This invention relates to a control system for reciprocating rams and especially to press rams. The object of the present invention is to provide an improved control system for a reciprocating ram which substantially eliminates the conventional servomotor from a reversible pump thereby greatly reducing the cost of the hydraulic system.

It is another object to provide a press operating system which is controlled by metering fluid from the retracting side of the ram and employing the pressure so generated to adjust the pump stroke to vary the press ram speed.

It is another object to provide such a circuit which includes the feature of slowing down the press ram on its advancing stroke.

It is another object to provide such a system in which the advancing speed of the ram is automatically and adjustably controlled.

It is still another object to provide an all hydraulic control system for a press having slow down and speed control.

In most cases where a reversible delivery pump is employed in a press circuit the pump is operated for the greater portion of the time on either full forward, full reverse or in neutral. It is customary to equip such a pump with a servomotor mechanism which is capable of positioning the pump shift ring so that any rate of delivery can be obtained in either direction. Such servomotor mechanisms are expensive and add considerably to the cost of the pump and system.

The present invention eliminates the major portion of the cost of the pump servomotor while retaining its most desirable operating features, namely, the shifting of the pump into full forward, full reverse, neutral, and in addition there to provides for a restricted delivery position to effect a slow-down of the ram and a means for continuously adjusting the pump stroke in order to control the speed of the ram.

These and other objects will become more apparent upon reference to the following description taken in connection with the accompanying drawings in which:

Figure 1 is a diagrammatic view of a press having a circuit according to this invention;

Figure 2 is a view showing the pump servomotor of this invention; and

Figure 3 is a view showing an open center type four way valve and a servomotor which includes centering springs.

Structural arrangement

Referring to the drawings, there is shown a press ram 10 which is reciprocably mounted in a cylinder 12 and is connected by the conduits 14 and 16 with a reversible variable delivery pump 18. The pump 18 includes a shift ring 20 which is attached to or is abutted by a pair of rods 22 and 24 which extend through and abut the bored pistons 26 and 28, respectively, which are reciprocably mounted in the cylinders 30 and 32, respectively. It will be noted that when the pistons are both under pressure, as in Figure 1, they bottom in their respective cylinders and, through the rods 22 and 24, hold the pump shift ring 20 in its no delivery position.

The cylinder 30 is connected by a conduit 34 with one service port of a four-way valve 36, the other service port of which is connected by a conduit 38 with the cylinder 32. A pump 40 supplies pressure fluid through a conduit 42 to the inlet port of the four-way valve while a conduit 44 including a choke valve 46 is connected with the exhaust ports of the said valve. The valve 36 comprises a valve member 48, the upper end of which terminates in a solenoid 50 and the lower end of which at 52 is adapted for engagement by an arm 54 carried by the ram 16. In the position shown in the drawings the valve 36 directs pressure fluid to both of the cylinders 30 and 32 so that the pistons 26 and 28 are bottomed in their cylinders and the pump is held in neutral.

The conduit 34 is connected by a conduit 56 which includes a check valve 60 and a normally closed two-way valve 62 with a normally closed port 62 in the valve 64. The valve 64 also comprises an inlet port 66 which is connected with the conduit 42 and a valve member 68 which is urged leftwardly by a spring and rightwardly by pressure standing in the chamber 70. The chamber 70 is connected with the press side of the metering choke 72 in the conduit 16 while the pump side of the said choke is connected with the chamber 74 which opposes the chamber 70.

The port 62 may be elongated, as shown in Figure 1, to permit a quantity of fluid to pass...
from the source 40 to the cylinder 30 in accordance with the speed of the ram 10.

**Operation**

In operation, a work cycle is started by energizing the solenoid 50 whereupon the member 48 moves upwardly and exhausts the cylinder 30 while continuing to supply pressure to the cylinder 32. This shifts the plungers 22 and 24 and shift ring 20 rightwardly so that pressure fluid is delivered through the conduit 44 to the advancing area of the ram 10. During the initial advancing stroke the ram 10 moves downwardly as rapidly as the pump 16 draws fluid from the push back area through the conduit 16. When the ram 10 has advanced a predetermined amount it engages and opens the valve 60. At this time the pressure drop across the main pump is sensed and has urged the valve member 68 rightwardly so that the ports 60 and 62 are interconnected and pilot fluid is directed through the conduit 56 and the conduit 34 into the cylinder 30 and the pump shift ring is moved toward reduced delivery position. The delivery of the pump will be reduced until the pressure drop across the choke 72 is such that the flow of pilot fluid through the valve 64 is equal to the flow of exhaust fluid through the conduit 44 and choke 46. The speed of the ram is thus controlled at any predetermined speed after the said ram opens the valve 60 by the rate of metering fluid through the valve 72.

A retracting stroke is instituted by de-energizing the solenoid 50 whereupon the pressure from the pilot pump is directed to the cylinder 30 while the cylinder 32 is exhausted. At the end of the retraction stroke the arm 14 picks up the position 52 and returns the valve member 48 to the position shown in the drawings. During the retraction stroke the valve 72 is made inoperative by the bypassing check 13.

The excess discharge of the pump 40 may be passed to the reservoir through the relief valve 16 at any time.

In Figure 2 the basic servomotor and servomotor control valve construction Figure 1 is illustrated separately from the press circuit. The elements of this view are numbered similarly to those in Figure 1 except with the addition of a subscript b.

Figure 3 shows a modified form of servomotor and servomotor control valve in which the pilot pump discharge is bypassed to exhaust by an open center type pilot valve when the press is in its retracted position, and the main pump is centered by the springs 39 and 82. The parts of Figure 3 which are similar to those of Figure 2 bear corresponding numbers with the addition of a subscript b.

It will be understood that various modifications and arrangements in structure could be made without departing from the spirit of my invention and, accordingly, I desire to comprehend such modifications and substitutions of equivalents as may be considered to come within the scope of the appended claims.

I claim:

1. A hydraulic system; a reciprocable plunger having advancing and retracting areas; a fluid source connected to supply said areas; opposed fluid operable control means associated with said source operable to position said source in full delivery in one direction or the other or to position said source in neutral; a pilot pump; a choke valve; valve means movable to connect said pump with one or the other or both of said control means; means selectively operable for actuating said valve to connect said pump with one or both of said control means while exhausting the other through said choke valve for positioning said source to deliver fluid to said advancing means; and means for supplying a variable pressure to said other control means during the advancing movement of said plunger comprising, valve means arranged between said pilot pump and said choke valve and operable during the advancing movement of said plunger for bypassing a portion of the delivery of said pilot pump to exhaust through said choke valve.

2. In a hydraulic system; a plunger having advancing and retracting areas; a fluid source connected to supply said areas; first and second fluid operable control means associated with said source respectively operable by fluid pressure to position said source to supply said advancing area or said retracting area and also operable when both are under pressure to position said source substantially to halt the supply to said motor; a choke valve; first valve means operable to supply actuating fluid to said first or to said second control means while exhausting the other thereof, through said choke valve, or to supply actuating fluid to both of said control means or a source of pressure; a second valve means responsive to a predetermined rate of discharge from said retracting area to establish a connection from said source to the inlet of said choke restricted inversely as the speed of said plunger; first fluid means operable by said plunger during a predetermined portion of the advancing movement thereof for completing said connection, whereby said source delivers through said choke valve to exhaust and supplies a variable pressure to said second control means.

3. In a hydraulic system; a reciprocable plunger having advancing and retracting areas; a fluid source connected to supply said areas; opposed fluid operable control means associated with said source operable to position said source in full delivery in one direction or the other or to position said source in neutral; a pilot pump; a fluid flow-restricting member; valve means movable to connect said pump with one or the other or both of said control means; means selectively operable for actuating said valve to connect said pump with one of said control means while exhausting the other through said fluid flow-restricting member for positioning said source to deliver fluid to said advancing area; and means for supplying a variable pressure to said other control means during the advancing movement of said plunger comprising, valve means arranged between said pilot pump and said flow-restricting member and operable during the advancing movement of said plunger for bypassing a portion of the delivery of said pilot pump to exhaust through said flow-restricting member.

4. In a hydraulic system; a plunger having advancing and retracting areas; a fluid source connected to supply said areas; first and second fluid operable control means associated with said source respectively operable by fluid pressure to position said source to supply said advancing area or said retracting area and also operable when both are under pressure to position said source substantially to halt the supply to said motor; a fluid flow-restricting member; first valve means operable to supply actuating fluid to said first or to said second control means while
exhausting the other thereof through said flow-restricting member, or to supply actuating fluid to both of said control means; a source of fluid pressure; a second valve means responsive to a predetermined rate of discharge from said retracting area to establish a connection from said source to the inlet of said member restricted inversely as the speed of said plunger; and third valve means operated by said plunger during a predetermined portion of the advancing movement thereof for completing said connection, whereby said source delivers through said flow-restricting member to exhaust and supplies a variable pressure to said second control means.

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