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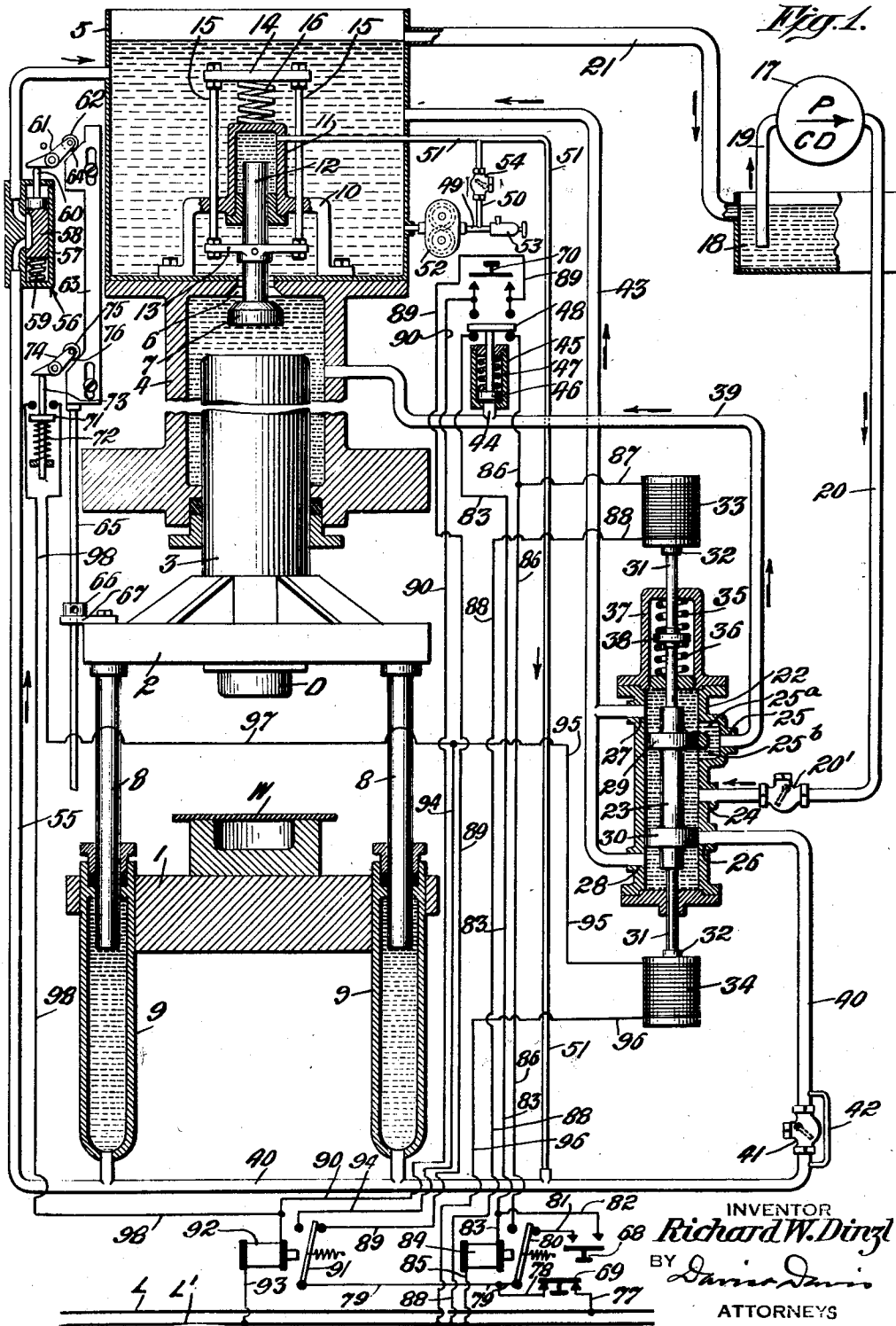
R. W. DINZL

2,210,284

CONTROL SYSTEM FOR HYDRAULIC PRESSES

Filed Dec. 14, 1937

3 Sheets-Sheet 1



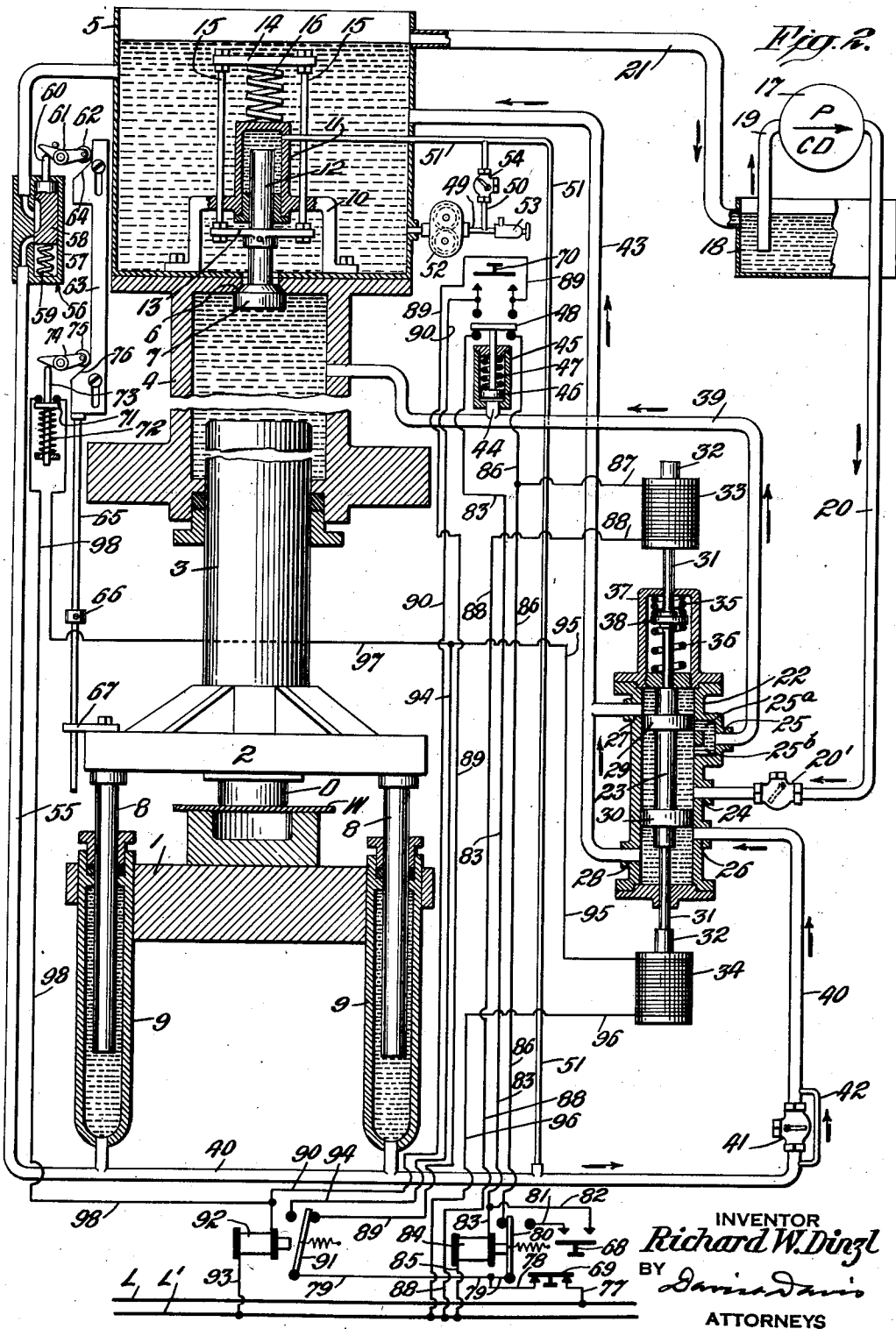
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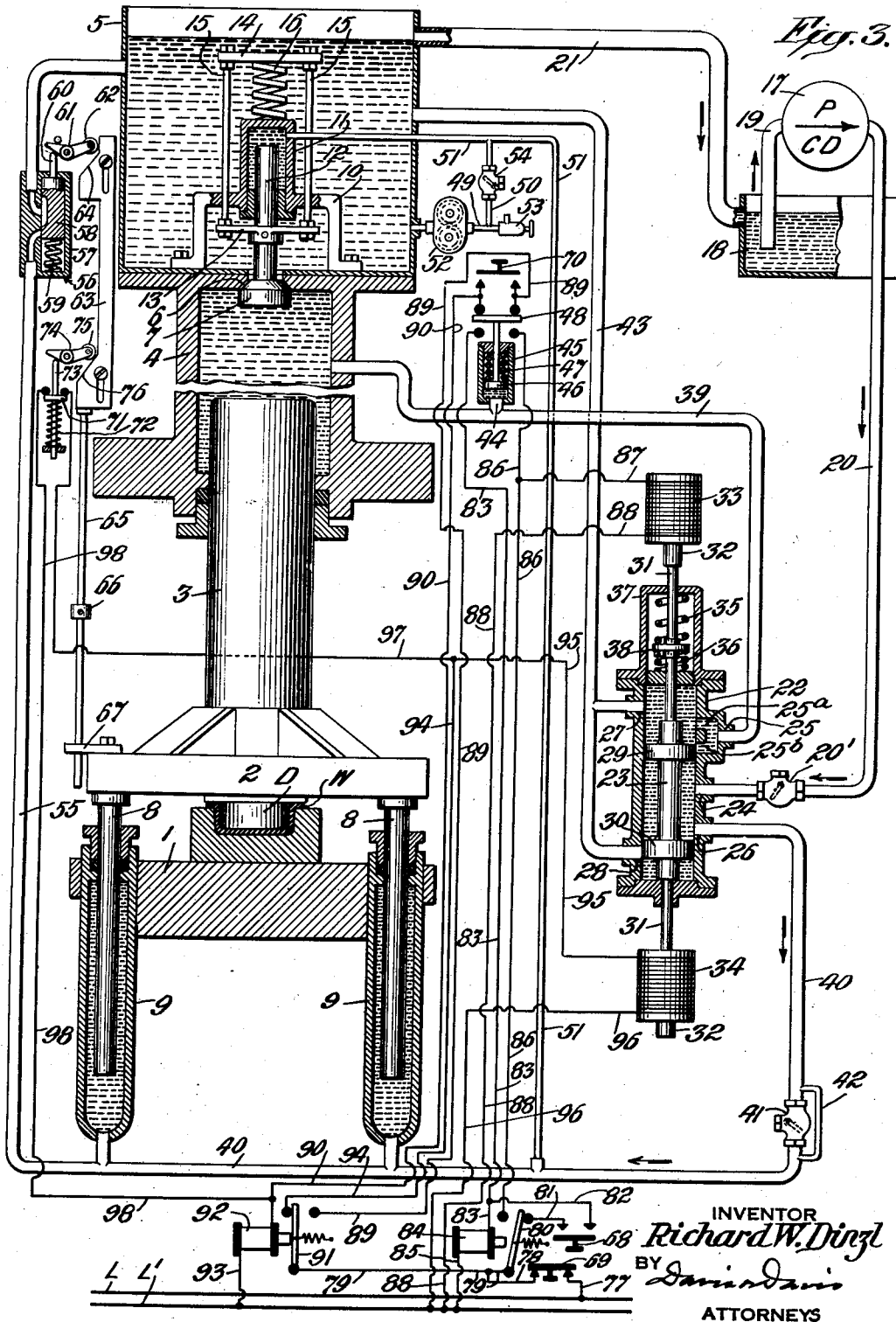
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UNITED STATES PATENT OFFICE

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CONTROL SYSTEM FOR HYDRAULIC PRESSES

Richard W. Dinzi, Westfield, N. J., assignor to
The Watson-Stillman Co., Roselle, N. J., a corporation of New Jersey

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8 Claims. (Cl. 60—52)

This invention relates more particularly to improvements in press apparatus of the type wherein a reciprocable press head is advanced on a working stroke by a hydraulically operated mechanism and, after completion of the pressing operation, the press head is retracted automatically by another hydraulically operated mechanism. Usually, in such an apparatus, a complicated and costly pump of a variable delivery, or variable stroke, type has been required to supply the said advancing and retracting mechanisms with hydraulic pressure. An important object of the present invention is to provide, for such a press, a control system designed for satisfactory employment of simple and inexpensive constant delivery pump apparatus. Other objects of the invention will appear hereinafter.

In the drawings, Fig. 1 is a diagrammatic sectional view of the press apparatus, with the reciprocable press head in retracted position and the control valve in neutral position;

Fig. 2 is a view similar to Fig. 1, with the control valve in a position to cause advance of the reciprocable press head and the latter advanced sufficiently to commence the pressing operation; and

Fig. 3 is a view similar to Figs. 1 and 2, with the reciprocable press head advanced sufficiently to complete the pressing operation and the control valve in a position to cause retraction of said press head.

My improved control system is shown in connection with a press having a fixed lower press head 1 and a reciprocable upper press head 2. The head 2 has an upwardly extending ram 3 reciprocable in a fixed vertical, hydraulic cylinder 4. A surge tank 5 is mounted upon the upper end of said cylinder and communicates with the cylinder through a port 6. A surge valve 7 is provided to open and close said port. Hydraulic push-back mechanism is provided to retract, or elevate, the press head 2. This mechanism includes depending rams or plungers 8 borne by the head 2 and reciprocable in fixed, vertical, hydraulic cylinders 9.

The surge valve 7 seats upwardly to close the port 6. It is constantly spring-urged to closed position and has hydraulically operated means to shift it to open position. A bracket 10 is mounted within the surge tank and bears a fixed, vertical, hydraulic cylinder 11. The valve has a vertical stem 12 forming a ram or plunger whose upper end portion is reciprocable within the cylinder 11. The valve stem bears a frame 13 or yoke which comprises a horizontal cross bar

13 affixed to the stem at a point between the valve and the lower end of cylinder 11, another parallel cross bar 14 located above the cylinder 11, and vertical tie-rods 15 rigidly connecting said cross bars. A spring 16 interposed between the closed upper end of cylinder 11 and the upper cross bar 14 constantly urges the frame upwardly to close the valve. As will be explained hereinafter, cylinder 11 is supplied with hydraulic pressure to force the plunger 12 downward to open the valve.

A constant delivery main pump 17 supplies the advancing and retracting mechanisms for the press head 2 with hydraulic pressure to operate them. This pump is shown diagrammatically. It may be of a simple conventional type. It is located directly over an open supply tank 18 and has a receiving connection 19 with the latter. A main delivery pipe 20 leads from the pump outlet to a control valve device which in turn has delivery connections with the press head advancing mechanism, the press head retracting mechanism and the surge tank. These connections will be described hereinafter. There is a check valve 20' in the pipe 20 and opening toward the valve device. There is also a fluid return connection between the surge tank 5 and the pump supply tank 18. This return connection is a constantly open overflow pipe 21 leading from the maximum permissible fluid level of the surge tank to the pump supply tank. The fluid employed in the system is preferably oil.

The control valve device comprises a cylindrical valve casing 22 closed at both ends and containing a reciprocable valve 23. The valve casing 22 has a port 24 located at a mid point in its length, ports 25 and 26 spaced outwardly from opposite sides of port 24, and ports 27 and 28 located near the opposite ends of the casing. The port 25 has branches 25^a and 25^b opening into the valve casing at points slightly spaced along the casing. The valve is of a plunger type and it has spaced heads 29 and 30 fitted within the casing and connected by a reduced portion or neck. Stems 31 extend from opposite ends of the valve, through apertures in the ends of the casing, and each stem bears a solenoid core 32, one shiftable through a solenoid winding 33 and the other through a solenoid winding 34. By energization of these windings in sequence the valve is shifted to cause advance and retraction of the press head 2. When neither solenoid is energized the valve is held in a neutral position by two opposed coiled springs 35 and 36. These are enclosed by a housing 37

mounted upon one end of the valve casing and they encircle one of the valve stems and bear against opposite sides of an abutment disk 38 affixed to the stem.

The main delivery pipe 20 leads from the pump 17 to the valve port 24. A delivery pipe 39 leads from port 25 to the cylinder 4 of the press head advancing mechanism. A pipe 40 leads from port 26 and is connected to the lower ends of the push-back cylinders 9. This pipe 40 has a check valve 41 opening toward the push-back cylinders. Provision is made for restricted back flow past said check valve. There is shown a small bypass pipe 42 around the check valve. The check valve may instead have a small port to permit back flow. A pipe 43 leads from both of the ports 27 and 28 to the surge tank 5. The pipe 39 which leads to the cylinder 4 has a branch 44 opening into a small cylinder 45 in which there is fitted a plunger 46 which is shifted by a predetermined pressure in pipe 39 against the resistance of a compression spring 47. Said plunger has a projecting stem bearing an electric switch member 48 whose purpose will be explained hereinafter.

There is provided an auxiliary hydraulic connection between the surge tank and the push back cylinders 9 to compensate for leakage from the cylinders. This connection is independent of the control valve device. It comprises a pipe 49 leading from the surge tank, a pipe 50 connected to the pipe 49, and a long pipe 51 connected at an intermediate point to pipe 50. One end of pipe 51 is connected to pipe 40 which leads to the push-back cylinders. The opposite end of the pipe 51 is connected to the small cylinder 11 forming part of the mechanism for opening the surge valve. A small constant delivery auxiliary pump 52 is connected into the pipe 49 to cause forced flow from the surge tank and through the said connected piping. Pipe 49 has a relief valve 53 to limit pressure therein and pipe 50 has a check valve 54 opening toward pipe 51. The pump 52 and the piping 49-50-51 are of materially less capacity than the main pump 17 and the piping leading to and from the control valve device.

There is a relief connection between the push-back cylinders 9 and the surge tank to limit the pressure developed in said cylinders by the auxiliary pump 52. Said relief connection comprises a pipe 55 forming an extension of the pipe 40. A valve device 56 is connected into pipe 55 to control flow therethrough. Normally said valve device is closed but it is opened in response to a predetermined extent of retraction of the reciprocable press head 2. The valve device comprises a casing 57 and a slide valve 58 mounted in the casing. A spring 59 within the casing constantly urges the valve to closed position. The valve has a stem 60 projecting from the casing and engageable by a small lever 61 mounted to rock about a fixed axis. The lever has one arm engageable with the valve stem and another arm bearing a roller 62. A slide 63 is mounted to shift vertically and has a cam surface 64 engageable with said roller when the slide is shifted upwardly to rock the lever and depress the valve to open position against the resistance of the spring 59. The slide 63 bears a depending stem 65 upon which a collar 66 is adjustably secured. The collar forms an abutment engageable by a thrust member 67 affixed to the reciprocable press head. The collar is adjusted along the stem 65 to such position that it

will be engaged by the thrust member 67 to shift the slide 63 upwardly and cause the valve 58 to be shifted to open position when the press head 2 has been elevated to a predetermined height.

Electrical circuits and switches are provided to control energization of the solenoids 33 and 34 and thereby, through the control valve device, control the advance and retraction of the reciprocable press head 2. The switches include a push button switch 68 operable to cause advance of the press head, the switch 48 which is operated automatically to cause retraction of the press head at the completion of a pressing operation, a push button switch 69 operable to arrest advance of the press head, and a push button switch 70 operable to cause retraction of the press head before it has completed a working stroke. There is also a switch 71 operable in response to retraction of the press head to a predetermined height to cause shifting of the control valve to neutral position. The switch 71 is constantly urged to circuit-closing position by a spring 72 and has a stem 73 engageable by a small lever 74, similar to the lever 61 for operating the relief valve 58. Said lever 74 is mounted for rocking about a fixed axis and has an arm engageable with the switch stem and an arm bearing a roller 75. The latter is engageable by a cam surface 76 on the slide 63 to rock the lever and open the switch 71 when the slide is shifted upwardly by engagement of the thrust member 67 with collar 66 on the stem of the slide.

When the control valve 23 is in neutral position, as shown in Fig. 1, the main pump 17 is in delivery connection with the surge tank 5 and also in receiving connection with said tank. The pump is constantly driven and draws fluid from the tank 18 and forces it through the pipe 20, into the valve casing 22, through the ports 25^a and 25^b and through the pipe 43 to the surge tank 5. When the fluid exceeds a certain depth in the surge tank it overflows into the pipe 21 and is returned to the pump supply tank 18. This circuit is a very desirable feature of the system. While the press is idle the constantly driven pump maintains a desired depth of fluid in the surge tank regardless of pump leakage or loss of efficiency. It prevents accumulation of fluid in the supply tank due to pump leakage and thus avoids the necessity for draining off excess fluid from said tank.

When the control valve is in neutral position there is also an open delivery connection from the main pump to the pipe 39 leading to the press cylinder 4. This connection, however, is purely an incidental one as the surge valve is open and fluid delivered through the pipe 39 can flow up into the surge tank. Flow from the main pump to the push-back cylinders, through the pipe 40, is blocked by the head 30 of the control valve, and the push-back cylinders are supplied with hydraulic pressure by the auxiliary pump 52 which delivers from the surge tank through the piping 49, 50 and 51. The auxiliary pump is constantly driven and its delivery compensates for leakage from the push-back cylinders and prevents settling of the press head 2. The pressure maintained in the push-back cylinders is also maintained in the small surge valve cylinder 11, through the connection of pipe 51 with said cylinder. This pressure in cylinder 11 holds the surge valve 7 open against the resistance of the spring 16. Should the pressure in the push-back cylinders 9 exceed that required for sustaining the press head 2 and

force the latter upwardly, as shown in Fig. 1, the slide 63 will be shifted upwardly to rock the small lever 61 and depress the valve 58 to open position against resistance of the spring 59. That will permit escape of fluid from the push-back cylinders through the pipe 55 to the surge tank and limit upward movement of the press head.

The press head 2 is caused to start downwardly on a working stroke by pressing the push button switch 68. This momentarily closes an electric circuit including a line wire L, a conductor 77, the push button switch 69, which is normally in closed position, a conductor 78, a conductor 79, a relay armature 80, a conductor 81, a conductor 82, a conductor 83, a relay winding 84, a conductor 85 and a line wire L'. By the current through the relay winding the armature 80 is shifted to close the relay and close a circuit including line wire L, conductors 77, 78 and 79, armature 80, a conductor 86, a conductor 87, the valve-operating solenoid 33, a conductor 88 and the line wire L'. At the same time there is closed a circuit including said conductor 86, switch 48, conductor 83, relay winding 84, conductor 85 and line wire L', to hold the relay closed and thus maintain the circuit through the solenoid 33 after release of the push button 68. Energization of solenoid 33 shifts the control valve 23 upwardly, against the resistance of spring 35, to press head advancing position as shown in Fig. 2.

When the control valve 23 is in the position shown in Fig. 2 the main delivery pipe 20 is connected, through port 25b, to pipe 39 leading to press cylinder 4 which is still in communication with the surge tank, as closing of the surge valve 6 is delayed. The push-back cylinders 9 are now in delivery connection with the surge tank through the pipe 40, the by-pass 42 around the check valve 41, the valve casing 22 and the pipe 43. Consequent relief of pressure in the push-back cylinders permits the press head 2 to settle by gravity. The pressure upon the fluid in the push-back cylinders as the plungers 8 move downward is transmitted through the pipe 51 to the small surge valve cylinder 11 and serves to hold the surge valve open. When, however, descent of the press head is arrested by contact of a die D, borne by said head, with the work W, the pressure of the plungers 8 upon the fluid in the push-back cylinders and the pipe 51 and the small cylinder 11 ceases and the spring 16 closes the surge valve. The latter is held closed by main pump pressure received in the press cylinder through pipes 20 and 39 and the press head 2 is positively forced downwardly by said pressure, to perform the pressing operation.

Upon completion of the pressing operation increased pressure in the press cylinder 4 and in pipe 39 overcomes the resistance of spring 47 and shifts the small plunger 46 and the switch 48 to break the electrical connection between conductors 83 and 86. Since the relay 80-84 is dependent upon said connection, when the connection is broken the relay opens and thereby opens the circuit including the solenoid 33. The said shift of the pressure responsive switch 48 also causes it to connect two conductors 89 and 90, as shown in Fig. 3. Thereby there is closed a circuit including line wire L; conductors 77, 78 and 79, the armature 91 of another relay, conductor 89, switch 48, conductor 90, a relay winding 92, a conductor 93 and the line wire L'. Thereby the relay 91-92 is closed and a circuit is established through conductors 77, 78, 79, armature 91,

a conductor 94, a conductor 95, the solenoid 34, a conductor 96 and the line L'. Consequent energization of solenoid 34 causes the control valve 23 to be shifted downwardly, against the resistance of spring 36, to press head retracting position, as shown in Fig. 3. When the relay 91-92 closes it also closes a circuit including a conductor 97 connected to the conductor 94 in the circuit just described, the switch 71, a conductor 98 and the conductor 90 leading to the relay winding 92. Thereby the relay 91-92 is held closed so long as the switch 71 remains closed, and said relay holds closed the circuit including the solenoid 34.

When the control valve 23 is in the position shown in Fig. 3 communication between the delivery pipe 20 and the pipe 39 leading to the press cylinder 4 is blocked by the valve head 29. Valve head 30 is in a position to open communication between the pipe 20 and the pipe 40 thus connecting the main pump to the push-back cylinders 9. The consequent pressure in the pipe 40 and in the push-back cylinders is transmitted through the pipe 51 to the small surge valve cylinder 11 to open the surge valve and place the cylinder 4 in communication with the surge tank. The pressure in the push-back cylinders then raises the press head 2 until the thrust member 67 borne by the head engages the collar 66 on stem of the slide 63 and forces the slide upwardly. The upward shift of the slide rocks the small lever 74 to shift the switch 71 to open the circuit through the relay winding 92. The relay 91-92 then opens and thereby breaks the circuit including the solenoid 34. Spring 36 then restores the control valve 23 to neutral position.

Advance of the press head 2 may be arrested, when necessary, before the working stroke is completed by pressing the normally closed push button switch 69. Thereby connection between the conductors 77 and 78 is broken, permitting the relay 80-84 to open and break the circuit through the solenoid 33. Valve spring 35 can then restore the control valve 23 to neutral position. Operation of the push button switch 70 enables the press head to be retracted independently of the pressure responsive switch 48. Switch 70 is normally open and when it is pressed it connects the conductors 89 and 90 and completes the circuit previously described for closing the relay 91-92. Closure of said relay completes the circuit previously described for energizing the solenoid 34. The control valve 23 is thereby shifted downwardly to cause retraction of the press head.

What I claim is:

1. In a press apparatus having press head advancing mechanism and press head retracting mechanism, both operable by hydraulic pressure, a surge tank, and a surge valve to control communication between the surge tank and said advancing mechanism and constantly urged to closed position, a control system for said mechanisms and surge valve comprising a constant delivery main pump having delivery connections with said mechanisms and with the surge tank, valve means operable to direct delivery from the main pump to said mechanisms and to cause flow from the latter to the surge tank for alternate operation of said mechanisms, and operable also to direct said delivery to the surge tank to render the press idle, forced feed means independent of said valve means and said main pump and including a constant delivery auxiliary pump of low capacity in comparison with the main pump to deliver fluid from the surge tank to the retracting mechanism to compensate for leakage from the

latter, means responsive to a predetermined extent of press head retraction to vent the retracting mechanism to the surge tank to limit retraction, and means operable in response to a predetermined fluid pressure in the retracting mechanism to open the surge valve.

2. In a press apparatus having press head advancing mechanism and press head retracting mechanism, both operable by hydraulic pressure, and a surge tank in valved connection with said advancing mechanism, a control system for said mechanisms comprising a constant delivery main pump, a hydraulic supply tank for said pump, the pump having a receiving connection with said tank and delivery connections with said advancing and retracting mechanisms and with the surge tank, valve means operable to control flow through said delivery connections for alternate operation of said advancing and retracting mechanisms and operable to direct the main pump delivery to the surge tank to render the press idle, a hydraulic return delivery connection leading from the surge tank to said pump supply tank for gravity flow of excess fluid from the surge tank, a hydraulic delivery connection between the surge tank and the retracting mechanism independent of said valve means and including a constant delivery auxiliary pump to compensate for leakage from the retracting mechanism, a hydraulic relief connection between the retracting mechanism and the surge tank and also independent of said valve means to relieve pressure in the retracting mechanism, and valve means normally closing said relief connection and operable in response to a predetermined extent of press head retraction to open the relief connection to limit retraction.

3. In a press apparatus having press head advancing mechanism and press head retracting mechanism, both operable by hydraulic pressure, a surge tank, and a surge valve to control communication between the surge tank and said advancing mechanism and constantly urged to closed position, a control system for said mechanisms and surge valve comprising a constant delivery pump having delivery connections with said mechanisms and with the surge tank, valve means operable to direct delivery from the main pump to said mechanisms and to cause flow from the latter to the surge tank, for alternate operation of said mechanisms and operable also to direct said delivery to the surge tank to render the press idle, fluid return means independent of said valve means to deliver excess fluid from the surge tank to the main pump, means operable in response to a predetermined pressure in the advancing mechanism to cause operation of said valve means for press head retraction, forced feed means independent of said valve means and said pump to deliver fluid from the surge tank to the retracting mechanism to compensate for leakage from the latter, means responsive to a predetermined extent of press head retraction to vent the retracting mechanism to the surge tank to limit retraction, and means operable in response to a predetermined fluid pressure in the retracting mechanism to open the surge valve.

4. In a press apparatus including press head advancing mechanism and press head retracting mechanism, both operable by hydraulic pressure, a control system for said mechanisms comprising a constant delivery main pump having delivery connections with said mechanisms, fluid return means to conduct fluid discharged from the pump back to the pump inlet, control valve means operable to control delivery from the pump

to said mechanisms and to cause flow from the latter to said fluid return means, for press head reciprocation, and operable also to fully by-pass the pump delivery to said fluid return means, a hydraulic delivery connection between said fluid return means and said retracting mechanism independent of said main pump and said valve means and including a constant delivery auxiliary pump of low capacity compared with said main pump, to compensate for leakage from the retracting mechanism, a hydraulic relief connection between the retracting mechanism and the fluid return means and also independent of said valve means, and valve means for closing said relief connection and responsive to a predetermined extent of press head retraction to open the connection to limit retraction.

5. In a hydraulic press apparatus including press head advancing mechanism and press head retracting mechanism, both operable by hydraulic pressure, a surge tank associated with said advancing mechanism, a surge valve to control flow between said tank and the advancing mechanism, hydraulically operable means for opening the surge valve, a constant delivery main pump in receiving connection with the surge tank, valve means operable to control delivery from said pump to said mechanisms and exhaust from said mechanisms, for press head reciprocation and operable also to fully by-pass the pump delivery to render the press idle, a constantly open hydraulic connection between said retracting mechanism and said surge valve opening means, a constant delivery auxiliary hydraulic pump of low capacity in comparison with the main pump in receiving connection with the surge tank and having a check-valved delivery connection with said hydraulic connection between the surge valve opening means and the retracting mechanism to supply the latter with hydraulic pressure independently of the main pump to compensate for leakage, a hydraulic relief connection between the retracting mechanism and the surge tank, and valve means for closing said relief connection and responsive to a predetermined extent of press head retraction to open said relief connection to limit retraction.

6. In a hydraulic press apparatus including press head advancing mechanism and press head retracting mechanism, both operable by hydraulic pressure, a surge tank associated with said advancing mechanism, a surge valve to control flow between said tank and the advancing mechanism, hydraulically operable means for opening the surge valve, a main pump in receiving connection with the surge tank, valve means operable to control delivery from said pump to said mechanisms and exhaust from said mechanisms, for press head reciprocation, a constantly open hydraulic connection between said retracting mechanism and said surge valve opening means, an auxiliary hydraulic pump of low capacity in comparison with the main pump in receiving connection with the surge tank and having a delivery connection with said hydraulic connection between the surge valve opening means and the retracting means to supply the latter with hydraulic pressure independently of the main pump to compensate for leakage, a hydraulic relief connection between the retracting mechanism and the surge tank, and valve means for closing said relief connection and responsive to a predetermined extent of press head retraction to open said relief connection to limit retraction.

7. In a press apparatus including press head-

advancing mechanism and press head-retracting mechanism, both operable by hydraulic pressure, a control system for said mechanisms comprising a main pump having delivery connections with said mechanisms, fluid return means to conduct fluid discharged from the pump back to the pump inlet, a single control valve operable to control delivery from said pump to said mechanisms and to cause flow from the latter, for press head reciprocation, and operable also to a position to cut off delivery from said pump to said retracting mechanism after press head retraction and at the same time fully by-pass the pump delivery to said fluid return means, a constant delivery auxiliary pump of low capacity in comparison with said main pump and having a delivery connection with said retracting mechanism to supply the latter with hydraulic pressure to compensate for leakage therefrom while the main pump is by-passed and cut off from the retracting mechanism, by-pass means for said auxiliary pump including valve means responsive to a predetermined extent of press head retraction by the auxiliary pump to direct the discharge of the latter back to the inlet of the auxiliary pump, an electromagnetic device mechanically connected to the said control valve and operable to shift the latter to a position for press head advance, another electromagnetic device mechanically connected to the control valve and operable to shift it to a position for press head retraction, and means responsive to deenergization of both of said electromagnetic devices to shift the control valve to its said cut-off and by-passing position.

8. In a press apparatus including press head-advancing mechanism and press head-retracting mechanism, both operable by hydraulic pressure, a control system for said mechanisms comprising a main hydraulic pump having delivery connections with said mechanisms, fluid return means to conduct fluid discharged by the pump back to the pump inlet, a single control valve operable to direct delivery from the pump to said mechanisms and to cause flow from the latter to the fluid return means, for press head reciprocation, and operable also to by-pass the pump discharge to said fluid return means, fluid pressure-operated means having a hydraulic connection with said advancing mechanism to cause press head retraction in response to a predetermined hydraulic pressure in the advancing mechanism, a switch operable in response to a predetermined degree of press head retraction to stop the retracting movement through the control valve, a constant delivery auxiliary pump of low capacity in comparison with said main pump and having a delivery connection with said retracting mechanism to supply the latter with hydraulic pressure to compensate for leakage therefrom while the main pump is by-passed and cut off from the retracting mechanism, and by-pass means for said auxiliary pump including valve means responsive to an additional predetermined degree of press head retraction by the auxiliary pump to direct the discharge of the latter back to the inlet of the auxiliary pump.

RICHARD W. DINZL.