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HYDRAULIC PRESS CIRCUIT

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2 Sheets-Sheet 1

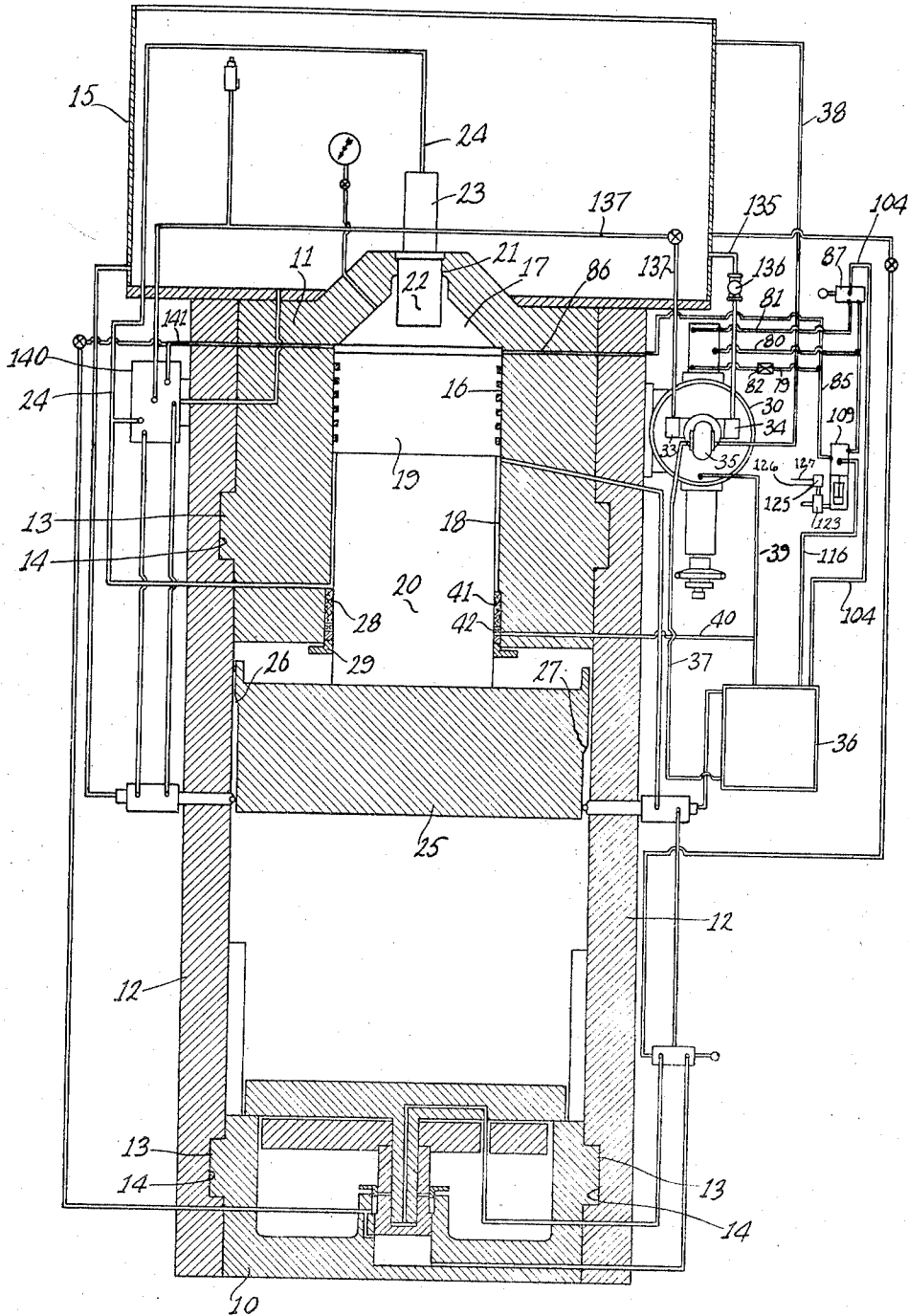


Fig. 1

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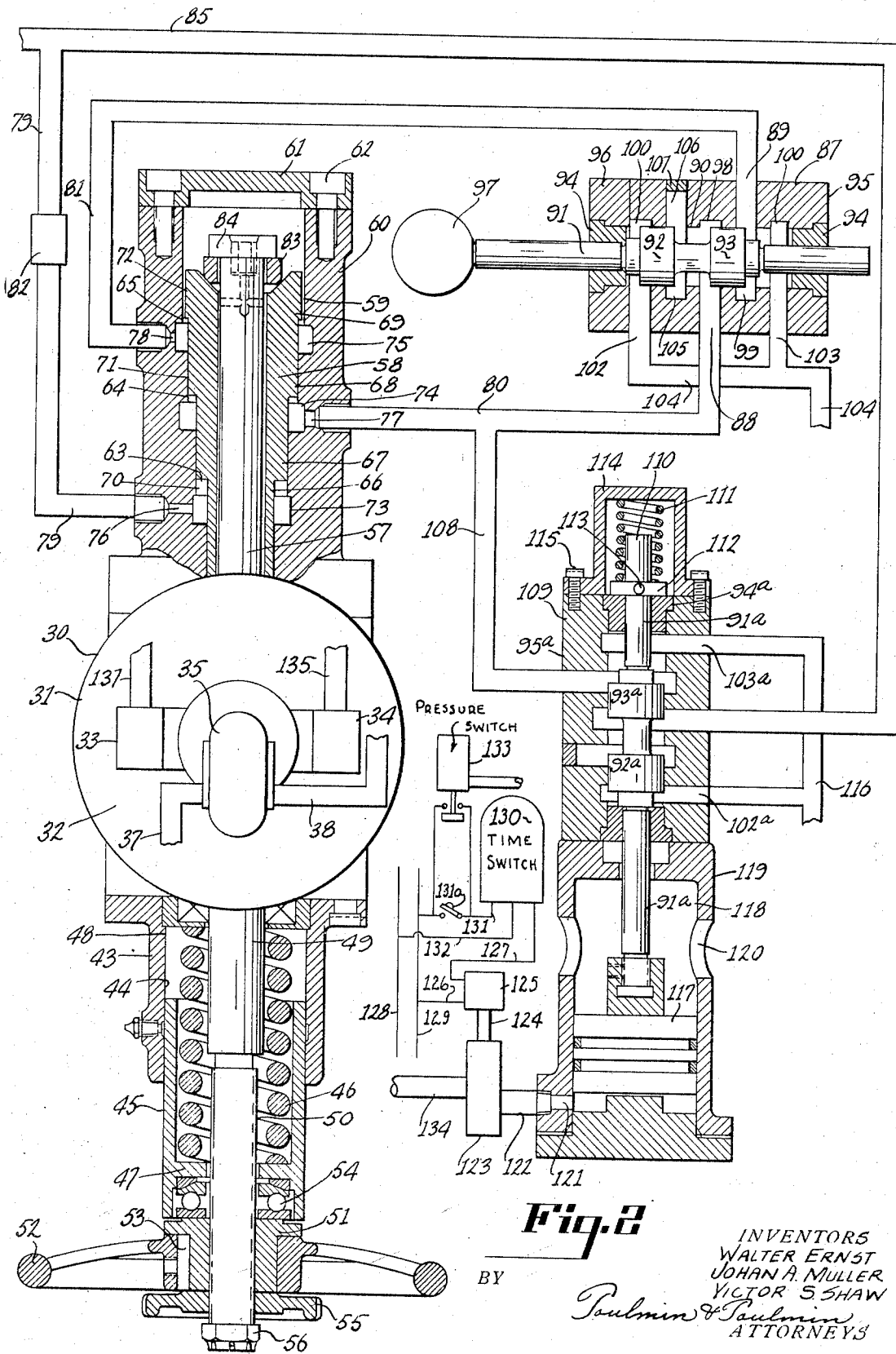
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UNITED STATES PATENT OFFICE

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HYDRAULIC PRESS CIRCUIT

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2 Claims. (Cl. 60—52)

This invention relates to hydraulic circuits, and in particular, to circuits for regulating the action of hydraulic presses.

One object of this invention is to provide a hydraulic press circuit having means associated therewith for causing the platen to approach the bed at a relatively rapid speed, and then to slow down when it reaches a predetermined point.

Another object is to provide such a press circuit, wherein the platen operates a valve which cuts off the free discharge of fluid beneath the double-acting main plunger and forces this fluid to flow through a restricted aperture, thereby slowing up the descent of the press platen when the platen reaches a predetermined position.

Another object is to provide a hydraulic press circuit for controlling the pressing pressure exerted by the platen by controlling the pressure at which the shift ring of a variable delivery pump is caused to move to its neutral or zero delivery position.

Another object is to provide a hydraulic press circuit, wherein the variable delivery pump is provided with a multiple piston servomotor with different areas on the pistons, and means for selectively directing the pressure fluid from the press cylinder to these areas so that the pump flow controlling member or shift ring will be moved to its neutral or zero delivery position at one of a series of selected pressures, depending upon which of the servomotor piston areas is exposed to the action of this pressure fluid.

Another object is to provide a hydraulic press circuit, as described immediately above, wherein the shift from one piston area of the pump servomotor to another piston area thereof is made in response to the action of a timing device so that the press will exert a predetermined pressing pressure for a predetermined length of time, and then will shift to exert another predetermined pressing pressure.

Another object is to provide a hydraulic press circuit having a double-acting main plunger, together with means for utilizing the fluid displaced from one side of this double-acting plunger to operate an auxiliary plunger, without the necessity of employing an additional pump.

Another object is to provide such an auxiliary plunger operating circuit, wherein the auxiliary plunger is caused to move to a predetermined position and then to automatically halt as the fluid supplied thereto reaches a discharge port uncovered by the auxiliary plunger in its motion.

Another object is to provide an auxiliary plunger operating circuit, as described above,

wherein the pump for operating the main plunger performs no work while the main plunger is in its retracted position other than circulating the oil, except when the auxiliary plunger is being moved either in a forward or a reverse direction.

In the drawings:

Figure 1 is a diagrammatic view, mainly in section, showing the complete hydraulic press operating circuit of this invention.

Figure 2 is an enlarged diagrammatic view, mainly in section, showing that part of the circuit of Figure 1 for applying different pressures to the press plunger at different periods of time by means of a multiple pressure servomotor pump control system.

General arrangement

In general, the hydraulic press operating circuit of this invention consists of a main circuit having a sub-circuit forming part of the main circuit. The said sub-circuit includes a variable delivery pump with a multiple piston servomotor for moving the pump flow-control member or shift ring to its neutral position when pressure is applied to these different areas, so that the pump is adapted to deliver a plurality of different pressures, depending upon which of the piston areas is exposed to the pressure fluid from the pressing cylinder to shift the pump flow-control member to its neutral position. The action of this multiple servomotor piston, as shown in detail in Figure 2, is opposed by an adjustable spring.

The shifting from one piston area to another is performed by a manual valve, cooperating with a time-responsive valve. The time-responsive valve system consists of a manually operated four-way valve having the supply of air controlled by a solenoidal valve, the solenoid being controlled in turn by a time switch. In this manner the pressure delivered by the pump is of a predetermined degree for a predetermined period of time, after which the valves are shifted so that the servomotor moves the flow-control member to cause the pump to deliver a different predetermined pressure for an additional period of time.

This invention is found to be of great value in certain applications of fluid pressure, where it is desirable to vary the intensity of the applied pressure in a predetermined manner. In the molding of certain compounds, for example, it has been found desirable to apply a moderate pressure for a time while the molding material softens and partially conforms to the shape of the mold, and thereafter to apply a higher pres-

sure to force the softened material into the more intricate recesses of the mold so as to fill these recesses fully. The present invention provides means for enabling this to be done, thereby resulting in the production of workpieces of improved quality, particularly where these workpieces are made with molds of intricate shape.

Press construction

Referring to the drawings in detail, Figure 1 shows diagrammatically in vertical section a hydraulic press having a bed 10 and head 11, interconnected by side members or uprights 12 at interlocking dove-tail portions 13 and 14, respectively. Mounted upon the press head 11 is a surge tank 15 for containing and supplying the operating fluid utilized in the circuit. The press head 11 contains a main cylinder bore 16, one end of which serves as a press-advancing chamber 17, and the other end 18 has a press-retracting chamber, these being on opposite sides of the piston head 19 of the main plunger 20. Thus, the main plunger 20 is a double-acting plunger, reciprocating in the cylinder bore 16.

Opening into the press-advancing chamber 17 is a port 21, providing communication with the interior of the surge tank 15. Mounted in the port 21 is a double-acting surge valve 22, of the type disclosed in the patent to Walter Ernst, No. 1,956,758, of May 1, 1934. The details of this surge valve 22 from no part of the present invention, and its function is as a check valve, which opens when the main plunger 20 starts on its downward stroke under the influence of gravity, so as to permit the rapid traversing of the main plunger 20. The surge valve 22 is provided with a hydraulic motor within the casing portion 23 thereof, this being connected by the conduit 24 with the return chamber 18 beneath the main piston head 19, so as to forcibly open the surge valve 22 and keep it open during the retraction stroke of the main plunger 20. This action, as described in the above-mentioned patent, permits the fluid to pass directly from the chamber 17, through the port 21, back into the surge tank 15 without traversing the remainder of the hydraulic circuit. Attached to the main plunger 20 is a platen 25 which moves up and down between the press side members 12 and is guided thereby. The platen 25 is provided with two cam portions 26 and 27 for operating certain valves at predetermined positions upon the stroke of the platen 25. Surrounding the main plunger 20, for the prevention of leakage therefrom, is a packing 28 compressed by a gland 29.

Multiple pressure pump control sub-circuit

The multiple pressure pump-control sub-circuit is shown in the upper right-hand corner of Figure 1, and in more detail in Figure 2. This part of the circuit is employed for applying different pressures to the main plunger 20 at different portions of its stroke, for different periods of time. The sub-circuit consists of a variable delivery radial piston pump 30, shown in Figure 1 as mounted upon the side of one of the press uprights 12. Ordinarily, however, this pump 30 is most conveniently mounted upon the head of the press. The pump 30, insofar as its actual pumping mechanism is concerned, is well known to those skilled in the hydraulic art, and is of the type having radial pistons and cylinders with variable strokes, as regulated by the shift ring for shifting the eccentricity of the axis of rotation of the cylinder barrel with respect to the

secondary rotor for actuating the pistons. Such a pump is shown in the Ernst Patent No. 2,021,354, of November 19, 1935.

The pump 30 consists of a central casing 31 having therein the pumping mechanism, together with the shift ring for varying the delivery of the pump. This casing 31 is closed by end plates 32, on one of which are mounted the pressure and suction connections 33 and 34, respectively. The pump 30 is driven by any suitable means, such as an electric motor (not shown).

Coaxial with the main pump 30 and driven by the same motor from the shaft thereof, is a slippage pump 35, of any suitable type, such as of the gear type, for providing the low pressure service of pumping slippage fluid from the slippage tank 36, back to the surge tank 15 by means of the conduits 37 and 38, respectively, (Figures 1 and 2). The slippage tank 36 is connected by the line 39 to the pump casing 31 for the purpose of collecting leakage therefrom, and also by the line 40, to the port 41 immediately above the packing 28 and opposite the perforated drainage ring 42. This ring 42 provides for slippage past the packing 28 from the main cylinder chamber 18.

Mounted upon one side of the main pump casing 31 is a casing 43 having a bore 44 for telescopically receiving a sleeve 45 containing a coil spring 46, abutting the wall 47 at one end of the sleeve 45 and the plate 48 at the other end within the casing 43. Passing through the plate 48 is the pump control rod 49, having a threaded portion 50 thereon engaged by a nut 51, to which is secured a hand wheel 52, as by the key 53. Arranged between the nut 51 and the end wall 47 of the sleeve 45 is a ball thrust bearing 54. Also mounted upon the threaded portion 50 of the control rod 49 is a lock-nut 55, in the form of a second hand wheel, whereas a nut 56, threaded upon the end of the control rod 49, serves as a retaining nut to retain the parts in position.

The control rod 49 is secured at its inner end to the pump flow-control member or shift ring (not shown), while similarly mounted upon the other end thereof is the servomotor rod 57, carrying thereon the stepped servomotor piston, generally designated 58, reciprocable within the stepped bore, generally designated 59, of the servomotor casing 60 (Figure 2). The servomotor casing 60 is mounted upon the side of the pump casing 31, in a manner similar to the casing 43. The end of the bore 59 in the casing 60 is closed by an end plate 61 by means of the cap screws 62.

The stepped piston 58 is provided with annular piston areas 63, 64 and 65, formed between the different diameter portions 66 and 67, 67 and 68 and 68 and 69, respectively. The smallest piston area 63 reciprocates within the small diameter bore portion 70, the intermediate piston area 64 within the intermediate bore 71, and the large piston area 65 within the large bore portion 72. These bore portions 70, 71 and 72 form parts of the stepped bore 59. Adjacent the respective piston areas 63, 64 and 65 their bores 70, 71 and 72 are widened out in the annular chambers 73, 74 and 75, respectively. Communicating with these chambers are ports 76, 77 and 78, respectively connected to conduits 79, 80 and 81.

The conduit 79 contains a choke 82 for the purpose of preventing too sudden a shifting of the stepped piston 58 in response to a sudden change of pressure. The stepped piston 58 is held in position by a collar 83, secured upon the

rod 57 by the end member 84. The conduit 79 is connected to the conduit 85, leading to the passageway 86 opening into the press-advancing chamber 17 of the main cylinder bore 16. The conduits 80 and 81, however, lead to a manually operated four-way valve, generally designated 87, at the ports 88 and 89 thereof, respectively. These ports lead into a bore 90 having therein a valve rod 91 with spaced heads 92 and 93. The valve rod 91 emerges through plugs 94, one plug being mounted in the valve casing 95 and the other in the end plate 96 thereof. The valve rod 91 terminates in a handle 97 for the manual manipulation of the valve. The valve bore 90 is provided with annular chambers 98 and 99, adjacent the ports 88 and 89, additional end chambers 100 and 101 being likewise provided and having ports 102 and 103 connected to a discharge conduit 104 leading to the slippage tank 36. The fifth chamber 105 has its port 106 closed by a plug 107.

Pressure fluid is supplied to the conduit 80 by means of a conduit 108, from an air-operated four-way valve 109 having the valve portions of similar construction and therefore similarly designated as in the four-way valve 87, with the distinguishing numerals 90^a to 107^a, respectively. The valve rod 91^a of the valve 109, however, terminates at one end in an extension 110 surrounded by a coil spring 111, engaging a collar 112 secured to the valve rod 91^a as at 113. The coil spring 111 urges the valve rod 91^a downwardly until the collar 112 engages the upper plug 94^a. The coil spring 111 at its upper end engages the inner wall of a cap 114, secured by the screws 115 to the casing 95^a of the valve 109. Communicating with the ports 102^a and 103^a is the conduit 116, leading downwardly to the slippage tank 36 (Figure 1). On the lower end of the valve rod 91^a is mounted a piston head 117, reciprocable within the bore 118 of an air cylinder 119, mounted upon the lower end of the valve casing 95^a. This bore 118 is provided with breather ports 120, whereas the opposite end of the air cylinder 119 is provided with a port 121, to which is connected the conduit 122 leading to the air valve 123, having the valve rod 124 arranged to be shifted by the solenoid 125. The latter is energized by the lines 126 and 127, the former leading directly to the electrical supply line 129, whereas the latter leads to the electrical supply line 128 by way of the time switch 130 and line 131 (Figure 2). The time switch 130 is of any conventional type, and operates a predetermined time after its energization through the lines 131 and 132 to change the energization of the solenoid 125 and to shift the valve rod 124 of the valve 123, opening the conduit 122 to the compressed air conduit 134. With the switch 131^a closed, the time switch 130 starts when the valve 140 is shifted to commence a pressing stroke, but with the switch 131^a open, the time switch 130 starts by the closing of the pressure switch 133 upon the attainment of a predetermined low pressure during the pressing stroke. The variable delivery pump 30 draws in fluid from the surge tank 15 by way of the conduit 135, and discharges pressure fluid through the conduit 137. The globe valve 136 and the check valve 138 merely serve to prevent the escape of fluid from the surge tank 15 when the pump 30 is disconnected for repairs, or other purposes.

In the operation of the multiple pressure sub-circuit shown in Figures 1 and 2, the operator

rotates the hand wheel 52 to adjust the compression of the spring 46 to the desired amount suitable for opposing the action of the stepped piston 58, and locks it by turning the locknut 55. The spring 46 tends to force the flow-control member or shift ring of the pump toward an eccentric position relatively to the pump cylinder barrel, thereby putting the pump on stroke to deliver pressure fluid. When the stepped piston 58 is supplied with pressure fluid of a sufficient degree to its stepped piston areas 63, 64 or 65, it tends to overcome the force of the spring 46. When a sufficient pressure has thus been built up to overcome the force of the spring, the pump shift ring or flow-control member is moved back to its neutral or no delivery position, compressing the spring 46. Thus, with a given pressure supplied to the stepped piston 59, a lower pressure will be required to overcome the spring force and move the pump to its no delivery position when the pressure is admitted to the larger areas thereof than to a smaller area.

When the pump 30 is started in operation, it delivers pressure fluid through the line 137, to the upper chamber 17 of the main cylinder bore 16, and the main piston head 19 starts downwardly on its pressing stroke in response to the shifting of the main control valve, generally designated 140 (Figure 1). The platen 25 moves downwardly under the influence of gravity upon its weight, and opens the surge valve 22, thereby drawing fluid from the surge tank 15 into the upper chamber 17. When the platen 25 encounters the workpiece, or other mechanism operated upon, pressure develops within the upper chamber 17 of the main cylinder bore 16, this pressure being transmitted through the passageway 86 and conduits 85 and 79, through the choke 82 to the chamber 73 within the servomotor casing 60, acting against the small diameter annular piston area 63. At the same time, pressure fluid also continues onward through the line 85, to and through the valve 109, the valve rod 91^a, and its piston heads 92^a and 93^a being raised under the influence of air reaching and raising the piston head 117 within the air cylinder 119. This air comes from the compressed air line 134, through the now open valve 123 and line 122, through the port 121, forcing the piston head 117 upward. The pressure fluid emerges from the valve 109, through the conduit 108, and thence through the conduit 80 and port 77, into the intermediate chamber 74 of the servomotor casing 60. Here it acts against the intermediate annular piston area 64 upon the stepped piston 58.

At the same time, pressure fluid from the line 80 passes through the manually operated valve 87, which the operator has shifted to the right of the position shown in Figure 2 so as to permit this pressure fluid to pass outwardly through the port 89, conduit 81 and port 78, into the upper chamber 75 of the servomotor casing 60. In this manner the pressure fluid coming from the upper chamber 17 of the main cylinder bore 16 is transmitted simultaneously to all three piston areas 63, 64 and 65 upon the servomotor piston 58. As a large area is exposed to the action of this pressure fluid, a relatively low pressure within the chamber 17 will suffice to overcome the resistance of the coil spring 46, and shift the flow-control member or shift ring of the variable delivery pump 30 to its neutral or no delivery position. The pump, therefore, operates at low pressure so long as the pressure is admitted to

all three areas of the servomotor piston 58. If, however, it is desired to operate the press at an intermediate pressure, the hand-operated valve 87 is shifted to the left, into the position shown in Figure 2. This action closes the valve 87 to the entrance of pressure fluid from the conduit 96, and at the same time opens up the upper chamber 75 of the servomotor casing 60 to the discharge line 104, by way of the valve chamber 99 in the hand-operated valve 87, thereby rendering ineffective the upper annular piston area 65 upon the servomotor piston 58.

Meanwhile, of course, the time switch 130 has been energized and is running. At the expiration of the period of time for which the time switch 130 is set, the latter changes the energization of the solenoid 125 so as to shift the valve rod 124 and close the valve 123, thereby cutting off the supply of air to the piston 117. Accordingly, the valve rod 91^a of the valve 109 moves downwardly, carrying with it its piston heads 92^a and 93^a, into the position shown in Figure 2. This cuts off the valve 109 from the entrance of pressure fluid from the line 85 and opens the middle chamber 76 to the discharge line 116, so that the fluid from the chamber 74 may flow through the conduits 89, 108 and 116, back to the slippage tank 36. With the upper and middle chambers 75 and 74 of the servomotor casing 60 thus rendered ineffective, the lower chamber 73 and its annular piston area 63 alone are supplied with pressure fluid. Under these conditions, the pump 30 operates at high pressure since a relatively high pressure is required to be exerted against the annular piston area 63 to overcome the force of the coil spring 46 and to shift the pump flow-control member or shift ring to its neutral or no delivery position. By suitably shifting the handle 97 of the manual valve 87, the operator can selectively apply either a low or an intermediate pressure initially by the pump 30, and follow it up with a high pressure after a predetermined period of time, according to the setting of the time switch 130.

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

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

1. In a hydraulic press system, a press having a

cylinder, a hydraulic plunger in said cylinder, a variable delivery pump connected to said cylinder and having a flow-control member for regulating the delivery of said pump, yielding means for urging said flow-control member in one direction, a servomotor having at least three piston areas adapted to act under pressure in one and the same direction for urging said flow-control member in a direction opposite to the first mentioned direction, means for establishing constant communication between one of said areas and the press cylinder, a first valve controlling the flow of pressure fluid between the press cylinder and the other two areas simultaneously, a second valve controlling the flow from said first valve to one of said two areas, time-controlled means for operating said first valve, and means responsive to the attainment of a predetermined pressure in said press cylinder for rendering said time-controlled means operative, upon expiration of a predetermined time, for moving said first valve to disconnect said two areas from the press cylinder.

2. In a hydraulic press system, a press having a cylinder, a hydraulic plunger in said cylinder, a variable delivery pump connected to said cylinder and having a flow-control member for regulating the delivery of said pump, yielding means for urging said flow-control member in one direction, a servomotor having at least three piston areas adapted to act under pressure in one and the same direction for urging said flow-control member in a direction opposite to said first-mentioned direction, means for establishing constant communication between the press cylinder and one of said areas, a first valve controlling the flow between the press cylinder and the other two areas simultaneously, a second valve controlling the flow from said first valve toward and from one of said two areas, said second valve being manually operable, time-controlled mechanism for controlling the operation of said first valve, and means responsive to the attainment of a predetermined pressure in said press cylinder for rendering said time-controlled means operative, upon expiration of a predetermined time, for moving said first valve to disconnect said two areas from the press cylinder.

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