the exhaust valve and its valve rod are smaller, and the air passages through the cylinder blocks are located in slightly different positions. As a comparison between Figs. 21 and 14 will show clearly the duplicating features, specific reference is unnecessary. In this modification, however, the control of the air is different in that only one selective slide valve is provided and this is cross-connected to both air cylinders of the hydraulic unit. As a result, air is simultaneously admitted to the top of one operating cylinder and the bottom of the other, the bottom of the first and the top of the second simultaneously exhausting.

Although capable of various constructions, in that here shown as an example, bolted to the flat front face of the common cylinder casting, and centrally located thereon, is a block 517 (Figs. 24, 25) having three vertical passages 518, 519, 520 opening out of its top face. These are analogous to the three passages of the block 462 above described. The middle passage 519 connects with a transverse passage 521 leading to an exhaust pipe or outlet 521a. Communicating with vertical passage 518, near the top thereof, is a transverse passage 522 which registers with a bore or passage 523 formed in the cylinder casting and leading to the upper end of inlet valve cylinder 524. Also communicating with the vertical passage 518 is a second transverse passage 525 leading to a hook-shaped groove or slot 526 cut in the rear face of the block 517, that is, the face opposed to the face of the cylinder casting. The far end of this slot, which becomes a closed passage when the parts are assembled, registers with a bore or passage 527 formed in the cylinder casting and leading to the lower end of exhaust valve cylinder 528. Thus, when pressure fluid is admitted to vertical passage 518 it passes to the upper end of the inlet valve cylinder and to the lower end of the exhaust valve cylinder. The vertical passage 520 communicates with an upper transverse passage 529, which registers with a bore or passage 530 formed in the cylinder casting and leading to the upper end of exhaust cylinder 532. Also opening out of vertical passage 520 is a bottom transverse passage 531 leading to a straight slot or groove 532 cut in the rear face of the block 517. This groove also becomes a closed passage by virtue of the opposing face of the cylinder casting when the parts are assembled. The far end of groove 532 registers with a bore or passage 533 formed in the cylinder casting and leading to the lower part of inlet cylinder 524. Thus, when pressure fluid is admitted to vertical passage 520 it passes both to the top of the exhaust valve cylinder and to the bottom of the inlet valve cylinder. Bolted to the top of the block 517 is a valve casing 537 that is a duplicate of the

one described. In it is a D-slide valve 538 operated by a piston rod 539, these parts and their operation being as described. Fig. 23 shows the solenoid unit as exemplified by the housing 540 and it is to be understood that the by-pass and its solenoid-operated valves are duplicates of these features above described.

When the solenoid is de-energized the by-pass is shut off and the D-valve piston is moved by normal pressure to the left as viewed in Fig. 24. This connects vertical passage 518 with exhaust and opens vertical passage 520 to the valve chamber pressure. The air passes from vertical passage 520 in two courses, (a) via passages 529 and 530 to the top of the exhaust valve cylinder, thus lowering the exhaust valve piston to close exhaust valve and (b) via passage 531, slot 532 and passage 533 to the bottom of inlet valve cylinder, thus raising the inlet valve piston and opening inlet valve. Meanwhile air in the bottom of the exhaust valve cylinder exhausts via passage 527, slot 526 and transverse passage 525 into vertical passage 518, and air in the top of the inlet valve cylinder exhausts via passages 523, 522, into vertical passage 518. Here the paths join and both streams exhaust via the recess of the D-valve 538 and passages 519, 521 to pipe 521a.

When the solenoid is energized, the by-pass control valve is opened to by-pass pressure fluid around the D-valve piston head. This moves the D-valve 538 in the opposite direction (to the right in Fig. 24) to open vertical passage 518 to the valve chamber and to connect vertical passage 520 with exhaust. The flow is now reversed so that air passes to the bottom of the exhaust valve cylinder to open the exhaust valve and to the top of the inlet valve cylinder to close the inlet valve. Meanwhile exhaust takes place from the top of the exhaust valve cylinder and the bottom of the inlet valve cylinder. It will be seen that in this embodiment the operating valve units are operated simultaneously but inversely, by a common control.

In both the embodiments described the magnetic valve units are located adjacent the hydraulic units which they control. The valve chamber of the D-valve may be connected with the hydraulic valve unit by intervening pipes. Such an arrangement is used, for example, when it is desired to collect a number of magnetic valves at some central station. An example of such an arrangement is shown in Figs. 27, 28. As there shown, carried by framework 601 is a block 602 having a plurality of downwardly projecting bosses 603. This block is analogous to the block 462. As appears more clearly in Fig. 28, the bottom of boss 603 is tapped to receive the ends of two pipes 604, 605. Leading upwardly from the taps and open-

ing out of the top face of block 602 are two vertical bores or passages 606, 607 which are analogous to bores 464, 465 (Fig. 17). Between the two bores is a third vertical bore 608, also opening out of top face of the block and leading to an exhaust conduit 609 which passes from end to end of the block 602. At the ends it connects with pipes 610, 611 so that exhaust may take place in both directions.

Each of the bosses 603 receives two pipes and associated with each pair of pipes is a set of three vertical bores, conduit 609 being common to the several exhaust bores.

Associated with each set of vertical bores is a D-slide valve. To this end, as here shown as an example, bolted to the top of block 602 is a common valve casing element in the form of a casting 614. Formed in this casting and extending from near one end to near the other is a recess 615 that forms, with the top face of block 602, a common valve chamber for the several units. Pressure fluid, e. g. compressed air, is admitted to the common valve chamber 615 by a pipe 616 tapped into a boss 617 and communicating with a passage 618 in the top wall of casting 614. Sliding in the valve chamber 615 over each set of vertical bores is a D-valve 620 which is like the D-valves above described. It is moved by a piston rod 621 having a piston 622 reciprocating in a cylindrical extension 623, there being one such extension formed in the casting 614 for each unit. Opposite chambers 623 are smaller cylindrical extensions 624 in which slide bearing and sealing pistons 625. The outer ends of extensions 623 are closed by caps 626. Movement of each piston is limited in one direction by cap 626, in the other by a stop 638.

To by-pass the air around the several pistons 622, as here shown as an example, the casting 614 has an upright portion 628 and on the front face of this upright, above each valve unit is a rib 629. In each rib is a vertical bore 630 leaning to the outer end of chamber 623 outside the piston. Communicating with each bore 630 is a transverse bore 631 opening out of the rear face of upright 628. Below each bore 631 is a second transverse bore 632, also opening out of the face of upright 628. The several lower bores 632 communicate with a common supply conduit 633 which runs from end to end of casting 614. This conduit is connected by a slanting bore or passage 634 with the common valve chamber 615. Bolted to the rear face of upright 628 opposite each pair of transverse bores 631—632 is a by-pass control valve unit that is a duplicate of that shown in Fig. 20 and above described. Associated with each by-pass valve unit is a solenoid duplicating those described. Fig. 28 shows a by-pass valve casing 635 and solenoid hous-

ing 636, it being understood that the parts are like those shown in Fig. 20.

Each pair of pipes exemplified by pipes 604, 605 may be connected up in various ways depending on how the air is to be utilized. If the control is for the air that actuates the operating cylinders of a hydraulic valve unit, such as that of Fig. 14, two such pairs of pipes, representing two magnetic valves, lead to the hydraulic unit. One pipe of each pair leads to the top of one air cylinder, the other pipe to the bottom. In this connection it is noted that an energized solenoid may result in an opened hydraulic valve, and a de-energized solenoid in a closed hydraulic valve, or vice versa, depending on the air connections. Since a de-energized solenoid means a closed by-pass and that the D-valve is shifted under normal pressure, the position of Fig. 28 represents a de-energized solenoid. Consequently, if it is desired to have a de-energized solenoid represent a closed hydraulic valve, pipe 605 or its equivalent, which is open to pressure, is connected to the top of the operating cylinder for the hydraulic valve and pipe 604 or its equivalent is connected to the bottom of such operating cylinder. If, on the other hand, it is desired to have a de-energized solenoid represent an open hydraulic valve the pipe connections are reversed. A like election may be made in the case of the direct magnetic valve connection of Figs. 14-18. As there shown, Fig. 17 represents a de-energized solenoid and air is passing to the bottom of the operating cylinder for the hydraulic valve to open the latter. Fig. 18 represents an energized solenoid to close the hydraulic valve. If it is desired to have the hydraulic valve opened by an energized and close by a de-energized solenoid, a block is substituted for block 462 having transverse bore 467 at the bottom of vertical bore 464 instead of the top and transverse bore 468 at the top of vertical bore 465 instead of the bottom, corresponding changes being made in the passages through the cylinder block.

The central control station just described in connection with Figs. 27, 28, is an exemplification of the automatic control station indicated in the diagrams of Figs. 12, 13 by 335. The D-slide valve 620, with its operating piston, its solenoid, its by-pass valve and various connections and passages, is typical of the magnetic valves V3, V4, V5, V6, above referred to. The pair of pipes indicated by 345 in Fig. 12, leading from magnetic valve V5 to the inlet valve of hydraulic unit 344 corresponds to typical pipes 604, 605, and the pair of pipe 346 leading from magnetic valve V6 to the exhaust valve of the unit 344 corresponds to another pair exemplified by 604, 605. The same relation exists with respect to hydraulic unit 341 and its magnetic valves V3, V4. It will be recalled that in the description of the press and coiler it was as-

sumed that an energized magnetic valve represented an open hydraulic valve. Consequently, that pipe of the various pairs for hydraulic units 344, 341 which corresponds to typical pipe 604 is connected with the bottom of the corresponding air cylinder of the hydraulic unit and the pipe corresponding to typical pipe 605 is connected with the top of such cylinder. Consequently, when the magnetic valve is de-energized (Fig. 28) the hydraulic valve is closed and when energized the hydraulic valve is opened.

In the case of air power units, the power cylinder is connected with the valve chamber of a magnetic valve unit which may be either a single unit or the unit of a centralized station. The air connections depend on how the power unit is operated. If its piston is moved in both directions by variable pressure, pipe 604, or its equivalent, is connected with one end of the power cylinder and pipe 605, or its equivalent, with the other end. If the air power piston is under constant return pressure, only one end of the cylinder receives variable pressure. Consequently, only one connection from the magnetic valve is necessary. That is, the D-valve simply alternately connects this one pipe with the valve chamber pressure or with exhaust. Which of the two connections typified by pipes 604, 605, is used depends upon whether the power unit is to be advanced under variable pressure upon an energized magnetic valve or upon a de-energized magnetic valve. If an energized solenoid is to represent an advanced power unit, pipe 604 or its equivalent is connected with the variable pressure end of the power cylinder and pipe 605 is plugged or removed. If, on the other hand, a de-energized solenoid is to represent an advanced solenoid, pipe 605, or its equivalent, is connected with the variable pressure end of the power cylinder and pipe 604 or its equivalent is plugged.

Figure 30 illustrates, more or less diagrammatically, the connection between an individual magnetic valve unit with an air power unit, though it is to be understood that it applies equally to the magnetic valve unit of a centralized station. As there shown the power unit comprises a cylinder 651 in which operates a piston 652 having its piston rod 653 connected with a power-receiving element represented by the rod 654. The variable pressure end of the cylinder is connected by a pipe 662 with a vertical bore 658 leading to the valve chamber of the magnetic valve unit. The other end bore 656 connects with a pipe 661 that is plugged. The rear end of cylinder 651 is under constant return pressure from a pipe 663. In the position of Fig. 30, the solenoid being de-energized, the D-valve is moved over under its normal chamber pressure to connect pipe 662 with exhaust. Consequently, piston 652 has been withdrawn

under return pressure from pipe 663. When the solenoid is energized, the D-valve will be reversed, opening pipe 662 to variable pressure, and piston 652 will be advanced. That is, an energized solenoid represents an advanced power unit.

This arrangement is typical of the control of the elevator power units and coil discharge power units above described. The magnetic valve of Fig. 30, or rather its equivalent in a centralized station, is typical of magnetic valves V7, V8, V9. Cylinder 651 is typical of main elevator cylinders 304, auxiliary elevator cylinders 305 and discharge cylinders 314. Pipe 662 is typical of pipes 340, 339 and 338. And pipe 663 is typical of the constant pressure line for the units referred to.

If it is desired to have piston 652 of Fig. 30, or its equivalent, advanced under a de-energized solenoid, pipe 662 is plugged and pipe 661 connected with the variable pressure end of cylinder 651. If it is desired to operate piston 652 in both directions by variable pressure, return pressure pipe 663 is disconnected and pipe 661, the plug removed, is connected with the cylinder.

In this connection it is noted that it has been assumed that the hydraulic power units are under constant return pressure. If it is desired to operate the piston of a hydraulic power unit in both directions by variable pressure, a duplicate hydraulic valve unit is supplied for each end of the cylinder.

While the electrical control for the magnetic valve units may vary, in structures embodying the invention to the best advantage the solenoid of the magnetic valve will be included in the wiring of a D. C. system and the D. C. circuit will be controlled by a relay or contactor, the solenoid coil of which is in the wiring of an A. C. system. The A. C. circuit, in turn, will be controlled by make-and-break devices automatically operated by some moving part. Fig. 26 illustrates, diagrammatically and by way of example, an arrangement for a typical magnetic valve unit. The latter is shown in connection with an independent magnetic valve coupled directly with a hydraulic valve unit but it will be applicable to any of the magnetic valves above referred to. The winding 670 of the typical solenoid of Fig. 26 is connected in a D. C. line 671. In this line is a relay or contactor 672 having a core 673 surrounded by a coil 674 connected in an A. C. line 675. In this A. C. line is a make-and-break device such as a normally open switch 676. When switch 676 is closed, contactor 672 lifts or closes to close the D. C. circuit, whereby the solenoid of the magnetic valve is energized. When switch 676 is open, contactor 672 drops or opens, thus breaking the D. C. circuit and de-energizing the magnetic valve.

Switch 676 may have various forms and be operated in various ways. It may, for ex-

ample, be actuated by means dependent on the movement of the power unit which it controls, as shown in Fig. 30. In the exemplification there shown, the power-receiving element 654 has two collars 641, 642 arranged to actuate a two-armed switch 643 in the A. C. line 675; this switch corresponding to switch 676. Collar 641 is located to close the switch at the end of the return stroke of the piston 652. In the position of Fig. 30 the piston has just been withdrawn under return pressure and the switch is on the point of closing. This closing of the A. C. circuit is about to result in the closing of contactor 672 which will close the D. C. circuit and energize the solenoid of the magnetic valve. This will cause the D-valve to move to the left (Fig. 30) and admit variable pressure to pipe 662, whereby the piston is advanced. Collar 642 is located to open switch 643 at the end of the advance stroke whereby the A. C. circuit is broken, causing opening of contactor 672 and de-energizing of the solenoid of the magnetic valve. This results in a reverse movement of the D-valve and pipe 662 being again connected with exhaust, piston 652 is withdrawn under return pressure. In this construction, therefore, the power unit moves back and forth continuously and automatically. If it is desired to hold the power unit at the end of either stroke, one of the collars 641, 642 is omitted and a branch circuit is added having another switch which may be actuated, for example, by some part of another power unit. That is, Fig. 30 represents a simple example of an automatic control, which control is developed in the circuit arrangements of Fig. 13 above described.

Fig. 29 illustrates diagrammatically an automatic control for the reversely alternating type of hydraulic valve unit. In this exemplification the control is from the power unit itself. As shown, the A. C. line 675 has a two-armed switch 680 corresponding to switch 676. The A. C. circuit includes the coil of a contactor 672 in the D. C. line 671, which, in turn includes the solenoid coil of the magnetic valve. On the power-receiving element, indicated by 664, are two switch-actuating collars 681, 682. In Fig. 29, piston 683 is about to start its advance stroke. Switch 680 is open, contactor 672 is open, and the magnetic valve is de-energized. Consequently, the D-valve (Fig. 24) is to the left, admitting air to the top of the exhaust cylinder and to the bottom of the inlet valve cylinder. This opens the inlet valve and closes the exhaust valve (Fig. 21). Consequently, the variable pressure water passes to power cylinder 684 advancing piston 683. When the piston reaches the end of its advance stroke, collar 682 closes switch 680. This closes contactor 672 thereby closing the D. C. circuit

and energizing the magnetic valve. This reverses the D-valve and causes the inlet valve to close and the exhaust valve to open. Piston 683 then withdraws under return pressure from pipe 685. As it reaches the end of its back stroke, collar 681 again opens switch 680 and the power stroke is repeated. In case it is desired to hold this power unit withdrawn, collar 681 may be omitted and the A. C. circuit opened later by some other means, e. g. by some other power unit.

For the automatic control for the independent hydraulic unit of Fig. 14, each magnetic valve has an electrical control similar to that described, as will be apparent from the above general description of the press and coiler control.

This invention in its entirety includes means whereby the magnetic valves may be operated, e. g. manually, independently of the electric control. As here shown as an example, the solenoid core of each magnetic valve has a button, of which button 690 of Figs. 19, 20 is typical, this button being accessible above the solenoid housing. By pressing down on button 690, either manually or mechanically, the solenoid core is depressed to open the by-pass valve just as when the solenoid is energized. When the button is released, the solenoid core is spring-returned to shut the by-pass valve just as when the solenoid is de-energized.

Figs. 27, 28 illustrate an example of a manual control in which the solenoid cores of the magnetic valves may be latched down, i. e. may be mechanically held in the position in which they are normally held by an energized solenoid. As there shown, the core of each solenoid has the button previously referred to. Straddling the button 690 is a bracket 691 in which is pivoted a cam 692 operated by a lever 693. By actuation of lever 693 button 690 is cammed down. The cam is so arranged that it latches the button in depressed position until reversed by reverse actuation of the lever. By this means the magnetic valve may be manually placed and mechanically held in the position corresponding to an energized solenoid.

It is sometimes desired, for various reasons, to operate a given controlled part independently of the electric control. With the construction described, a shift from automatic to manual control is accomplished with facility.

The invention in its entirety includes means for automatically limiting the water pressure in a hydraulic system. In some hydraulic systems it is desired to utilize relatively high pressure in certain steps and relatively low pressure in other steps. For example, in the apparatus above described, while the main ram and the container pullback are operated on high pressure, e. g. 5000 pounds, it is desired to avoid this high pressure in the

operation of the other hydraulic units such as the billet pusher and cutter and a relatively low pressure, e. g. 2000 pounds, is used. Means is provided, therefore, for limiting the main line pressure to any one of a plurality of critical pressures, in this instance either of two. Structures embodying the invention to the best advantage will include two relief units, one arranged to relieve pressure at a given high point, the other at a given low point, and means for rendering the low pressure relief unit inactive to permit pressure up to the highest critical point. This may be accomplished by two loaded relief valve units having different critical loads, the low pressure unit having in addition, an elective discharge valve between its relief valve and the discharge water line. When such valve is open the low pressure unit functions but when such valve is closed the low pressure unit is cut out because even though its relief valve opens as normally, the water is checked by the elective valve and consequently pressure can build up to the higher critical point by control of the high pressure unit.

Although capable of various constructions, in that here shown as an example, and referring to Fig. 31, which shows the low pressure unit, a frame 716 carries a pressure cylinder 701 connected by an inlet 702 with the main pressure line of a hydraulic system, e. g. by branch pipe 700 of the main line of Fig. 12. In this cylinder is a plunger 703 working in a stuffing box 704. Plunger 703, as will be apparent, is forced upwardly by the main line pressure and a balancing load is provided to prevent such movement below a given critical pressure. While the loading means may vary, it may conveniently be accomplished by fluid pressure. As here shown, as an example, plunger 703 at its upper and outer end takes into a socket formed in the bottom of a piston rod 705 on a piston 706 working in a loading cylinder 707. Cylinder 707 is connected by a pipe 708, through a valve chamber 709, with a tank 713 containing compressed air. To avoid undue leakage, the air pressure may operate through the intermediation of a column of water which fills cylinder 707, being acted upon by the air in the above mentioned receptacle. To this end, pipe 708 may lead almost to the bottom of the tank, the air driving the water up through the pipe into the loading cylinder. Valve casing 709 contains a skeleton valve 710 freely mounted in a conical valve seat 711 and limited in its upward movement by a plug nut 712. The valve is arranged to permit, when seated, a relatively slow flow of loading water into cylinder 707, but upon a reverse flow of loading water, out of cylinder 707, valve 710 lifts from its seat and permits a relatively rapid flow through an unrestricted passage. It will be seen that the load opposed to movement of pressure plunger 703 is gov-

erned by the pressure of the loading air and the diameter of piston 706. By a proper combination of these two factors a balancing load for the desired critical pressure may be obtained. Assuming that in the control unit being described the critical pressure is 2000 pounds, until that limit is reached the balancing load holds down piston rod 705 which in turn holds down plunger 703 against the main line pressure. When, however, that limit is exceeded, plunger 703 is raised, forcing back piston 705 against the load and this movement is utilized to open a relief valve. While the relieving means may vary, in structures embodying the invention to its best advantage the relief valve will be positively controlled in its movements. Although capable of various constructions, in the embodiment illustrated, carried by frame 716 is a valve block 717 having a horizontal bore 718 connected by a vertical bore 719 with a pipe 720 which, in turn, is connected into the main pressure line. Between the vertical passage 719 and the end of horizontal bore 718 is a tubular element 721 provided with a conical valve seat. Seating on this valve seat is a conical relief valve 722 formed on the end of a rotary valve rod 723. This valve rod has a screw-threaded portion 724 working in an internally threaded stuffing box 725, and an end portion journaled in a bearing bracket 726. The valve is moved away from and toward its seat by rotation of its valve rod and this is effected, as shown, by movement of piston rod 705.

While the connection between the latter piston and the valve rod may vary, as here shown as an example, loosely mounted on the valve rod is a pinion 730 which meshes with rack teeth 731 formed in the under side of piston rod 705. Keyed to valve rod 723 is a disk 732 having in its face an annular channel 733 (Fig. 32) blocked at a number of spaced intervals, e. g. four intervals, by abutment blocks 734. The channelled face of this disk abuts a plate 735 formed on the end of pinion 730. This plate has four lugs 736 which project into channel 733. Between each lug and one of the abutment blocks 734 is a spring 737 housed by the channel. Assuming that the relief valve is open, when the pressure drops and piston rod 705 moves down under its load, pinion 730 is rotated, clockwise as viewed in Fig. 32, each lug 736 being pushed against its adjacent spring 737. This force is transmitted through the springs to blocks 734 to rotate disk 732 which, being keyed to the valve rod, rotates the latter. This rotation, through the screw-thread mounting, moves the relief valve into its seat. The teeth of pinion 730 are long enough to accommodate the endwise movement of the valve rod. The parts are so arranged that the valve is seated shortly before piston rod 705 completes its down stroke. Thereafter,

the final rotary movement of the pinion is taken up by the compression of springs 737 through the movement of lugs 736. As a result, the relief valve is not forced into its seat by the full load of the loading unit but is only under the force of compressed springs 737.

When critical pressure is exceeded and piston rod 705 moves up, the pinion is reversely rotated, i. e. counterclockwise as viewed in Fig. 32. The resulting movement of lugs 736 permits reexpansion of the springs 737, thus removing pressure from the seated valve. Continued movement of lugs 736 brings them into engagement with the immediately adjacent blocks 734 and thereafter disk 735 is reversely rotated by this engagement to rotate the valve rod and withdraw the relief valve from its seat.

The relief valve described is always controlled in its movement by its threaded connection so that chattering, such as is usually encountered in blow-off valves, is avoided and the valve is capable of relatively long life even under almost constant operation. The loading means described is such that there is relatively no inertia of mechanical parts to be overcome in relief movement.

Beyond the end of horizontal bore 718, valve block 717 has a vertically disposed valve chamber 740 containing a tubular element 741 providing a valve seat. Cooperating with this valve seat is a conical valve 742 carried on a valve stem 743 which extends down below the valve block. Valve 742 and its seat are located between the end of horizontal bore 718 and discharge pipe 744 which may conveniently lead to the suction side of the water pumps. In the present embodiment pipe 744 connects with a pipe 745 (Fig. 12) leading to a storage tank 746 connected with the suction side of pumps 321. Valve 742 may be termed an elective valve because by its position election is made between an active or inactive low pressure control. That is, if elective valve 742 is open, when relief valve 722 opens, water from main line connection 720 is bypassed through bores 719, 718, valve chamber 740, and discharge connection 744, back to the suction side of the pumps. But if elective valve 742 is closed, relief cannot take place even though relief valve 722 opens. Consequently, this low pressure unit is cut out and pressure builds up to the higher limit. The operation of valve 742 will be referred to hereinafter.

Since pressure cylinder 701 is under main line pressure, packing 704 exerts a considerable friction which tends to retard movement of the plunger 703. Ordinarily, therefore, the relief valve would not open at the true critical pressure because its movement would be opposed by both the balancing load and the friction referred to. There is provided means for counteracting this frictional drag on the valve-opening movement. Although

capable of various constructions, as here shown as an example, sliding on rods 750 adjacent piston rods 705 is a crosshead 751. This crosshead bears against two coil springs 752, the lower ends of which bear against adjustably fixed abutments 753. Bearing against the top of the crosshead is a block 754 attached to piston rod 705. In the normal position of the parts, that is, with the relief valve closed and piston rod 705 down, springs 752 are compressed so that they tend, through the crosshead and block, to raise piston rod 705. The springs are so arranged that this tendency substantially counteracts frictional drag of packing 704. That is, relief movement of the parts is opposed by the load on piston 706 plus the frictional drag of packing 704. Balanced against this is the main line pressure plus the force of springs 752. Consequently, the valve opens at a point approximating true critical pressure.

When the critical pressure is exceeded and piston rod 705 moves upwardly, the springs expand. It will be apparent, therefore, that since they must be re-compressed upon the down movement of the piston rod, the parts cannot return to normal position upon a drop of pressure that is only slightly below critical pressure, because such reverse movement is opposed not only by the main line pressure but by the springs. As a result, the relief valve stays open until the main line pressure drops sufficiently to permit the balancing load to overcome the main line pressure and compress the springs. The point of this drop will be considerably removed from the critical pressure but it is noted that the system is not designed to maintain a constant pressure but merely to prevent excess pressure. This substantial drop does no harm for once the relief valve is closed the main line pressure quickly builds up again.

The high pressure unit, in the present embodiment, is basically a duplication of the low pressure unit except that it lacks a valve corresponding to elective valve 742. Fig. 33 illustrates this high pressure unit. This view shows a tank 713a like tank 713 connected by a pipe 708a to a loading cylinder 707a which corresponds to cylinder 707 but is larger. As this unit is set for a higher critical pressure, e. g. 5000 pounds, the balancing load is correspondingly greater. This is conveniently accomplished by using the same loading air pressure and increasing the diameter of the loading piston sufficiently to give the desired balancing load value. Fig. 33 shows a valve block 717a corresponding to block 717 but in which the horizontal bore 718a corresponding to bore 718, leads directly to a discharge connection 744a corresponding to pipe 744 and connected to pipe 745. That is, there is no valve such as valve 742 between the relief valve and the discharge line. It is to be understood that this high

pressure unit has a relief valve and operating connections that are duplicates of like parts in the low pressure unit. When elective valve 742 of the low pressure unit is closed to cut out that unit, an excess of main line pressure above the high limit causes the high pressure relief valve to open and pressure is relieved by by-passing water via pipe 720a, bore 718a and pipe 744a to the storage tank.

In the embodiment illustrated the high pressure unit has a supplemental feature lacking in the low pressure unit. In hydraulic systems, such as the extrusion press above described, there sometimes occurs a sudden building up of pressure considerably beyond the desired critical point. Since the relief valve mechanism described requires some little interval of time to function, there is provided a supplemental blow-off valve for preventing dangerous peak pressures. To this end, as here shown as an example (Figs. 33-34), bolted to valve block 717a of the high pressure unit is a supplemental valve block 760. This block has a valve chamber 761 in which is located a bushing 763 having suitable openings for connection with a bore 764 formed in the valve block and communicating with an inlet passage 766. Beyond the end of bushing 763 is a discharge passage 765. Seated in the bushing is a tubular valve seat element 762 having a cross bore 774 connecting, through the bushing openings, with the inlet. The end of tubular element 762 is dished to form a conical valve seat for a conical blow-off valve 767. This valve is formed on the end of a valve stem 768 slidable in a packing 773 and spring-held to its seat by a loading spring 769. This spring is set for a load at least as high as the high critical pressure. The parts are so arranged that inlet 766 connects with the water passage of valve block 717a inside the relief valve and discharge bore 765 connects with such passage outside the relief valve. That is, the water passage through supplemental valve block 760 is a by-pass around the relief valve of the high pressure unit. In case of sudden peak loads that might cause trouble before the main relief valve can open, valve 767 opens against its spring and allows passage of water around the main relief valve from pipe 720a to pipe 744a.

The tubular element 762 has a stem 770 threaded in bushing 763 and having a nut 771 on its outer end. In case the valve seat in the end of element 762 should wear, compensation can be effected by manipulating nut 771 to move the seat element toward the valve. Moreover, by manipulation of nut 771 valve 767 can be ground in situ without removal of its spring.

With the construction described, with the discharge passage between the valve seat and the packing 773 for the valve stem, the packing is not under main line pressure and con-

sequently does not exert an undue frictional drag on the movements of the valve stem.

The invention in its entirety includes means for automatically changing from one control to the other. This may be accomplished by normally maintaining the system under low pressure control and, when high pressure is required, automatically causing the low pressure control to be rendered ineffective. For example, in control systems such as that above described, the elective valve 742 may be kept open normally so that the low pressure unit normally controls and, upon requirements for high pressure, causing closing of such valve to cut out the low pressure control.

While the valve-operating means may vary, it may conveniently be accomplished by connecting valve stem 743 with the piston rod of an air-operated piston and controlling the air flow by a magnetic valve such as described. That is, valve 742 and its operating parts may be considered as the equivalent of either half of a hydraulic unit such as that described, e. g. the inlet valve half of the unit shown in Fig. 14. The operating parts are not shown in Fig. 31 but the construction will be apparent upon assuming valve stem 743 to correspond to valve stem 430 of Fig. 14. Associated with the air cylinder, corresponding to cylinder 438, is a magnetic valve unit duplicating that shown and described in connection with the inlet valve of Figs. 14, 17 and 18.

While the control may vary, as here shown as an example, and referring to Fig. 13, the solenoid coil of the magnetic valve unit, indicated by 780, for the elective valve 742, is in a loop 781 in the main D. C. system. In this loop is a normally open switch S13 arranged to be closed when the inlet valve of hydraulic unit 323 for the main ram, opens. This may be accomplished by a suitable arm, similar to arm T3, mounted on the protruding end of the inlet valve stem of unit 323. Under what may be termed normal conditions, i. e. while the main ram is not under variable pressure and its inlet valve is closed, switch S13 is open, the solenoid of magnetic valve 780 is de-energized, its D-valve (in the position of Fig. 17) admits air to the bottom of the air cylinder for valve stem 743 and elective valve 742 is open. Consequently, the low pressure control unit is active and the main line pressure is limited to the low figure, e. g. 2000 pounds, for the operation of such units as the billet pusher, slide and cutter. When, however, the main ram is to be advanced, the demand for high pressure is put into effect by the opening of the inlet valve of hydraulic unit 323, and the opening movement of this valve closes switch S13. As a result, the solenoid of magnetic valve 780 is energized, its D-valve is reversed (to the position of Fig. 18), air is admitted to the top of the air cylinder for valve stem 743, and valve 742 is closed.

Consequently, the low pressure control is rendered inactive and the main line pressure builds up to the high figure, e. g. 5000 pounds. This condition exists as long as the inlet valve of hydraulic unit remains open. When it closes, switch S13 opens again and the parts return to original position.

In the present embodiment, high pressure is desired also in pulling back the container to eject the sprue. The container moves back, it will be recalled, under return pressure when the exhaust valve of its hydraulic unit 327 opens. The valve rod of this exhaust valve has a switch-operating arm, like the arm for switch S13, and arranged to close a normally open switch S14 when such exhaust valve opens. This switch S14 is connected in a shunt 782 on loop 781. Closing of this switch by the opening of the exhaust valve unit 327 results, as did closing of switch S13, in closing valve 742 and in rendering the low pressure control inactive. That is, when either of switches S13, S14 is closed the system is under high pressure control but when both are open it is under low pressure control. It will be apparent that various other circuit arrangements for the control of valve 742 are possible.

The operation of the apparatus as a whole will be clear from the above without further description.

What is claimed is:

1. In combination, means including a reciprocating ram and a die for extruding billets into rod form, a rotary whipping block for laying the emerging rod in a coil, means including a series of pairs of opposing rolls for feeding the emerging rod from the press to the whipping block, one roll of each pair being yieldably mounted to permit slip with respect to the rod, a cutter for cutting the rod after completion of the extruding stroke of the ram, and means for continuously rotating said rolls and whipping block, whereby the rod, even while stopped for cutting, is under tension so that the trailing end, after cutting, is immediately fed forward.

2. In combination, means including a reciprocating ram and a die for extruding a billet into rod form, means including a rotary whipping block having a diagonal bore for laying the emerging rod in a stationary coil, and means for feeding the emerging rod from the die to the whipping block and including a series of pairs of opposing rolls, each pair comprising a positively driven roll and a roll frictionally driven therefrom.

3. In combination, means including a reciprocating ram and a die for extruding a billet into rod form, means including a rotary whipping block having a diagonal bore for laying the emerging rod in a stationary coil, means for feeding the rod forward including a series of pairs of opposing rolls, means for positively rotating one roll of each pair, the sec-

ond roll of each pair being frictionally rotated from the first, and means for yieldably mounting said frictionally driven rolls.

4. In combination, means including a recip-
5 rotating ram and a die for extruding a billet
into rod form, means including a rotary whip-
ping block having a diagonal bore for laying
the emerging rod in a stationary coil, means
for feeding the rod forward including a
10 series of pairs of opposing rolls, means for
positively rotating one roll of each pair at
a speed substantially in excess of the normal
speed of emergence of the rod, the second roll
15 of each pair being frictionally rotated from
the first, and means for rotating said whip-
ping block at substantially the normal speed
of emergence of the rod.

5. In combination, means including a recip-
rotating ram and a die for extruding a billet
20 into rod form, means including a rotary whip-
ping block having a diagonal bore for laying
the emerging rod in a stationary coil, means
for feeding the rod forward including a series
of pairs of opposing rolls having flanges ex-
25 tending outwardly from the edge faces there-
of, means for positively rotating one roll of
each pair, means for yieldably and resiliently
mounting the other roll of each pair, the pass
of the two rolls of a pair being less than the
30 diameter of the emerging rod, whereby the
resiliently mounted roll is frictionally driven
from the first roll by contact of said flanges
when no rod is present and yields upon pas-
sage of a rod, being thereafter driven fric-
35 tionally from the first roll through the in-
tervening rod.

6. In combination, means including a recip-
rotating ram and a die for extruding a billet
into rod form, a rotary whipping block for
40 laying the rod into a stationary coil, fric-
tion-slip-feeding means for feeding the
emerging rod under tension from the die to
the whipping block, and means for cutting the
rod.

45 7. In combination, means including a ram
and a die for extruding a billet into rod form,
a rotary whipping block for laying the rod
in coil form, means for feeding the rod from
the die to the whipping block including a
50 series of pairs of opposing rolls, means for
positively rotating the one roll of each pair,
the other rolls being frictionally driven there-
from, removable frame pieces on which the
frictionally driven rolls are mounted, and
55 means for changing the speed of the positive-
ly driven rolls.

8. In combination, means including a ram
and a die for extruding a billet into rod
form, a rotary whipping block for laying the
60 rod in coil form, means for feeding the rod
from the die to the whipping block including
a series of pairs of opposing rolls, means for
positively rotating the one roll of each pair,
the other rolls being frictionally driven there-
65 from, removable frame pieces on which the

frictionally driven rolls are mounted, means
for changing the speed of the positively
driven rolls, and means, including removable
change-speed gears, for rotating the whip-
ping block from the drive of said rolls. 70

9. In combination, means including a ram
and a die for extruding a billet into rod form,
a coiling tank, a normally stationary receiv-
ing platform in said tank, a rotary whipping
75 block above said tank and having an oblique
bore for receiving the emerging rod and lay-
ing it in a coil on said platform, a coil-dis-
charge pusher movable across the mouth of
said tank, and means for moving said plat-
form from receiving position to discharge 80
position.

10. In combination, means including a ram
and a die for extruding a billet into rod form,
a coiling tank having its lower end extend-
ing into a cooling pit, a receiving platform 85
normally stationary in said tank intermediate
the mouth and the cooling pit, a whipping
block above said tank and having an oblique
bore for receiving the emerging rod and lay-
ing it in a coil on said platform, a coil-dis- 90
charge pusher movable across the mouth of
said tank, and means for moving said plat-
form in both directions from coil-receiving
position.

11. In combination, means including a ram 95
and a die for extruding a billet into rod form,
a coiling tank having its lower end extend-
ing into a cooling pit, a stationary post cen-
trally located in said tank, an annular re-
ceiving platform normally surrounding said 100
post and having a sliding bearing in said
tank, a rotary whipping block above said
tank and having an oblique bore for receiv-
ing the emerging rod and laying it in a coil
on said platform, a coil-discharge pusher 105
movable across the mouth of said tank, a
crosshead above the tank, draft rods connect-
ing said crosshead with the platform, and
means associated with the crosshead for nor-
mally holding the platform in an interme- 110
diate position in the tank and moving it in
either direction from such intermediate posi-
tion.

12. In combination, means including a ram
and die for extruding a billet into rod form, 115
a receiving platform, means for laying the
emerging rod in a coil on said platform, a pit
for a water bath below the initial position of
said platform, a discharge pusher above such
initial position, and means for moving the 120
platform from initial to discharge position,
from discharge to cooling position, and from
cooling to initial position.

13. In combination, means including a ram
and die for extruding a billet into rod form, 125
a receiving platform, means for laying the
emerging rod in a coil on said platform, a
pit for a water bath below the initial posi-
tion of said platform, a discharge pusher
above such initial position, and means for 130

moving the platform from initial to cooling position, from cooling to discharge position, and from discharge to initial position.

14. In combination, means including a ram and die for extruding a billet into rod form, a receiving platform, means for laying the emerging rod in a coil on said platform, a pit for a water bath below the initial position of said platform, a discharge pusher above such initial position, platform moving and positioning means for moving the platform from initial to cooling position, then to discharge position, and back to initial position, and platform moving and positioning means for moving the platform from initial to discharge position, then to cooling position, and back to initial position.

15. In combination, means including a ram and die for extruding a billet into rod form, a receiving platform, means for laying the emerging rod in a coil on said platform, a pit for a water bath below the initial position of said platform, a discharge pusher above such initial position, a fluid pressure power unit including a piston connected with said platform and capacitated to make a stroke equal to the extreme range of platform movement, and an auxiliary fluid pressure power unit including a piston rod having a stroke equal to the platform movement between cooling and initial positions, and a part connected with said platform and adapted to be engaged by said piston rod.

16. The combination with a movable unit to be moved between two extreme positions and an intermediate position, of a main fluid pressure power unit having its piston rod connected with said unit and having a stroke equal to the extreme range of movement of said movable unit, and an auxiliary fluid pressure unit having its piston rod adapted to abut said movable unit and having a stroke equal to the movement of said movable unit between one extreme and intermediate position, whereby the auxiliary power unit may serve to move the movable unit from such extreme position to intermediate position, or may serve as a stop-to step the movable unit in intermediate position when moved away from the other extreme position.

17. In combination with the main line of a fluid pressure system, an extruding ram, a fluid pressure power unit connected in said main line for operating said ram, a billet pusher, a fluid pressure power unit connected in said main line for operating said billet pusher, a carrier slide, a fluid pressure power unit connected in said main line for operating said carrier slide, and means whereby the power units for the billet pusher and carrier slide are operated at a pressure limited automatically to a given amount and the power unit for the ram is operated at a pressure automatically limited to a given higher amount.

18. In apparatus of the character described, and in combination, means including a ram and a die for extruding a billet into rod form, a rod cutter, a receiving platform, means for laying the emerging rod in a coil on said platform, a coil-discharge pusher above the initial receiving position of the platform, a cooling pit for a water bath below such initial position, an elevator for moving the platform into cooling and discharge positions, and means whereby the operations of the cutter, the discharge pusher, and the elevator are automatically effected upon the operation of some other of said elements.

19. In apparatus of the character described, and in combination, means including a ram and a die for extruding a billet into rod form, a rod cutter, a receiving platform, means for laying the emerging rod in a coil on said platform, a coil-discharge pusher above the initial receiving position of the platform, a cooling pit for a water bath below such initial position, an elevator for moving the platform into cooling and discharge positions, means for advancing said cutter, means whereby the advance of the cutter automatically causes operation of the elevator, and means whereby operation of the elevator to move the coil into position for discharge automatically causes operation of the discharge pusher.

20. In apparatus of the character described, and in combination, means including a ram and a die for extruding a billet into rod form, a rod cutter, a receiving platform, means for laying the emerging rod in a coil on said platform, a coil-discharge pusher above the initial receiving position of the platform, a cooling pit for a water bath below such initial position, an elevator for moving the platform into cooling and discharge positions, means for advancing said cutter, means whereby the operation of the cutter automatically causes operation of the elevator and withdrawal of the cutter, means whereby operation of the elevator to move the coil into position for discharge automatically causes operation of the discharge pusher, and means whereby operation of the discharge pusher automatically causes return out of discharge position and withdrawal of the pusher.

21. In apparatus of the character described, and in combination, a ram, an extruding die, a rod cutter, a coil-receiving platform, means for laying the emerging rod in a coil on said platform, a cooling pit for a water bath below the initial receiving position of the platform, a coil-discharge pusher above the initial position of the platform, an elevator for moving said platform, means for advancing the cutter to cut the extruded rod from the stump, means whereby advance of the cutter automatically causes movement of the elevator into discharge position and

withdrawal of the cutter, means whereby movement of the elevator into discharge position automatically causes advance of the discharge pusher, means whereby advance of the discharge pusher automatically causes movement of the elevator to a position to immerse the platform in said cooling bath and the withdrawal of the pusher, and means whereby the movement of the elevator into cooling position automatically causes return of the elevator to initial position.

22. In apparatus of the character described, and in combination, a ram, an extruding die, a rod cutter, a coil-receiving platform, means for laying the emerging rod in a coil on said platform, a cooling pit for a water bath below the initial receiving position of the platform, a coil-discharge pusher above the initial position of the platform, an elevator for moving said platform, means for advancing the cutter to cut the extruded rod from the stump, means whereby advance of the cutter automatically causes movement of the elevator to a position to immerse the coil in said cooling bath, means whereby movement of the elevator to cooling position automatically causes movement of the elevator to discharge position, means whereby movement of the elevator into discharge position automatically causes advance of the discharge pusher, and means whereby advance of the discharge pusher automatically causes return of the elevator to initial position and withdrawal of the pusher.

23. In apparatus of the class described, a ram, an extruding die, a rod cutter, means for laying the emerging rod in a coil, a platform for receiving the coil, a coil-discharge pusher, an elevator for moving said platform, fluid pressure power units for moving said cutter, pusher and elevator, means including a solenoid-operated valve for controlling operation of said power units, circuits for the coils of said solenoids, and means for automatically controlling said circuits to cause said power units to operate through a given automatic cycle.

24. In apparatus of the class described, a ram, an extruding die, a rod cutter, means for laying the emerging rod in a coil, a platform for receiving the coil, a coil-discharge pusher, an elevator for moving said platform, fluid pressure power units for moving said cutter, pusher, and elevator, means including a solenoid-operated valve for controlling operation of said power units, circuits for the coils of said solenoids, means for automatically controlling said circuits to cause said power units to operate through a given automatic cycle, and switch means for rearranging the circuits to cause said power units to operate through another given automatic cycle.

25. In combination, means including a die and a ram for extruding a billet into rod form,

a receiving platform, means for laying the emerging rod in a coil on said platform, a discharge pusher above the initial receiving position of the platform, fluid pressure power means for said pusher, a cooling pit for a water bath below the initial position of the platform, an elevator for moving the platform, fluid pressure power means for moving said elevator, means including a solenoid for controlling the operation of each said power means, means including circuits comprising the coils of said solenoid and circuit make-and-break devices for causing said power means to operate through an automatic cycle to move the elevator to discharge position, to discharge the coil, move the platform to cooling position and back to initial position, and switch means for rearranging said circuits whereby the power means is caused to operate through an automatic cycle to move the elevator to cooling position, then to discharge position, discharge the coil, and return the elevator to initial position.

26. In combination, means including a ram and a die for extruding a billet into rod form, means for laying the emerging rod in a coil, a platform for receiving said coil, a discharge pusher above the initial position of said platform, means for reciprocating said discharge pusher, means tending to automatically move said platform to discharge position, and means dependent on the position of said pusher for preventing such movement of the platform unless said pusher is withdrawn.

27. In combination, means including a reciprocating ram and a die for extruding a billet into rod form, means including a rotary whipping block having a diagonal bore for laying the emerging rod in a stationary coil, and means for feeding the emerging rod from the die to the whipping block and including a series of pairs of opposing rolls.

28. In combination, means including a reciprocating ram and a die for extruding a billet into rod form, means including a rotary whipping block having a diagonal bore for laying the emerging rod in a stationary coil, and means for feeding the emerging rod from the die to the whipping block and including a series of pairs of opposing rolls, at least one roll of each pair being yieldably mounted.

In testimony whereof, I have hereunto set my hand.

DAVID L. SUMMEY.