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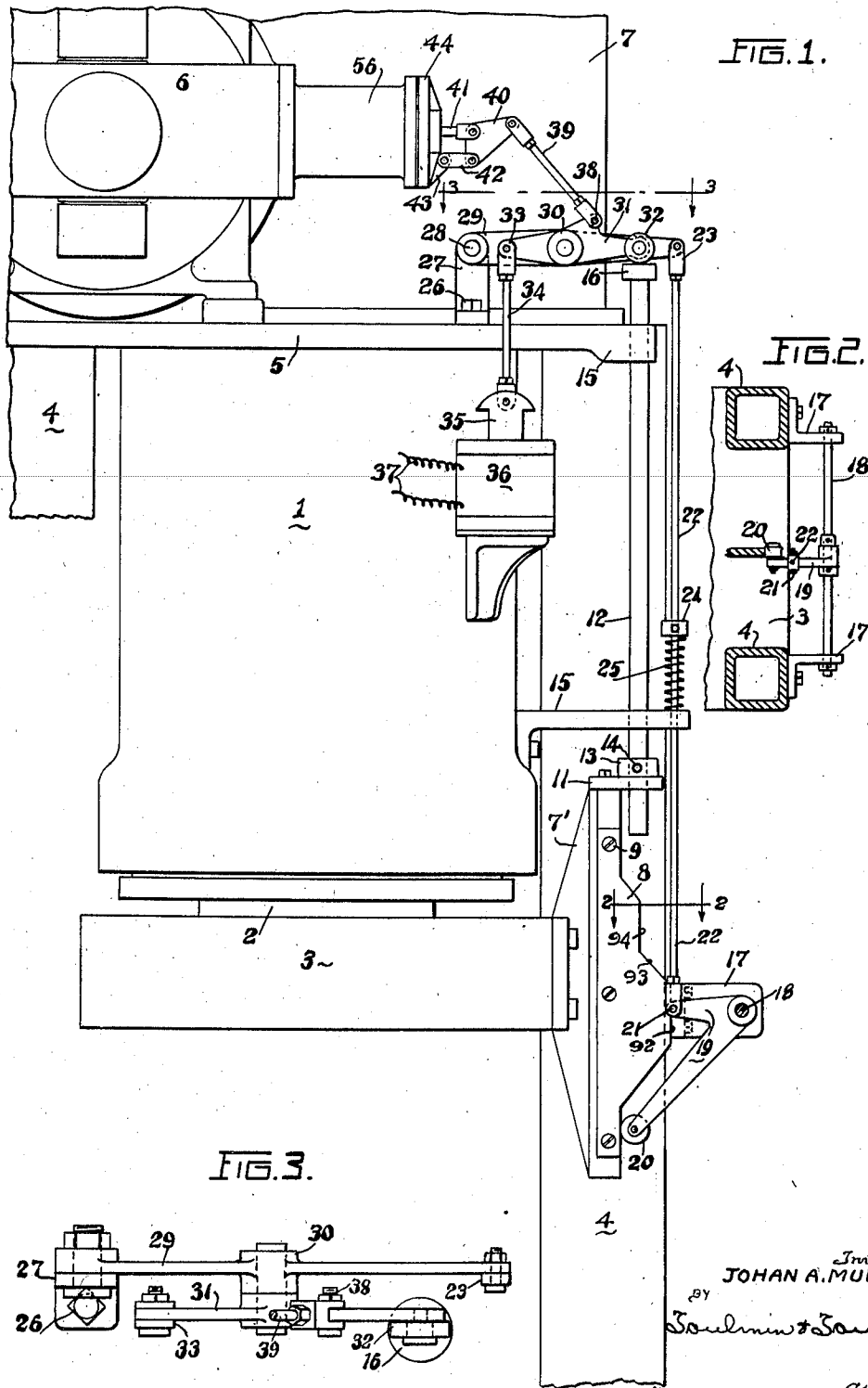
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2,273,721

SPEED CONTROL MECHANISM FOR HYDRAULIC PRESSES

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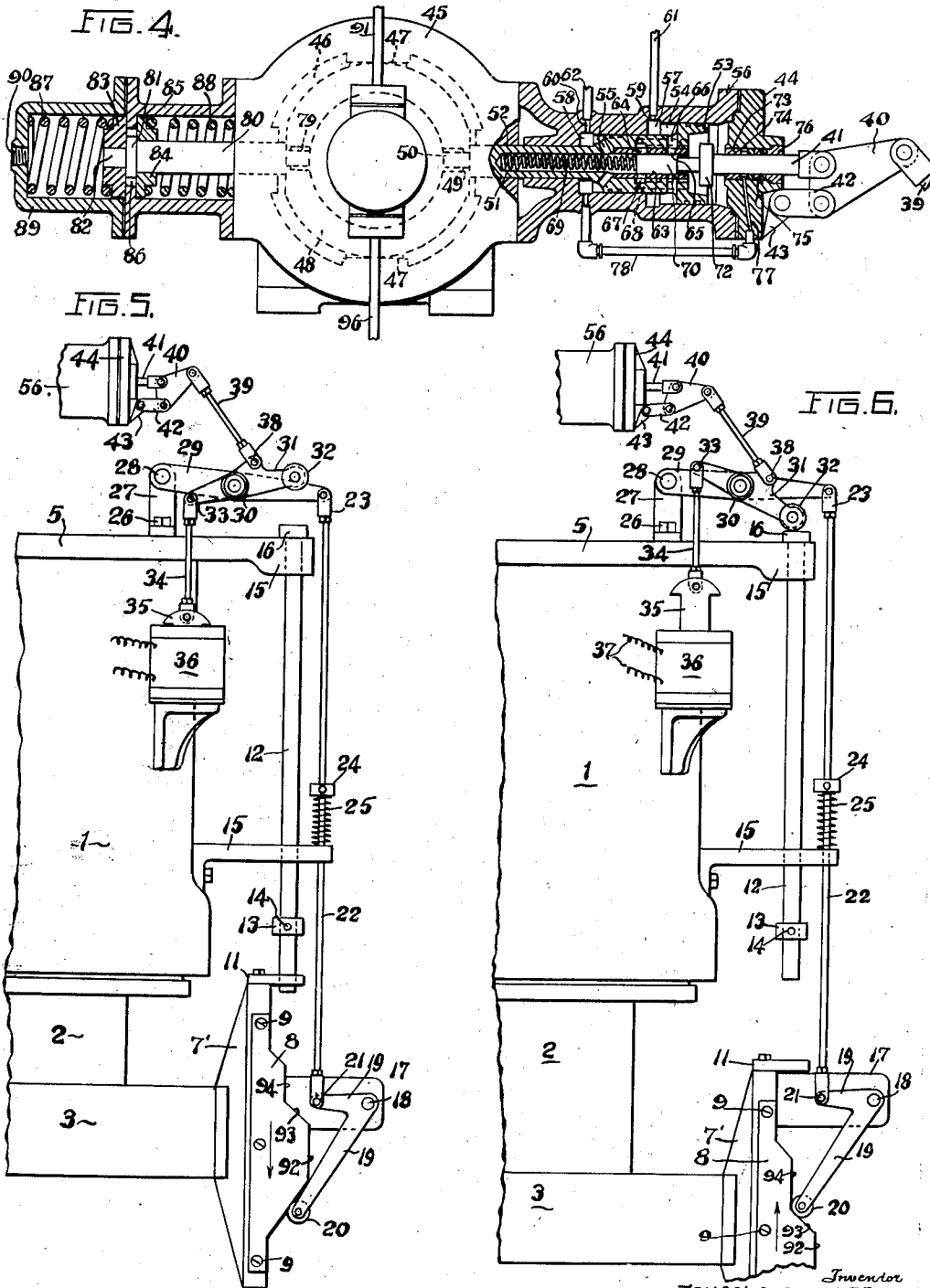
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Inventor
JOHAN A. MULLER,
BY
Saulman & Saulman
Attorneys.

UNITED STATES PATENT OFFICE

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SPEED CONTROL MECHANISM FOR HYDRAULIC PRESSES

Johan A. Muller, Mount Gilead, Ohio, assignor to
The Hydraulic Development Corp. Inc., Wil-
mington, Del., a corporation of Delaware

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5 Claims. (Cl. 60—52)

This invention relates to hydraulic machinery, and in particular to speed control mechanism for hydraulic presses.

Hydraulic presses are employed in the metal-working art to perform various kinds of work in the fabrication of metal manufactures. The latter may be fabricated as the result of forming, bending or drawing operations, in which the press is called upon to operate at different speeds during the power stroke, depending on the nature of the work and the character of the metal on which the work is performed. The last two factors may necessitate a press speed which is not constant throughout the length of the stroke but may require abrupt changes in speed at any position in the stroke. In the case of the press fabricating articles on a quantity production basis, it is desirable that the changes in speed of the press, demanded by the character of the work, shall be uniform for each excursion of the press in order that each article shall conform to the same dimension, configuration, etc.

The primary object of the present invention is to provide a simple and inexpensive mechanism for automatically controlling the speed of a hydraulic press in accordance with a predetermined schedule, and for assuring an exact repetition of the speed control during every subsequent excursion of the press.

Other objects are to provide an improved structure by which the speed of a hydraulic press can be accurately controlled at any position within its stroke, and continuously throughout its stroke; to provide in the combination of a hydraulic press and a servomotor hydraulic control mechanism, a device by which the control mechanism can be controlled to regulate the instantaneous speed of the press; to provide in the combination of a hydraulic press and a servomotor hydraulic control mechanism a device responsive to the instantaneous position of the press anywhere along its stroke for controlling the speed of the press at that position, and operating through the hydraulic control mechanism.

A final and more general object is to provide a mechanism which can be readily adapted to existing hydraulic presses for automatically controlling the speed of the press at will, and for quickly changing a schedule of speed into another speed schedule without affecting the uniformity of the current speed schedule as between repeated excursions of the press.

The above objects are attained, in brief, by providing a linkage connected to the servomotor

control mechanism and actuated by the movement of the press plunger or platen. The relative movement between the linkage and the plunger is gradated in accordance with a predetermined determination of schedule, which can be readily replaced or substituted depending on the character of the work being done by the press.

Other objects and features will be apparent as the following specification is perused in connection with the accompanying drawings.

In the drawings:

Figure 1 is a fragmentary elevational view of a combined hydraulic press and variable delivery pump provided with the improved device for controlling the instantaneous speed of the press. This figure shows the position of the linkage for controlling the speed of the press at the time the platen is in its fully retracted or neutral position.

Figure 2 is a cross sectional view taken along the line 2—2 in Figure 1, but somewhat diminished in size.

Figure 3 is a plan view looking down on the line 3—3 in Figure 1, in the direction of the arrows.

Figure 4 is a longitudinal sectional view, partly in elevation, of a reversible variable delivery pump employed in connection with the press shown in Figure 1.

Figure 5 is a fragmentary elevational view of the press and delivery pump, with the control linkage shown in the position of down-stroke of the press.

Figure 6 is a view similar to Figure 5, but showing the control linkage in the position of up-stroke of the press.

Referring to the drawings in detail, the main operating cylinder of the hydraulic press is indicated generally by the reference character 1, and projecting from the lower part of the cylinder there is a plunger or ram 2 to which is secured a platen 3. The cylinder 1 is supported preferably in a vertical direction in any suitable manner, and as illustrated this support takes the form of a rectangular frame constituted of four or more vertical stanchions or hollow columns 4, which rise up from a bed plate (not shown). A horizontally extending head plate 5 is carried by the top of the columns 4, and the upper surface of the plate supports a variable delivery pump, generally designated 6, also a surge tank 7. This pump will be described in detail in connection with Figure 4. The surge

tank is of well known construction and needs no detailed description.

There is secured to the platen 3 an outwardly extending bracket, generally designated 7', to which is secured, as by screws 9, a metal cam plate 8 which has its right-hand edge machined to a particular configuration for purposes which will appear presently. From the upper end of the bracket 7' there extends an arm 11 which projects horizontally, and has an opening for receiving a vertical control rod 12. A collar 13 is pinned, as at 14, to the control rod and bears against the upper surface of the arm 11. The rod 12 is guided by brackets 15 which project from the main cylinder 1 and the metal plate 5, the rod terminating at its upper end in an enlargement or collar 16.

As seen more particularly in Figure 2, there is a pair of L-shaped brackets 17 bolted to the two opposite columns 4, and to which are secured in any suitable manner the opposite ends of a rod 18. About midway between the brackets 17, loosely carried by the rod 18, there is a bellcrank lever 19 having legs of unequal length. The longer leg terminates in a follower 20, which is adapted to roll along the machined portions of the metal plate 8. The shorter leg of the lever 19 is pivoted, as at 21, to a long upright link rod 22 which passes loosely through the lower bracket 15 and terminates in a bifurcated yoke 23. Positioned about midway of the length of the rod 22 there is a collar 24, pinned to the rod. A compression spring 25 is inserted between the collar 24 and the upper surface of the lower bracket 15.

There is secured to the plate 5, as by the bolts 26, an upright 27 which carries a pivot 28 for a lever 29 (Figure 3). The end of the lever opposite from the pivot 28 is pivoted to the bifurcated yoke 23 of the rod 22. The middle portion of the lever 29 is provided with a hub 30, which serves as a pivot bearing for a modified form of bellcrank lever 31, one end of which terminates in a roller 32 which bears against the collar 16 of the control rod 12. The opposite end of the lever 31 is pivoted, as at 33, to a downwardly extending link 34, which is secured to an armature 35 of a powerful electromagnet 36. Wires 37 are taken from the electromagnet for energization purposes. The lever 31 is provided with an intermediate pivot 38, on which rotates a link or rod 39, pivoted at its upper end to one apex of a triangular plate 40. The servomotor control valve stem 41 is pivotally secured to the second apex of the plate 40, and a link 42 pivotally secured to the remaining apex of the plate 40. The link 42 is pivotally mounted on an ear 43 which extends outwardly from the cylinder head 44 of the variable delivery pump 6. The details of the latter are shown in Figure 4.

The variable delivery pump 6 includes a pump casing 45, having a chamber 46 containing bearing pads 47 supporting and guiding the horizontal reciprocation of the pump shiftring or flow-control member 48. The latter, as is known to those skilled in the art, controls the delivery of the variable delivery pump 6 so as to advance or return the plunger 2 of the press 1, or to cause it to remain in a neutral position depending upon the eccentricity of the shiftring 48 from its neutral position. It will be understood in this connection that the press 1 is of the double-acting type in which the fluid, usually oil, fed and controlled by the variable delivery pump 6, causes

the piston within the press 1 to be forced downwardly and then to be retracted back to its initial position.

Secured, as at 49, to the shiftring 48 is the threaded end 50 of the servomotor piston rod 51, which passes through the bore 52 in the pump casing 45 and carries at its opposite end the piston head 53. The latter reciprocates within the stepped cylinder bores 54 and 55 in the servomotor casing 56. The bores 54 and 55 are provided with annular enlargements 57 and 58, having ports 59 and 60 to which are connected the pipe lines 61 and 62, respectively. The piston rod 51 contains a central longitudinal bore which carries a fixed sleeve 63, having ports 64 and 65 opening into the inner bore of the sleeve. The piston rod 51 likewise is provided with ports 66 communicating with the ports 65, and likewise with an annular space 67 adjacent the port 64.

The piston rod 51 is provided with axially bored passageways 68 running from the right-hand face of the piston head 53 to the annular space 67. The piston rod 51 is bored out to receive a compression spring 69, one end of which engages the end of the bore and the other end engages the reduced diameter portion or valve head 70 of the servomotor control valve stem 41. This reduced diameter portion or valve head 70 is movable to and fro within the inner bore of the sleeve 63. The valve rod 41 carries a disc-like baffle member 72 before it enters a bore within the plug 73 carried by a bore 74 in the servomotor cylinder head 44. A packing 75 and gland 76 reduce fluid leakage around the valve rod 41. Communicating with the servomotor cylinder head 44 is a leakage duct 77, which is connected to the enlargement 58 by the leakage pipe 78. The latter serves to carry away any fluid leaking past the plug 73.

Secured to the shiftring 48 is the threaded end 79 of a centering rod 80. The latter is provided with an enlargement 81, beyond which is a reduced portion 82. On opposite sides of the enlargement 81 are collars 83 and 84, slidably mounted upon the reduced portion 82 and the centering rod 80, respectively. The centering device casing 85 is provided with an annular internal flange 86, against which the collars 83 and 84 are urged by coil springs 88 and 87 within the casing 85 and cap 89, respectively. A threaded port 90, normally closed by a plug, permits access to the interior of the cap 89 so as to check the condition of the spring 87.

In the operation of the press and variable delivery pump combination, the electromagnet 36 is energized by closing the switch in the usual manner. The energization of the electromagnet causes the latter to draw its armature 35 downwardly, as can be seen more clearly in Figure 5. Assuming that the linkage has the relative position indicated in Figure 1 before the electromagnet is energized, the downward movement of the armature 35 will cause the link 34 to move downwardly, and will cause the lever 31 to swing about its large central pivot. A study of Figure 5 will show that the rod 39 is caused to move upwardly and the servomotor valve stem 41 is caused to move inwardly. This, in turn, compresses the coil spring 69 and shifts the valve head 70 to the left, uncovering the port 65 in the sleeve 63. Pressure fluid from a pilot pump (not shown) is thus permitted to pass through the line 61, into the port 66 of the pis-

ton, and through the port 65 of the sleeve 63, into the open space to the right of the piston head 53. This pressure forces the servomotor piston head 53 and the piston rod 51 to the left, together with the pump shifting 48, the centering rod 80 and collar 81, thereby compressing the centering spring 87. While the piston rod 51 is moving to the left, the fluid within the annular enlargement 58 is discharged through the pipe line 62, into the surge tank 7. With the pump shifting 48 shifted to the left of its neutral position in this manner, the pump 45 discharges pressure fluid into the space above the plunger in the press 1, by way of the line 91, thus forcing the plunger downwardly.

The surge tank 7 ordinarily contains a surge valve (not shown), which is well known to those skilled in the art and which valve opens automatically in response to the gravitational descent of the plunger and admits fluid into the space above the plunger from the surge tank until the platen encounters resistance. When this occurs the surge valve automatically closes and pressure is built up within the space on top of the cylinder. This pressure may be transmitted in any suitable manner to a tonnage control valve, which is also well known in the art, and the function of which is to open-circuit the electromagnet 36 when the platen 3 has reached its lowermost position. An example of a suitable form of tonnage control valve is shown in the Ernst patent, Re. 19,694, granted September 10, 1935. Instead of determining the lowermost limit of the platen by the pressure built up in the chamber immediately above the press plunger, this limit of travel may be set by the use of a positional reversing switch, which depends for its operation on the position of the platen with respect to the supporting frame, and has for its purpose, as in the case of the tonnage control valve, the deenergization of the electromagnet 36 when the platen has reached its lowermost position.

As stated hereinbefore, certain classes of work do not require a constant velocity of the downwardly moving platen, but instead may require a fast speed during a certain portion of the power stroke and then a different speed during another portion thereof. The number of combinations of different speeds is multitudinous and depends on the character of the work and the kind of material on which the press is operating for the moment. In accordance with the present invention, I have provided a cam and follower mechanism which controls, in a variable manner, the distance which the valve stem 41 will move inwardly during the downward excursion of the platen and in accordance with a predetermined speed schedule.

Assuming that the cam takes the general shape of that indicated in Figures 1, 5 and 6, it is further assumed that the electromagnet has been energized and that the valve stem 41 is moved inwardly to cause the platen 3 to descend. As the platen moves downwardly the machined surface of the metal plate 8 moves with the platen under the roller 20, and depending on the shape of the surface, will cause the bellcrank lever 19 to rotate on its shaft 18. Assuming, for example, that this plate has a hump which extends to the right, as seen in the drawings, the downward movement of the plate 8 will cause the upper leg 19 to move counterclockwise, pulling the rod 22 downwardly. The lever 29, to which the rod

22 is attached, will move downwardly about the pivot 28, and carry with it the hub 30. Inasmuch as the rod 34 of the electromagnet is rigidly held in its lowermost position, the upper end of this rod serves as a fixed pivot so that as the hub 30 descends, this movement will, in turn, cause the lever 31 to rotate about the pivot 33 and will give the rod 39 a downward pull. This, in effect, causes a retraction of the valve stem 41.

As the valve head 70 moves to the right as the result of the valve stem 41 being drawn outwardly, the port 64 in the sleeve 63 uncovers, permitting the pressure fluid which has collected to the right of the piston head 53 to exhaust through the longitudinal port 68, and through the port 64 into the central opening containing the spring 69, out through the diagonal ports 55 and into the annular enlargement 58, and thence through the pipe 62 back to the surge tank. The spring 87 will now move the piston 53 to the right to cover port 64 by head 70.

As the roller 20 ascends the incline on the cam plate 8, the valve stem 41 is moved farther and farther to the right until when the dwell 92 is reached, the flow-control member or shifting 48 has been shifted to the right to such an extent that the output of the delivery pump 45 is fairly low. Under these conditions the speed with which the plunger in the press 1 descends is correspondingly low, and this speed is maintained during that part of the time that the roller 20 traverses the dwell portion 92. It will be noted in this connection that the compression spring 25 urges the rod 22 upwardly, and thereby causes the roller 20 to follow the contour of the cam 8 quite closely. The spring 25 should be sufficiently strong to not only overcome the weight of the total linkage but also to compress the spring 69.

As the platen 3 continues to descend, carrying with it the cam 8, the roller 20 will follow the track portion 93, in which case the valve stem 41 will again move inwardly, uncovering the port 65 to admit pressure fluid to the right-hand side of the piston head 53. Thus, the piston head 53 is urged to the left until the valve head 70 again covers the exhaust port 65, causing the shifting 48 also to move to the left to increase the speed of the press plunger 2 and platen 3. The spring 87 will be compressed under these conditions. When the dwell 94 is reached, the speed of the plunger 2 will have been increased to approximately two-thirds of its maximum value, which conveniently may represent the lowermost point of travel of the platen.

It is obvious that the cam plate 8 may be provided with any configuration, including any number of dwell portions and also any number of inclined or declined surfaces, with any angle of inclination or declination; in order to cause the press plunger to vary its speed at any point in its stroke, these speeds being governed by the character of the work being performed—that is, whether it is a bending, forming or pressing job. As stated hereinbefore, when the platen has reached its lowermost position, the electromagnet 36 is immediately deenergized by any suitable and well known form of pressure or positional reversing switch, and thus the platen is ready to return.

While the platen is moving downwardly and the electromagnet 36 is energized, it will be noted that the control rod 12 also slides downwardly in its guiding arms 15, and the roller 32 is moved upwardly away from the head 16 of the control

rod. However, as soon as the electromagnet 36 is deenergized, the lever 31 is caused to rotate on its pivot at the hub 30, due to the weight of the roller and the force exerted by the compression spring 69, causing the rod 39 to be moved downwardly, as shown in Figure 6, and also causing the roller 32 to contact with the collar 16 on the control rod 12. The downward movement of the rod 39 moves the valve stem 41 to the right, which causes the valve head 70 to uncover the port 64. The pressure fluid contained to the right of the piston head is therefore exhausted through the ports 68 and 64, through the diagonal ports 55 and the line 62 to the surge tank. Pressure fluid is admitted from the pipe line 61 to the annular enlargement 57 and therefore to the left-hand side of the piston head 53, causing the latter to be moved to the right. The piston head 53 therefore moves the shifting or flow-control member 48 through the neutral position to its extreme right-hand position. This movement of the shifting also causes the centering rod 80 to move and place the spring 88 under compression.

It is well known in the art that when the flow-control member or shifting is shifted from right to left, through neutral, the variable delivery pump 45 will pump pressure fluid through the pipe 96 to the under side of the piston head in the cylinder 1 of the press. Thus, the plunger 2 starts to move upwardly, carrying with it the cam plate 8 and causing the bellcrank lever 19 to oscillate about its pivot 18. As the platen moves upwardly, the arm 11 picks up the collar 13 and proceeds to move the control rod 12 upwardly. This upward movement of the rod causes the collar 16 to contact with the roller 32, and as seen more clearly in Figure 1, causes the lever 31 to be rotated at its hub 30, pushing up the rod 39 and moving the valve stem 41 inwardly. As explained hereinbefore, this movement of the valve stem causes the piston head 53 to move to the left by admitting pressure fluid to the right-hand side of the piston head, so that the shifting 48 is returned to its neutral or no-stroke position. This movement of the shifting is accelerated by the spring 88, which is now permitted to relieve itself of its compressional strains. Thus the plunger 2 has now reached its uppermost—that is its neutral or no-stroke position, awaiting further energization of the electromagnet 36 to continue its pressing or bending operation. It was pointed out that during this upward movement of the plunger 2 the roller 20 retraces the track along the cam 8.

Inasmuch as the electromagnet 36 is in a deenergized condition, its core or armature 35 is free to move so that all motion of the linkage, brought about by the oscillations of the lever 19, merely causes the armature to move up and down within the electromagnet without causing any movement of the rod 39. The springs 87 and 88, which assist in bringing the shifting 48 back to neutral when the latter has been moved to the right or left of neutral depending on the position of the piston head 53, are sufficiently stiff to hold the servo-motor at its full-stroke position during the vertical oscillations of the rod 22. The compression spring 69 also tends to prevent any undesired movement of the valve stem 41 to the left. Consequently, while the cam and roller mechanism 8; 20 exerts a decided effect on the instantaneous speed of the platen during its descent or work-stroke operation, this mechanism exerts no effect whatever during the

time that the platen is moving upwardly. The latter may, therefore, be retracted at any practical maximum speed.

From the foregoing it is evident by reason of the fact that the cam plate 8 is secured to the platen, or any other suitable moving part of the press, and since the linkage, including the bellcrank lever 19, has fixed pivot points, that the speed of the press at any point in its downward travel is exactly duplicated during each excursion of the plunger. Consequently, when the most favorable speed schedule has been determined for a given character of work, and translated into a contour on the cam plate 8, the press will operate at that speed, which is a very important consideration in quantity production work. It is no longer necessary to regulate these instantaneous speeds by hand, employing merely the skill of the operator, but by the use of the cam and roller arrangement this speed can be accurately predetermined and even more accurately duplicated.

No claim is made in this application on the use of the centering springs 87 and 88, which assist in returning the flow-control member or shifting 48 to its neutral position as the valve stem 41 is moved, since this subject-matter has been disclosed and claimed in Ernst Patent No. 2,184,665. In that application it was also pointed out that centering springs serve to shift the flow-control member to a neutral or no-delivery position when the power connected to the pilot pump, which supplies fluid to the servomotor, or the power for operating the delivery pump itself, is interrupted. By returning the flow-control member to its neutral position, upon failure of power, the operation of the delivery pump as a motor and the consequent coasting down of the press platen under its own weight are prevented.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims and the invention.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. The combination of a hydraulic press containing a piston which terminates in a platen and a variable delivery pump including a flow-control member for controlling and supplying pressure fluid alternately to the opposite sides of the piston whereby the piston moves first on its working stroke and then returns, a servomotor piston in said delivery pump for shifting said flow-control member in order to control the supplying of pressure fluid to the press, the movement of said piston being controlled by a valve associated with the piston, means including an electromagnet and an armature therefor for initially moving the servomotor valve to cause the press piston to start its working stroke, means for controlling the further movement of the servomotor valve in a predetermined manner and in accordance with the position of the press piston in its stroke, said last-mentioned means including a cam secured to said platen and a co-operating follower, a first lever pivoted at one end on the press and connected at the other end to said follower through a follower rod, and a second lever pivotally mounted on said first lever and connected at one end to said armature and at the other end connected to the servomotor valve through a connecting rod, said electromagnet when energized to initiate the working stroke serving to hold the armature in a fixed position by which a fixed pivot is provided for said second

lever whereby the connecting rod secured to the second lever pushes the servomotor valve to one of a plurality of on-stroke positions determined by the relative positions of the cam and its follower in order to vary the instantaneous speed of the press platen.

2. The combination of a hydraulic press containing a piston which terminates in a platen and a variable delivery pump including a flow-control member for controlling and supplying pressure fluid alternately to the opposite sides of the piston whereby the piston moves first on its working stroke and then returns, a servomotor piston in said delivery pump for shifting said flow-control member in order to control the supply of pressure fluid to the press, the movement of said piston being controlled by a valve associated with the piston, means including an electromagnet and an armature therefor for initially moving the servomotor valve to cause the press piston to start its working stroke, means for controlling the further movement of the servomotor valve in a predetermined manner and in accordance with the position of the press piston in its stroke, said last-mentioned means including a cam secured to said platen and a cooperating follower, a first lever pivoted at one end on the press and connected at the other end to said follower through a follower rod, a second lever pivotally mounted on said first lever and connected at one end to said armature and at the other end connected to the servomotor valve through a connecting rod, said electromagnet when energized to initiate the working stroke serving to hold the armature in a fixed position by which a fixed pivot is provided for said second lever whereby the connecting rod secured to the second lever pushes the servomotor valve to one of a plurality of on-stroke positions determined by the relative positions of the cam and its follower in order to vary the instantaneous speed of the press platen, said electromagnet upon de-energization permitting the armature to float and to render movable the pivot of the second lever whereby the relative movements of the follower over its cam are independent of the movements of the servomotor valve, and means including the servomotor and operable on the deenergization of the electromagnet for causing retraction of the press piston to its initial position.

3. The combination of a hydraulic press containing a piston which terminates in a platen and a variable delivery pump including a flow-control member for controlling and supplying pressure fluid alternately to the opposite sides of the piston whereby the piston moves first on its working stroke and then returns, a servomotor piston in said delivery pump for shifting said flow-control member in order to control the supply of pressure fluid to the press, the movement of said piston being controlled by a valve associated with the piston, means including an electromagnet and an armature therefor for initially moving the servomotor valve to cause the press piston to start its working stroke, means for controlling the further movement of the servomotor valve in a predetermined manner and in accordance with the position of the press piston in its stroke, said last-mentioned means including a cam secured to said platen and a cooperating follower, a first lever pivoted at one end on the press and connected at the other end to said follower through a follower rod, a second lever pivotally mounted on said first lever and connected at one end to said armature and at the other end

connected to the servomotor valve through a connecting rod, said electromagnet when energized to initiate the working stroke serving to hold the armature in a fixed position by which a fixed pivot is provided for said second lever whereby the connecting rod secured to the second lever pushes the servomotor valve to one of a plurality of on-stroke positions determined by the relative positions of the cam and its follower in order to vary the instantaneous speed of the press platen, said electromagnet upon de-energization permitting the armature to float and to render movable the pivot of the second lever whereby the relative movements of the follower over its cam are independent of the movements of the servomotor valve, and means associated with said second lever for moving the servomotor valve in a direction such as to cause the press piston to return to its initial position.

4. The combination of a hydraulic press containing a piston which terminates in a platen and a variable delivery pump including a flow-control member for controlling and supplying pressure fluid alternately to the opposite sides of the piston whereby the piston moves first on its working stroke and then returns, a servomotor piston in said delivery pump for shifting said flow-control member in order to control the supply of pressure fluid to the press, the movement of said piston being controlled by a valve associated with the piston, means including an electromagnet and an armature therefor for initially moving the servomotor valve to cause the press piston to start its working stroke, means for controlling the further movement of the servomotor valve in a predetermined manner and in accordance with the position of the press piston in its stroke, said last-mentioned means including a cam secured to said platen and a cooperating follower, a first lever pivoted at one end on the press and connected at the other end to said follower through a follower rod, a second lever pivotally mounted on said first lever and connected at one end to said armature and at the other end connected to the servomotor valve through a connecting rod, said electromagnet when energized to initiate the working stroke serving to hold the armature in a fixed position by which a fixed pivot is provided for said second lever whereby the connecting rod secured to the second lever pushes the servomotor valve to one of a plurality of on-stroke positions determined by the relative positions of the cam and its follower in order to vary the instantaneous speed of the press platen, said electromagnet upon de-energization permitting the armature to float and to render movable the pivot of the second lever whereby the relative movements of the follower over its cam are independent of the movements of the servomotor valve, and means associated with said second lever for moving the servomotor valve in a direction such as to cause the press piston to return to its initial position, said last-mentioned means comprising a roller counterweight secured to the second lever opposite the position where said lever is connected to the armature, said counterweight being adapted to swing the second lever about its pivot on the first lever when the armature is in a floating state within the electromagnet.

5. The combination of a hydraulic press containing a piston which terminates in a platen and a variable delivery pump including a flow-control member for controlling and supplying pressure fluid alternately to the opposite sides of

the piston whereby the piston moves first on its working stroke and then returns, a servomotor piston in said delivery pump for shifting said flow-control member in order to control the supply of pressure fluid to the press, the movement of said piston being controlled by a valve associated with the piston, means including an electromagnet and an armature therefor for initially moving the servomotor valve to cause the press piston to start its working stroke, means for controlling the further movement of the servomotor valve in a predetermined manner and in accordance with the position of the press piston in its stroke, said last-mentioned means including a cam secured to said platen and a cooperating follower, a first lever pivoted at one end on the press and connected at the other end to said follower through a follower rod, a second lever pivotally mounted on said first lever and connected at one end to said armature and at the other end connected to the servomotor valve through a connecting rod, said electromagnet when energized to initiate the working stroke serving to hold the armature in a fixed position by which a fixed pivot is provided for said second lever whereby the connecting rod secured to the second lever pushes the servomotor valve to one of a plurality of on-stroke positions determined

by the relative positions of the cam and its follower in order to vary the instantaneous speed of the press platen, said electromagnet upon de-energization permitting the armature to float and to render movable the pivot of the second lever whereby the relative movements of the follower over its cam are independent of the movements of the servomotor valve, means associated with said second lever for moving the servomotor valve in a direction such as to cause the press piston to return to its initial position, said last-mentioned means comprising a roller counterweight secured to the second lever opposite the position where said lever is connected to the armature, said counterweight being adapted to swing the second lever about its pivot on the first lever when the armature is in a floating state within the electromagnet, and means for stopping the press piston when it has returned to its initial position, said last-mentioned means comprising a control rod adapted to be engaged at one end by the platen when the press piston has returned to its initial position, the other end of said control rod being adapted to engage said roller counterweight which causes said second lever to move on its pivot and to return the flow-control member to neutral.

JOHAN A. MULLER.