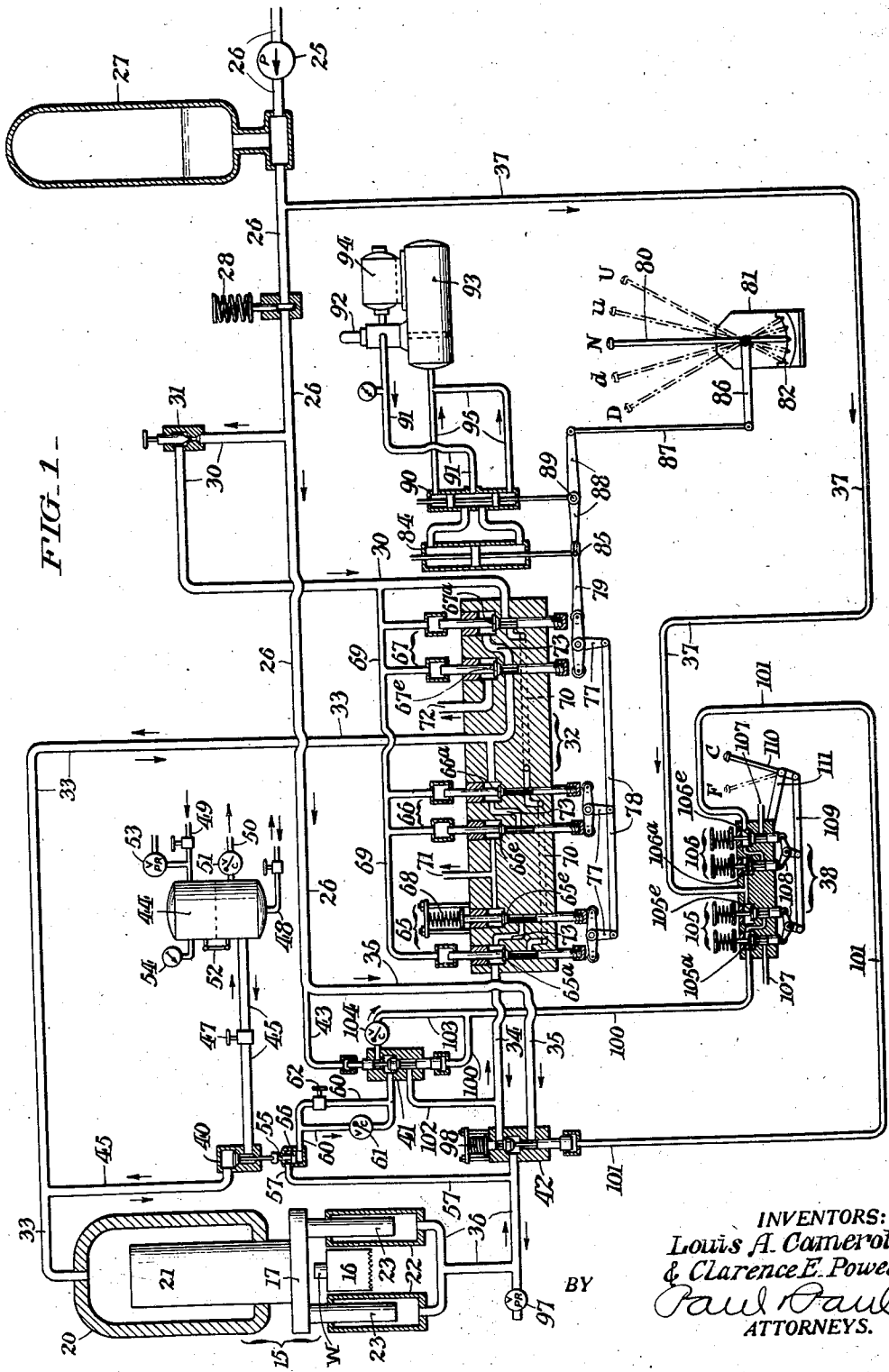
Oct. 27, 1942. L. A. CAMEROTA ET AL 2,300,338

HYDRAULIC PRESS AND THE LIKE

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FIG. 1.



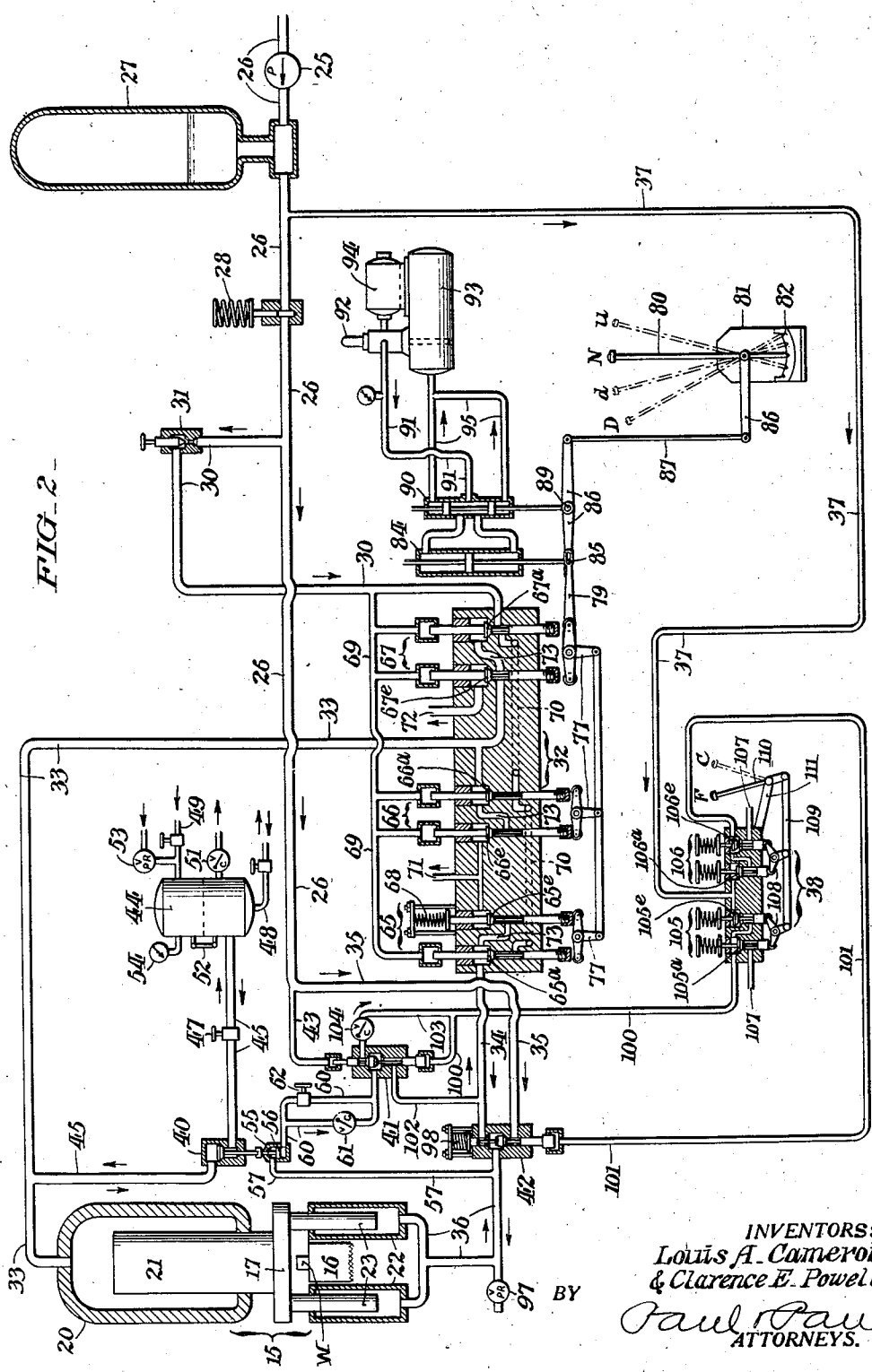
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Filed Oct. 3, 1940 4 Sheets-Sheet 2

FIG. 2.



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HYDRAULIC PRESS AND THE LIKE

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FIG. 3.

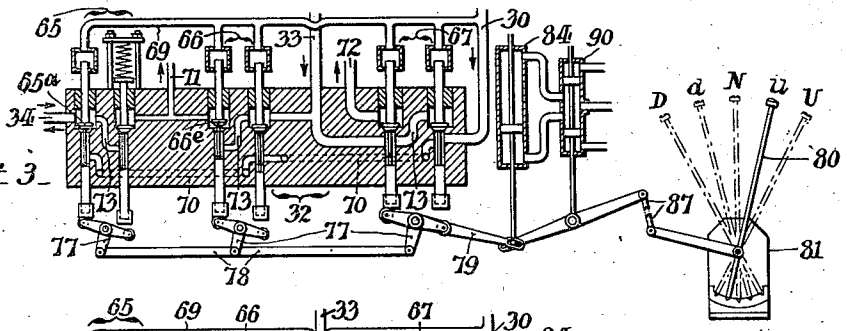


FIG. 4.

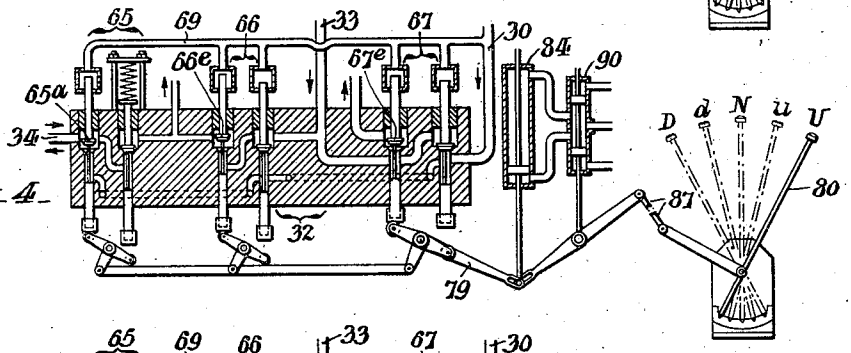


FIG. 5.

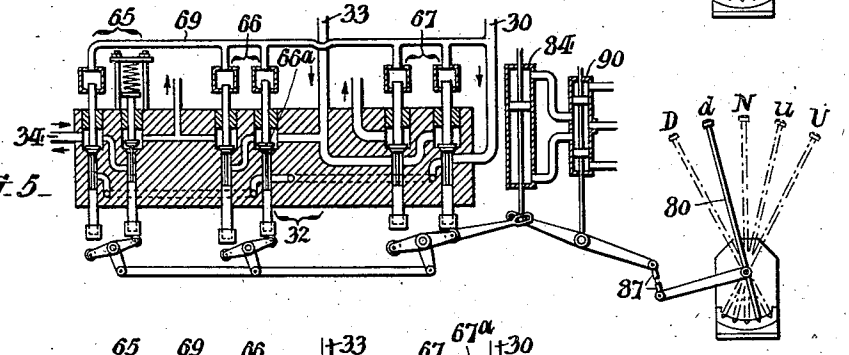
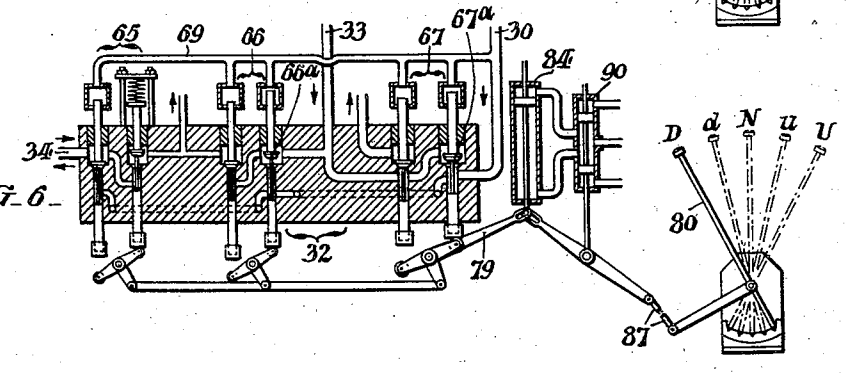


FIG. 6.



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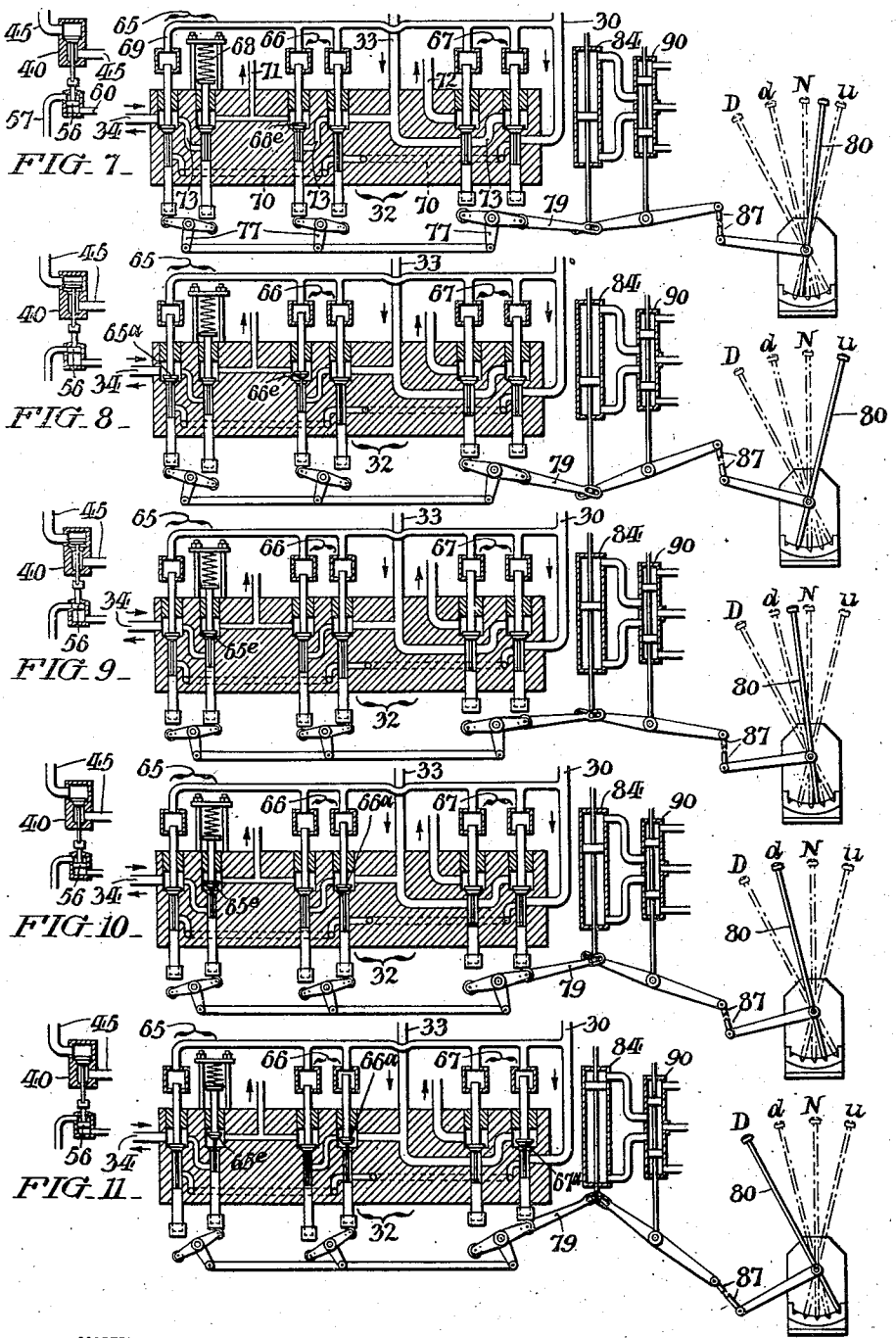


FIG. 7.

FIG. 8.

FIG. 9.

FIG. 10.

FIG. 11.

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Patented Oct. 27, 1942 2,300,338

UNITED STATES PATENT OFFICE

2,300,338

HYDRAULIC PRESS AND THE LIKE

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Application October 3, 1940, Serial No. 359,532

11 Claims. (Cl. 60—51)

This invention relates to machinery operated by fluid pressure, such as presses and the like, and more particularly to the provisions for supplying and controlling the operating or working fluid for such machinery. The general purpose of the invention is to improve and simplify the fluid supply and control system, and to simplify and facilitate the manipulation of the control for various operations. The invention is of special advantage for presses employing different working fluids, or fluid at different pressures, and for presses adaptable for diverse modes of operation. We have hereinafter explained the invention in connection with a metal-working hydraulic press using inelastic fluid at high and low pressures as its working fluid, and adaptable for the modes of operation distinctively known in the art as "cogging" and "forging." In this particular press, the opposite movements of the press head are produced by separate single acting pistons of plunger type, operating in separate cylinders; but it will be understood that the invention is equally applicable to presses having other types or arrangements of piston means or the like for producing the movement of the press head, such as an ordinary double-acting piston on a piston rod, for example.

In "cogging," the press operates under high pressure to slowly squeeze out or "crush" a relatively large (hot) metal billet or ingot between flat surfaces for the purpose of reducing its cross-section or of changing its shape. It is desired to control the movement of the press quite accurately; and the working fluid is generally used at relatively high pressure for both the working and the return (or closing and opening) movements or strokes of the press head or platen with respect to the work and the bed of the press.

In "forging," a (hot) metal blank is pressed to shape between dies; and it is desired to have the press move quite rapidly in one direction, at least (usually the working or closing movement), until the resistance of the blank or work is encountered by the moving press head or platen, and thereafter to apply high pressure to shape the metal while the working movement or stroke is being completed. Accordingly, part of the press movement is generally effected by working fluid at relatively low pressure, and part by fluid at high pressure.

Heretofore, it has been necessary to provide a press for cogging and forging with two separate systems of piping and valves for supplying, venting or exhausting, and controlling the high pressure fluid and the low pressure fluid. For operating the controls, there have been a plurality of levers to be manipulated; and severe effort has been required of the operator in manipulating them properly.

Our invention permits, amongst other advantages, of simplifying the fluid supply and control system and its operation, eliminating the necessity of double piping and valve systems such as heretofore used, as well as the necessity of manipulating a number of control levers in operating the press. The physical exertion of manipulating the controls may also be very greatly reduced. In the system herein particularly illustrated and described, the control is effected by a single easily moved hand lever for both cogging and forging operations; and an auxiliary selector shiftable by an easy movement of the hand adapts the press for either cogging or forging, as desired.

Various features and advantages of the invention will appear from the following description of a species and form of embodiment, and from the drawings. All the features and combinations shown and described are of our invention, so far as novel; and it will be understood that various such features or combinations herein disclosed may be used separately from the rest, in presses quite different from that here illustrated.

In the drawings, Fig. 1 is a general diagrammatic view of a hydraulic press with a working fluid supply and control system conveniently embodying our invention, the control system being adjusted or set for cogging; and Fig. 2 is a similar view with the control system set for forging. In these figures, adjustable shoes on the valve stems of the main control valves are shown in section.

Figs. 3, 4, 5, and 6 are diagrammatic views of the main operating valve means of the fluid supply and control system, showing their positions in various stages of the cogging operation of the press; and Figs. 7, 8, 9, 10, and 11 are diagrammatic views of the main operating valve means and supplemental valve means, illustrating various stages in the forging operation of the press.

In Figs. 1–11, the pipe lines which carry fluid to and from the press cylinders are distinguished by being shown somewhat larger than the subsidiary pipe lines which merely carry fluid pressure for operating supplemental or auxiliary valves of the control system.

The press 15 herein illustrated (Figs. 1 and 2) is of a well-known type, comprising cooperating relatively movable heads or platens 16 and 17 by and between which the metal billet, ingot, or

work W is acted on. As shown, the lower head or press bed 16 is fixed, and the upper head or platen 17 moves vertically up and down relative thereto. Cylinder and piston means 20 21 are shown for imparting the downward working movement to the head 17; and for imparting the upward return movement to said head 17, there are cylinder and piston means 22, 23, here shown in duplicate. The piston means 21, 23 are illustrated as simple rams or plungers of uniform diameter. For the downward working movement of the head 17, pressure fluid is admitted to the cylinder 20, and may be concurrently vented from the cylinders 22; while the upward return movement of the head 17 is effected by pressure fluid admitted to the cylinders 22 during outflow of fluid from the cylinder 20.

High pressure working fluid for operating the press 15 may be supplied from any suitable source (such as one or more hydraulic pumps 25) through a main supply pipe line 26 in which a hydraulic equalizer 27 is shown interposed, comprising a closed chamber having its bottom connected into the pipe line 26, and containing a body of air or other elastic cushioning fluid above the water or other (inelastic) working fluid. A spring-actuated hydraulic shock absorber 28 may also be interposed in the pipe line 26, preferably in advance of most of the connections thereto. The connections to the pipe line 26 include a branch 30 (in which may be interposed an adjustable control throttle valve 31), for supplying high pressure fluid through the main operating valve means 32 (and a pipe line 33) to the main working cylinder 20 and its piston means 21, and also (through a pipe line 34) to the return cylinders 22 and their piston means 23; another branch 35 for also supplying high pressure fluid to the return cylinders and piston means 22, 23 (through connections hereinafter described, including an admission and vent pipe 36); a branch 37 for supplying high pressure fluid, through the selector valve means 38 and other connections hereinafter described, to certain supplemental and auxiliary control valves 40, 41, 42 of the system; and a (continuation) branch 43 for supplying high pressure fluid to one of said auxiliary control valves. As shown, the shock absorber 28 is connected in the pipe line 26 in advance of all of these branches, excepting the branch 37 to the selector valve means 38.

Besides the supply of high pressure working fluid through the pipe line 26, provision is also made for a supply of low pressure fluid, for rapid (unresisted) movement of the head or platen 17. As shown, this supply of low pressure fluid is not taken from an independent source, but is derived from the supply of high pressure fluid, through the action of the press on one of its movements. For this purpose, there is shown in Fig. 1 a pressure reservoir or tank 44 arranged for connection to the cylinder 20 through a pipe line 45, which may be connected to the high pressure fluid pipe line 33 from the main operating valve means 32 to said cylinder. In this pipe line 45 is interposed the supplemental control valve 40 already referred to, and also a shut-off valve 47. The reservoir 44 normally contains a suitable amount of water or other working liquid, as well as a body of air or other elastic cushion fluid above the water. Liquid may be introduced into the reservoir 44 (or withdrawn, if required) through a valved outlet pipe 48 from its bottom, and compressed air to any desired pressure may be introduced through a valved pipe connection 49 to the upper portion of said reservoir. The reservoir 44 is preferably equipped with a liquid overflow pipe 50 having therein an overflow check-valve 51. As shown, the reservoir 44 is also provided with a gauge glass 52, an excess air pressure relief valve 53, connected to the pipe 49, and a pressure gauge 54.

During periods when high pressure fluid is employed in the cylinder 20, the valve 40 remains closed and prevents entrance of such high pressure into the reservoir 44; but under conditions of press operation when the high pressure fluid is shut-off and low pressure working fluid is to be used in the cylinder 20 (for rapid unresisted movement of the head 17) the valve 40 is open during both the return and working movements of the head 17. When the valve 40 is thus open, upward return movement of the plunger 21 into the cylinder 20 (due to the action of the plungers 23, 23) forces working liquid through the pipe lines 45, 33 into the reservoir 44, thus increasing the air pressure in said reservoir; while during the downward movement of the press head 17, when working fluid is being vented from the return cylinders 22, 22, the accumulated pressure of the air in the reservoir 44 forces liquid back through the pipes 33, 45 into the cylinder 20 to produce (or permit) downward movement of the head 17.

As shown, the valve 40 is fluid-operated, having its stem connected to the rod 55 of a piston 56 in a cylinder whose upper end is connected to a branch 57 from the pressure supply and exhaust pipe 36 of the cylinders 22, and whose lower end has a double pipe connection 60 to the auxiliary (three way) valve 41 already mentioned, into the cavity between its double valve seats. One branch of the double connection 60 has a check-valve 61 which only permits outflow from beneath the piston 56, while the other branch is shown provided with a shut-off and regulating valve 62. Thus the outflow of fluid from beneath the piston 56 is freer than the inflow. The normally-closed valve 40 responds to the pressure admitted beneath the piston 56 by the auxiliary valve 41, as well as to the pressure conditions (of admission or exhaust) in the cylinders 22; but as the area of the lower side of the piston 56 exceeds that at its upper side by the sectional area of its rod 55, the valve 40 tends to open when these pressures are equalized. Being as shown, an unbalanced (disc) valve, the valve 40 behaves as a check-valve whenever the pressures affecting the piston 56 permit: i. e., it tends to close with (and prevent) outflow from the cylinder 20.

The auxiliary valve 41 and its operation will be further explained hereinafter.

The main operating valve means 32 controls the admission or supply of high pressure fluid to the main working cylinder and piston means 20, 21, and the venting or exhaust of the spent fluid therefrom, both through the pipe line 33. Besides this, the valve means 32 also controls the supplying and venting of high pressure working fluid to and from the return cylinder and piston means 22, 23 (under certain operating conditions), as well as the operation of the supplemental valve 40. For this latter purpose, a valve device 65 separate from the valve means 32 for the cylinder 20 is shown. As here shown, multiple valve devices 66, 67 are provided for supplying and venting working fluid to and from the cylinder 20 through the pipe line 33: i. e., the valve device 66 for admitting and exhaust-

ing fluid slowly, for relatively slow movement of the press 15, and the valve device 67 for admitting and exhausting fluid freely and rapidly, for more rapid movement of the press. These valve devices 65, 66, and 67 may comprise separate fluid admission and exhaust valves of inverse flow plunger and disc type. The valves 65*a*, 65*e*, 66*a*, 66*e*, 67*a*, 67*e* may be normally held to their seats, as shown in Fig. 1, by any suitable means acting on the valve plungers, here indicated by a helical compression spring 68 acting on the upper end of the plunger of the valve 65*e*, and by cylinders into which the upper end of the other plungers extend, and to which high pressure fluid is constantly supplied through connections from a pipe line 69 that is itself connected into the pipe line 30.

High pressure fluid may be supplied to all three of the admission valves 65*a*, 66*a*, 67*a* through a duct 70 forming a continuation of the supply branch 30 and delivering into the cavities around the (reduced) valve stems below the valve seats. The cavities above the seats of the exhaust valves 65*e*, 66*e* are shown connected to a common vent or exhaust duct 71, and the cavity above the seat of the exhaust valve 67*e* is connected to a larger exhaust duct 72. Ducts 73 connect the cavities above the seats of the admission valves 65*a*, 66*a*, and 67*a* with the cavities below the seats of the exhaust valves 65*e*, 66*e*, and 67*e*, respectively. The cavity above the seat of the admission valve 66*a* and the cavity below the seat of the exhaust valve 67*e* are connected to the admission and exhaust line 33 of the cylinder 20. The cavity above the seat of the admission valve 65*a* is connected to the pipe line 34 which under certain conditions serves the cylinders 22, at will presently be explained.

Cam means for operating the valve devices 65, 66, 67 in proper sequence are diagrammatically represented in Figs. 1 and 2 by three-armed rockers 77 whose lower arms are interconnected by a link rod 78. The upper arms of the rockers 77 are shown provided with anti-friction rollers for engaging (adjustable) shoes on the lower ends of the plungers of the valves 65*a*, 65*e*, 66*a*, 66*e*, 67*a*, 67*e*. The clearances between the valve-plunger shoes and the rocker rollers correspond to the sequence in the operation of the several valves that is described hereinafter. For operating the rockers 77, there is shown a lever or crank arm 79 fast on the pivot shaft of the rocker 77 of the valve device 67.

For manually operating the whole main valve means 32 and controlling both cogging and forging operation of the press 15, there is shown a swingable hand lever 80 mounted for rocking movement on a fixed support 81, and preferably associated with a locking segment 82 notched to lock the lever 80 in a vertical neutral position N (shown in full lines), or in positions *d*, D, and *u*, U, to either side, which are indicated in dot-and-dash lines. In the present instance, the hand lever 80 does not operate the lever arm 79 above described directly, but through a servomotor 84 whose piston rod is (pivotally) connected at 85 to said lever arm 79. For this purpose, a crank arm 86 fast on the shaft of the hand lever 80 is connected by a link rod 87 to one end of a lever 88 which is pivoted at 89, intermediate its ends, to the stem of the controlling piston valve 90 for the servo-motor 84. The lever 88 is without a fixed fulcrum, having its other end pivoted to the lever arm 79, and (as shown) on the same pivotal axis 85 by which the piston rod is pivoted to said lever arm 79. Thus the floating lever 88 serves as a follow-up to return the valve 90 to mid-position and stop the servo-motor 84 as soon as the latter has made a movement proportionate to the actual movement of the hand lever 80.

As here shown, the servo-motor 84 is of the hydraulic type, and is supplied with operating fluid under pressure (preferably oil), between the pistons of its valve 90, through a pipe line 91 (to which a pressure gauge is shown connected) from a pump 92 drawing from a reservoir tank 93 and driven by an (electric) motor 94. The spent liquid exhausted from the opposite ends of the piston valve returns through a (branched) pipe line 95 to the reservoir 93.

The pipe lines 34 and 35 hereinbefore mentioned serve the cylinders 22 alternatively, according to the conditions of operation: the pipe line 35 for cogging operation of the press, and the pipe line 34 for forging. The use of one connection or the other is determined by the auxiliary (three-way) valve 42 already mentioned, and accordingly the pipe lines 34, 35 are connected to the cavities of this valve 42 at opposite sides of its double valve seats, while the (branching) pipe line 36 to the cylinders 22 is connected to the cavity of said valve 42 between the seats. A pressure relief valve 97 is also preferably connected to the pipe line 36.

The auxiliary three-way valves 41 and 42 are so interrelated in operation that they can best be described and explained together. Each of these valves 41, 42 has a middle cavity with double valve seats, and a valve body member seating on the two seats alternatively. Each valve 41, 42 is continually urged to seat on one (the lower) seat by a constantly acting force: in the case of the valve 41, high pressure fluid supplied through the pipe 43 to a cylinder into which the upper end of the valve plunger extends; and in the case of the valve 42, a helical compression spring 98 acting between the upper end of the valve plunger and a fixed abutment carried by the valve casing. The valve-body of each valve 41, 42 is moved the other way (upward) by fluid pressure in a cylinder acting on the (enlarged) lower end of the valve plunger, pressure being admitted to the cylinders through pipes 100, 101 under control of the selector valve means 38. The connections 34, 35, 36 to valve 42 have already been described. Besides the connection 60 to the cavity between its seats and the selector pipe connection 100 to its aforementioned (lower) operating cylinder, the valve 41 has a branch pipe connection 102 from the pipe 34 (which is connected as already mentioned, to the cavity of the valve 42 above its upper seat), and a branch pipe connection 103 from the pipe 100 to the cavity of said valve 41 above its own upper seat, with a check-valve 104 therein that only permits return flow from the valve 41 through the pipe 100.

It will be seen therefore, that when the selector 38 admits fluid pressure to the pipe 101 and vents the pipe 100, the valve body of valve 42 is raised and held to its upper seat, as shown in Fig. 1, admitting constant fluid pressure from the pipe line 35 to the cylinders 22, and preventing access of fluid pressure beneath the lower seat of the valve 41; while the valve body of valve 41 is depressed and held to its lower seat, as in Fig. 1, permitting outflow of fluid from beneath piston 56 of valve 40, so that this valve may close under

pressure coming from pipe line 33. When, on the other hand, the selector valve means 38 admits fluid pressure to the pipe 100 and vents it from the pipe 101, the valve 42 is depressed and held down as in Fig. 2, connecting the pipe line 34 controlled by the valve device 65 to the cylinders 22; while the valve 41 is raised and held up as in Fig. 2, shutting off pipe 100 from pipes 60 and connecting the latter to the said pipe line 34. So long as the selector valve means 38 remains in this Fig. 2 position, therefore, the pressure beneath piston 56 is determined by the valve device 65, as well as that (through pipe 57) above this piston.

The selector valve means 38 comprises valve devices 105, 106 generally similar to the valve devices 65, 66 of the operating valve means 32, though the relative positions of the admission and exhaust valves 105*a*, 105*e*, and 106*a*, 106*e* are interchanged as compared with those of the valve devices 65, 66, and their pressure supply and exhaust connections 37 and 107 are correspondingly changed. The valves 105*a*, 105*e*, 106*a*, 106*e* may all be normally held to their seats by any suitable means acting on the valve plungers, here indicated by helical compression springs. For operating the valve devices 105, 106, there are two three-arm rockers 108, 108 whose lower arms are interconnected by a link-rod 109 which is also connected to a swinging actuating hand-lever 110 fulcrumed on any suitable support 111. The upper arms of the rockers 108, 108 are shown provided with anti-friction rollers for engaging the lower ends of the valve-plungers 105*a*, 105*e*, and 106*a*, 106*e*. By throwing the lever 110 to one extreme position C as in Fig. 1, the system is set for cogging; by throwing it to the other extreme F, as in Fig. 2, it is set for forging.

It will be understood, of course, that the application of fluid through the pipe connections 100, 101 under control of the valve devices 105, 106 is only an illustrative mode of operative connection from the selector lever 110 for actuating the auxiliary valves 41, 42.

To prepare the press for operation, water at relatively low pressure is supplied to the slack water tank or reservoir 44 through the valved pipe 48, and compressed air to a suitable pressure is supplied to said reservoir through the valved pipe 49. The gate valve 47 being open, sufficient water is forced through the pipe lines 48, 45 (and 33) to fill the cylinder 20 and the pipe line 33. Throttle valve 31 being now opened, liquid under high pressure is supplied through the pipe lines 26 and 30.

For cogging, the selector lever 110 is set in the position shown in Fig. 1. In this condition, the valve body of the auxiliary valve 42 is in its upper position, and pressure is constantly supplied through the pipes 35, 36 to the return cylinders 22, constantly tending to raise the head or platen 17, pipe 36 and cylinders 22 being at this time shut-off from pipe line 34. Hence any operation of valve device 65 to admit pressure fluid to pipe 34 or to vent the latter is migratory and without effect on the press during cogging: i. e., cogging is controlled solely by the valve devices 66, 67. As the valve body of the valve 41 is depressed and held down by the constant pressure supplied through the pipe 43, fluid is constantly vented from the lower side of piston 56 (through pipe lines 60 and 100) and is constantly supplied above it (through pipe lines 35, 36, and 57), so that valve 40 is held closed under all conditions of cogging operation.

So long as lever 80 remains in its neutral or mid-position N as shown in Fig. 1, liquid is sealed in the cylinder 20 by the closed valve means 32, so that the pressure in the cylinders 22 cannot lift the press head 17, and the press remains idle or locked in the position shown.

To raise the press head 17, the lever 80 is moved to the right from its neutral position N in Fig. 1 to the position *u* in Fig. 3, thus lifting the small exhaust valve 66*e* and allowing fluid from the cylinder 20 to exhaust slowly (through pipe line 33). This allows the high pressure fluid constantly supplied to the cylinders 22 (through pipe line 35, valve 42, and pipe 36) to slowly lift the movable press head 17 away from the fixed press head 16. When the lever 80 is moved further to the right, to the position U in Fig. 4, the exhaust valve 66*e* remains open and the larger exhaust valve 67*e* is also opened, allowing rapid exhaust of fluid from the cylinders 20, (since the exhaust passage afforded by the valve 67*e* is equal to the full capacity of the pipe line 33), and rapid upward movement of the press head 17.

This upward movement of the press head 17 may be slowed down whenever desired by returning the lever 80 toward the left, to the position *u*, and may be stopped by returning the lever 80 to its neutral position N, thus closing all the valves of the main valve means 32, and restoring the system to its general condition in Fig. 1, with the press head 17 locked in the position to which it has been moved.

To lower or force down the press head 17, the lever 80 is moved to the left from its neutral position N in Fig. 1 to the position *d* in Fig. 5, thus lifting the small pressure admission valve 66*a* off its seat and admitting high pressure fluid in small quantities to the cylinder 20 (through the pipe line 33). The area of the piston 21 being greater than the total aggregate area of the pistons 23, the press head 17 is moved slowly downward toward the fixed head 16 against the pressure constantly supplied to the cylinders 22 (through the pipe line 26, valve 42, and pipe line 36). When the lever 80 is moved further to the left, to the position D in Fig. 6, the small admission valve 66*a* remains open and the larger pressure admission valve 67*a* is lifted off its seat, thus admitting high pressure fluid in larger quantities to the cylinder 20 and causing the press head 17 to move downward more rapidly and forcibly.

This downward movement of the press head 17 may be slowed down by returning the lever 80 to the right from position D to position *d*, and may be stopped by returning it to its neutral position N, thus restoring the system to its condition in Fig. 1 and locking the press head 17 in the position to which it has been moved. To raise the press head 17 again, it is only necessary to move the lever 80 to the right beyond the neutral position N, as already explained.

For "forging," the selector lever 110 is moved to the left, from the position C shown in Fig. 1 to the position F shown in Fig. 2. This permits fluid to exhaust through the pipe line 101, so that the valve body of valve 42 is forced downward by the spring 98 to its lower seat, as shown in Fig. 2, shutting off the constantly open pipe line 35 from the pipe line 36 and placing the latter in communication with the pipe line 34, which is controlled by the valve device 65. With this setting of the selector valve means 38, also, fluid is supplied through the pipe line 100 to lift and hold the valve body of valve 41 to its upper seat, as shown in Fig. 2, so that the pipe line 60 and

the lower side of the piston **56** are in communication with the pipe line **34**. Accordingly, the valve device **65** is effective to control the operation of the press in forging, as hereinafter explained.

So long as the main valve means **32** remains closed, as shown in Fig. 2, no fluid is supplied to the lower side of the piston **56** of valve **40**, or to either of the cylinders **20** or **22**, so that the press head **17** remains locked in position as shown in Fig. 2.

When the lever **80** is moved a short distance to the right, from its neutral position N in Fig. 2 toward its position *u*, as shown in Fig. 7, the small exhaust valve **66***e* is lifted from its seat, releasing the pressure in the cylinder **20** (through pipe line **33**). This, however, does not result in admitting pressure fluid (through the pipe lines **34** and **36**) to the cylinders **22**, and so the press head **17** still remains stationary. But when the lever **80** is moved further to the right, to the position *u* in Fig. 8, the small admission valve **65***a* is opened to supply high pressure fluid (through pipe line **34**, valve **42**, and pipe line **36**) to cylinders **22**, and pressure is also admitted (through pipe **102**, valve **41**, and pipe **60**) beneath piston **56** of valve **40**. Since the area at the lower side of this piston **56** is greater than that at its upper side (by the diameter of its stem-rod **55**), said piston **56** rises and opens the supplemental valve **40**, which allows the pressure in the cylinders **22** to lift the press head **17** slowly and expel liquid from cylinder **20** (through the pipe lines **33** and **45**) into the reservoir **44**, increasing the air pressure in said reservoir. This rising movement of the press head **17** is sufficiently rapid for forging purposes, so that it is never necessary to move the lever **80** still further to the right, to the position U of Fig. 1. While the small exhaust valve **66***e* remains open at this time and vents fluid from the pipe line **33**, this small loss of fluid does not materially affect the flow through the much larger valve **40** into the reservoir **44**.

Returning the lever **80** to the left from the position *u* in Fig. 8 to its neutral position N in Fig. 2 will close the valves **66***e* and **65***a*, restoring the system to its condition in Fig. 2, and locking the press head **17** in the position to which it has been moved.

Moving the lever **80** to the left from its neutral position N in Fig. 2 toward the position *d* as shown in Fig. 9 opens the small exhaust valve **65***e*, thus venting the cylinders **22** through the pipe lines **34** and **36**, and also equalizing the pressure above and below the piston **56** of valve **40**. The supplemental valve **40** therefore rises and opens (as a check valve) owing to the venting of the cylinders **22** and the suction created by the plunger **21**, due to the weight of this plunger and the associated parts, or under pressure existing in the reservoir **44**. The pressure previously stored in the reservoir **44** is thus admitted (through the pipes **45** and **33**) to the piston **21** in the cylinder **20**, so as to force the press head **17** downward. When the press head **17** engages the work W on the stationary head **16**, the resistance thus encountered stops the movement of the press head **17** and the flow of fluid upward past the valve **40**, which may then close by its own weight, cutting off the cylinder **20** from the reservoir **44**, as shown in Fig. 10. Movement of the lever **80** further to the left, to the position *d* in Fig. 10, lifts the small pressure admission valve **66***a* off its seat and admits high pressure fluid slowly (through the pipe line **33**) to the cylinder **20**, thus exerting a force upon the work W which ordinarily suffices to compress and flatten it, or otherwise change its shape as desired. As soon as the valve **66***a* is thus opened, the presure thereby created in the pipe **45** causes the valve **40** to close, if it has not done so already. Movement of the lever **80** yet further to the left, to the position D in Fig. 11, lifts the larger pressure admission valve **67***a* off its seat (in addition to the admission valve **66***a*), permitting full flow of high pressure fluid into the cylinder **20** to exert maximum force on the press head **17** and on the work W.

If not previously closed as above mentioned, the valve **40** closes (as a check-valve) when the opening of valve **66***a* creates pressure in the pipe **45** and a tendency toward back flow into the reservoir **44**, or, at any rate, when the opening of the larger valve **67***a* tends to create a more powerful backflow in said pipe **45**. In this latter case, the gentle backflow through pipe **45** after valve **66***a* opens results in an accumulation of pressure in reservoir **44** before valve **67***a* opens and creates a sufficiently vigorous backflow to close valve **40**. Which of these actions occurs may depend on the design of the valve **40** and its piston **56**, as well as on the exact operating conditions and pressures, including the adjustment of various valves **47**, **62**, etc.

Returning the lever **80** from the position D to the position *d* slows the downward movement of the press head **17**, or if the resistance of the work W is great enough, even arrests such downward movement. Returning the lever **80** to the neutral position N restores the system to its position in Fig. 2, with the press head **17** arrested and locked in the position to which it has been moved. To raise the press head **17** from the work W, it is only necessary to move the lever **80** to the right to its position *u*, Fig. 8, as already explained.

Having thus described our invention, we claim:

1. In a press of the character described, the combination with a moving press head or platten and piston means for imparting to said head its working and return movements, and means for supplying working fluid under pressure for moving said head; of operating valve means for controlling the supply and venting of working fluid at a relatively low rate to and from said piston means for movement of said head in opposite directions, operating valve means for controlling the admission and venting of working fluid at a relatively high rate to and from said piston means for movement of said head in opposite directions, and other operating valve means for controlling the venting and admission of working fluid to and from said piston means in reverse correspondence with the admission and venting of working fluid by the aforesaid operating valve means; alternative means for admitting fluid to said piston means to urge said head in the direction of the movement produced by admission of fluid by the last-mentioned operating valve means; and means for either connecting said alternative means to said piston means and shutting off connection of said other operating valve means thereto, or vice-versa.

2. In a press of the character described having divers modes of operation, the combination with a moving press head or platten and piston means for imparting to said head its working and return movements, and means for supplying working fluid of different pressures for moving said head; of operating valve means controlling the

supply and venting of fluid to and from the piston means for one of said movements of said head during divers modes of operation, but controlling the supply and venting of fluid to and from the piston means for the opposite movement of said head during only one mode of operation; selective means for determining the mode of operation of the press; and supplemental valve means controlling the connection of one of said fluid supplies to the piston means for one of said movements, and itself controlled by said selective means.

3. In a press of the character described, the combination with a moving press head or platten and piston means for imparting to said head its working and return movements, and means for supplying working fluid of different pressures for moving said head; of operating valve means for controlling the supply and venting of higher pressure fluid to and from the piston means for producing the movements of said head; fluid-operated supplemental valve means controlling the action of lower pressure fluid on said piston means, and itself controlled by said operating valve means; alternative means for supplying working fluid to the cylinder and piston means for moving said head, with auxiliary valve means controlling said alternative supply means; and selective means controlling said auxiliary valve means and the action of fluid on said supplemental valve means.

4. In a press of the character described having divers modes of operation, the combination with a moving press head or platten and piston means for imparting to said head its working and return movements, and means for supplying working fluid of different pressures for moving said head; of operating valve means controlling the supply and venting or fluid to and from the piston means for one of said movements of said head during divers modes of operation, but controlling the supply and venting of fluid to and from the piston means for the opposite movement of said head during only one mode of operation; selective means for determining the mode of operation of the press; alternative means for supplying high pressure fluid to the piston means for the last-mentioned movement of said head during another mode of operation, with valve means controlling said alternative supply means and itself controlled by said selective means; and supplemental valve means controlling the connection of the lower pressure fluid supply to the other piston means, and itself controlled by said selective means and by pressure acting on said piston means under control of said operating valve means.

5. In a press of the character described having divers modes of operation, the combination with a moving press head or platten and piston means for imparting to said head its working and return movements, and means for supplying working fluid of different pressures for moving said head; of operating valve means controlling the supply and venting of fluid to and from the piston means for one of said movements of said head during divers modes of operation, but controlling the supply and venting of fluid to and from the piston means for the opposite movement of said head during only one mode of operation; selective means for determining the mode of operation of the press and the control or non-control of the fluid supply for the last-mentioned movement of said head by said operating valve means; and supplemental valve means controlling the connection of one of said fluid supplies to the piston means for one of said movements when the fluid supply to said latter piston means is controlled by said operating valve means.

6. In a press of the character described having divers modes of operation, the combination with a moving press head or platten and piston means for imparting to said head its working and return movements, and means for supplying working fluid of different pressures for moving said head; of operating valve means controlling the supply and venting of fluid to and from the piston means for one of said movements of said head during divers modes of operation, but controlling the supply and venting of fluid to and from the piston means for the opposite movement of said head during only one mode of operation; selective means for determining the mode of operation of the press and the control or non-control of the fluid supply for the last-mentioned movement of said head by said operating valve means; and supplemental valve means controlling the connection of one of said fluid supplies to the piston means for one of said movements, and itself controlled by said selective means and by the pressure producing the other of said movements under control of said operating valve means.

7. In a press of the character described, the combination with a moving press head or platten and piston means for imparting to said head its working and return movements, and means for supplying working fluid under relatively high pressure for moving said head; of operating valve means for admitting fluid to the piston means for the movement of said head one way, and venting it therefrom during the reverse movement of said head; operating valve means for admitting fluid to the piston means for said reverse movement of said head, and venting it therefrom during the first-mentioned movement; alternative means for admitting fluid to the piston means to urge said head in the direction of said reverse movement; a liquid and gas pressure reservoir with connection for receiving and accumulating fluid from the above-mentioned supply at relatively low pressure; supplemental valve means controlling admission of the accumulated low pressure fluid to the piston means for the first-mentioned movement of the head, and responsive to fluid pressure controlled by said last-mentioned valve means; and selective means for determining whether fluid is admitted to the piston means by said alternative means, or admitted and vented by the last-mentioned operating valve means, and also coacting with said last-mentioned operating valve means to control said supplemental valve means.

8. In a press of the character described, the combination with a moving press head or platten and piston means for imparting to said head its working and return movements, and means for supplying working fluid under pressure for moving said head; of operating valve means for controlling the supply and venting of working fluid at a relative low rate to and from said piston means for movement of said head in opposite directions, operating valve means for controlling the admission and venting of working fluid at a relatively high rate to and from said piston means for movement of said head in opposite directions, and operating valve means for admitting fluid to the piston means for movement of the head and venting it therefrom in reverse correspondence with the admission and venting of working fluid

by the aforementioned operating valve means; alternative means for admitting fluid to said piston means to urge said head in the direction of the movement produced by admission of fluid by the last-mentioned operating valve means; a common operator shiftable to and fro for actuating the aforesaid operating valve means, with actuating connections therefrom for opening the second operating valve means for admission after opening of the first and third operating valve means for admission and venting respectively, when said operator is shifted further and further toward one extreme of its movement, and for opening the second operating valve means for venting after opening of the first and third operating valve means for venting and admission, respectively, when said operator is shifted further and further toward the other extreme of its movement; and means for either connecting said alternative means to said piston means and shutting off connection of said third operating valve means thereto, or vice-versa.

9. In a press of the character described, the combination with a moving press head or platten and piston means for imparting to said head its working and return movements, and means for supplying working fluid under relatively high pressure for moving said head; of operating valve means for controlling the supply and venting of working fluid at a relative low rate to and from said piston means for the working and return movements of said head, operating valve means for controlling the admission and venting of working fluid at a relatively high rate to and from said piston means for the working and return movements of said head, and other operating valve means for admitting fluid to the piston means for the return movement of said head, and venting it therefrom during the working movement; alternative means for constantly admitting fluid to the piston means to urge said head continually in the direction of return movement; means for receiving and accumulating, at relatively low pressure, fluid discharged from the piston means during the return movement of the head; supplemental valve means for controlling this accumulation, and for admitting the accumulated low pressure fluid to the piston means for working movement of the head; a common operator shiftable to and fro for actuating said operating valve means, with actuating connections therefrom for successively opening the first and second operating valve means for admission when said operator is shifted further and further toward one extreme of its movement, and for successively opening the first and second operating valve means for venting when said operator is shifted further and further toward the other extreme of its movement; and selective means for determining whether fluid is constantly admitted to the piston means by said alternative means, or admitted and vented by the last-mentioned operating valve means, and also coacting with said last-mentioned operating valve means to control said supplemental valve means.

10. In a press of the character described, the combination with a moving press head or platten and piston means for imparting to said head its working and return movements, and means for supplying working fluid under relatively high pressure for moving said head; of operating valve means for admitting fluid to the piston means for the working movement of said head, and venting it therefrom during the return movement; operating valve means for admitting fluid to the piston means for the return movement of said head, and venting it therefrom during the working movement; alternative means for constantly admitting fluid to the piston means to urge said head continually in the direction of return movement; means for receiving and accumulating, at relatively low pressure, fluid discharged from the piston means during the return movement of the head; supplemental valve means for controlling this accumulation, and for admitting the accumulated low pressure fluid to the piston means for working movement of the head; and selective means for determining whether fluid is constantly admitted to the piston means by said alternative means, or admitted and vented by the last-mentioned operating valve means, and also coacting with said last-mentioned operating valve means to control said supplemental valve means.

11. In a press of the character described, the combination with a moving press head or platten and piston means for imparting to said head its working and return movements, and means for supplying working fluid under relatively high pressure for moving said head; of operating valve means for admitting fluid to the piston means for the movement of said head one way, and venting it therefrom during the reverse movement of said head; operating valve means for admitting fluid to the piston means for said reverse movement of said head, and venting it therefrom during the first-mentioned movement; alternative means for admitting fluid to the piston means to urge said head in the direction of said reverse movement; a liquid and gas pressure reservoir with connection for receiving and accumulating, at relatively low pressure, fluid discharged from the piston means during said reverse movement of the head, and for the return of accumulated fluid to the piston means for the first-mentioned movement of the head, with supplemental valve means for controlling this connection; and selective means for determining whether fluid is admitted to the piston means by said alternative means, or admitted and vented by the last-mentioned operating valve means, and also coacting with said last-mentioned operating valve means to control said supplemental valve means.

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