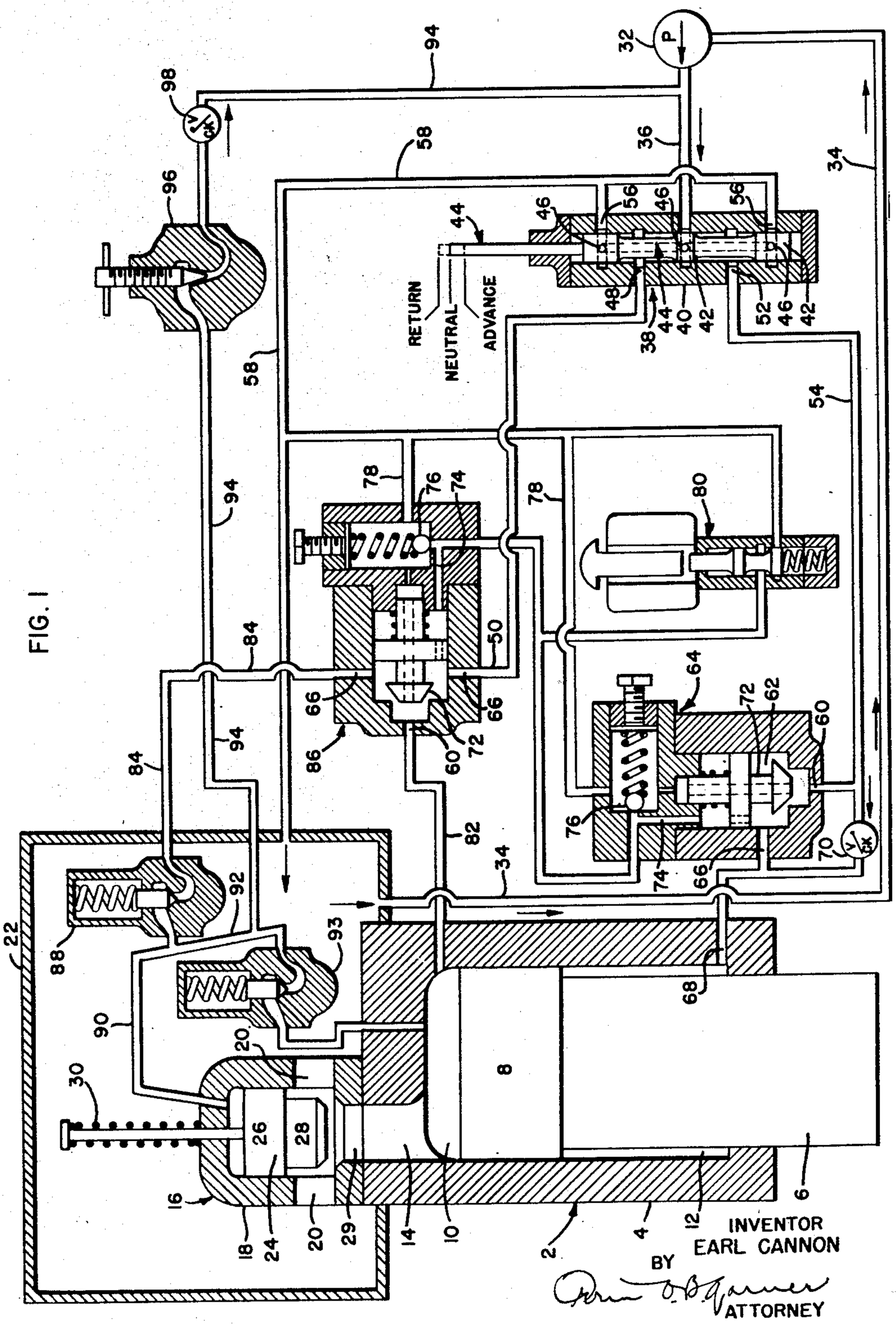
Jan. 23, 1951 E. CANNON 2,539,361

HYDRAULIC CIRCUIT FOR OPERATING HYDRAULIC MOTORS

Filed April 5, 1947 2 Sheets-Sheet 1

FIG. 1



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Filed April 5, 1947 2 Sheets-Sheet 2

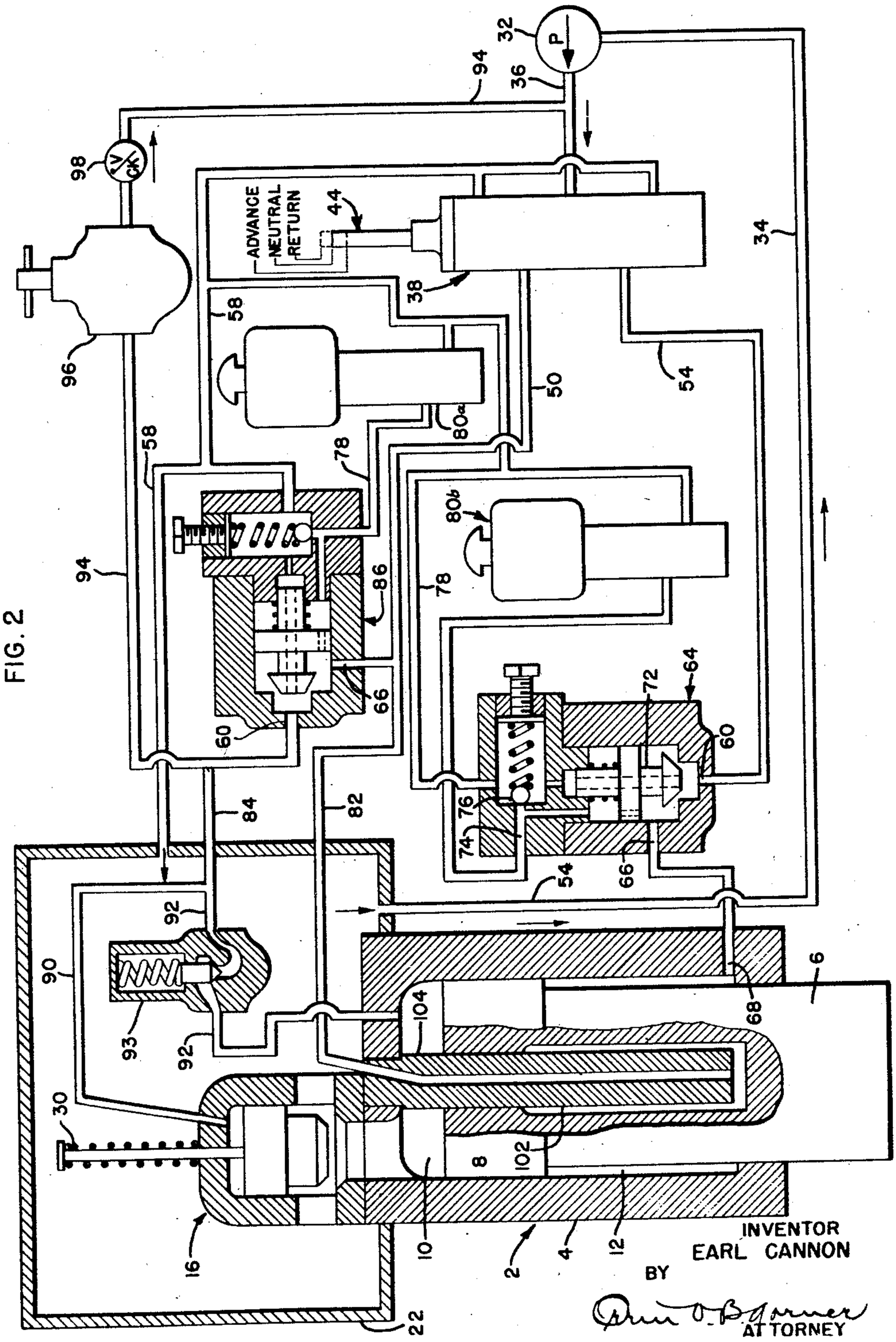

FIG. 2

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HYDRAULIC CIRCUIT FOR OPERATING HYDRAULIC MOTORS

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13 Claims. (Cl. 60—52)

1

This invention relates to hydraulic circuits and more particularly to a novel actuating circuit for a hydraulic motor such as is commonly utilized in hydraulic presses.

A general object of the invention is to provide a novel hydraulic circuit such as above described which is simple, economical in construction, and is capable of efficient actuation of a hydraulic motor in the various phases of an operating cycle such as is utilized in hydraulic presses.

Another object of the invention is to provide, in a hydraulic circuit of the above type, novel dumping valve means for accommodating rapid advance of the hydraulic motor to move the platen to the work and for thereafter accommodating the working stroke of the motor.

Still another object of the invention is to provide valve means which may be efficiently actuated without the necessity of pilot systems such as compressed air circuits, commonly utilized for this purpose.

A different object of the invention is to provide novel means for gradually relieving pressure in the advance chamber of the hydraulic motor before reversal of the same to initiate the return stroke thereof, thereby insuring shockless and noiseless operation of the circuit.

Still another object of the invention is to provide dumping valve means adapted to accommodate flow of hydraulic fluid into the return chamber of the hydraulic motor on the return stroke thereof and adapted to throttle flow of fluid from said return chamber at the end of the rapid advance stroke of said motor to check the advance stroke thereof prior to the engagement of the platen with the work.

The foregoing and other objects and advantages of the invention will become apparent from a consideration of the following specification and the accompanying drawings, wherein:

Figure 1 is a flow diagram of a gravity advance hydraulic circuit embodying the invention, portions of the hydraulic motor and associated valves being broken away to clarify the operation thereof; and

Figure 2 is a diagram similar to Figure 1 but illustrating a modification of the invention wherein the circuit comprises a positive advance motor for actuating the press ram on its rapid advance stroke to the work.

Describing the invention in detail and referring first to the embodiment of Figure 1, the hydraulic press which is diagrammatically indicated at 2 comprises an hydraulic motor including a cylinder 4 and a ram 6 with a head 8 reciprocal

2

in the cylinder and defining advance and return chambers 10 and 12 therein. It will be understood that the press may be of any suitable design incorporating advance and return chambers and associated ram means within the same or independent cylinders, as is well known to those skilled in the art.

The advance chamber 10 is connected by a passage or port 14 to a prefill valve, generally designated 16, comprising a casing or body 18 with one or more ports 20 connected to a tank or reservoir 22 of hydraulic fluid within which the valve 16 is preferably mounted. A valve stem 24 with a larger diameter portion 26 slidably fitted within a complementary bore in the casing 18 is provided for opening and closing the advance chamber 10 with respect to the ports 20 which are connected to the hydraulic fluid within the reservoir 22, as above noted. The smaller diameter portion 28 of the stem is adapted to seat against the upper extremity of a port 29 communicating with the before-mentioned passage 14 to close the same in the closed position of the prefill valve 16. A spring 30 is connected to the stem 24 for yieldingly urging it to its open position at which the passage 14 and the advance chamber 10 are in communication with the hydraulic fluid in the reservoir 22.

The novel circuit comprises a pump 32 having its suction side connected to a suction line 34 communicating with the reservoir 22, the discharge side of said pump being connected by a supply line 36 to a selector valve 38 of conventional design. The selector valve comprises a body or casing 40 with an internal bore receiving complementary spools or lands 42 of a valve stem, generally designated 44, said stem having an internal longitudinal passage connected by ports 46 to the bore of the casing 40. The casing comprises a port 48 connected to an advance line 50, a port 52 connected to a return line 54, and end ports 56 connected to a relief or discharge line 58 communicating with the reservoir 22.

The return line 54 is connected by a port 60 to a chamber 62 within a dumping valve, generally designated 64, said chamber being connected by a port 66 to a port 68 in the return chamber 12 of the hydraulic motor 2. The port 68 is also connected through a one-way check valve 70 to the return line 54 for a purpose hereinafter described in connection with the operation of the circuit. The valve 64 comprises a stem 72 adapted to close the port 60 and to open said port 60 upon the release of pressure within a passage 74 by the opening of an adjustably spring-pressed

valve 76 connected by a line 78 to the discharge line 58, or by the opening of a solenoid-operated pilot valve 80 connected to the discharge line 58.

The advance line 50 is connected to two branch lines 82 and 84 through a dumping valve 86 similar to the valve 64 and having the corresponding parts similarly numbered. It may be noted that the port 60 of the valve 86 is connected to the branch line 82 of the advance line 50, and the valve 86 is provided with two ports 66, the lower of which, as shown in Figure 1, is connected to the advance line 50, the upper port 66 being connected to the branch line 84.

The branch line 82 is connected to the advance chamber 10 of the hydraulic motor, and the branch line 84 is connected to a holding valve 88 adapted to resist flow therethrough until a predetermined adjustable back pressure is developed greater than that due to the frictional resistance to flow through the valve 86 and the line 82, thereby insuring that substantially no pressure fluid passes the valve 88 until the ram 6 has completed its rapid advance stroke to the work at which time the dumping valves 64 and 86 are closed, as hereinafter described.

The branch line 84 downstream of the valve 88 is divided into two sub-branch lines 90 and 92, the line 90 being connected to a port in the casing 18 of the prefill valve 16 to admit pressure fluid against the larger diameter portion 26 of the stem 24 to urge the same to its closed position after the valve 88 has opened, as hereinafter described. The sub-branch line 92 is connected to the advance chamber 10 through a holding valve 93 adapted to open after a predetermined back pressure has been developed in the sub-branch line 90 to close the prefill valve 16.

The sub-branch line 92 is connected upstream of the holding valve 93 and downstream of the holding valve 88 to a prefill valve relief or discharge line 94 which is connected to the supply line 36 downstream of the pump 32 and upstream of the selector valve 38. The relief line 94 comprises valve means including an adjustable throttle valve 96 and a one-way check valve 98 for throttling flow of hydraulic fluid from the prefill valve 16 and sub-branch line 90 when the selector valve 38 is in its neutral position, relieving pressure in the supply line 36. This insures a gradual opening of the prefill valve 16, as hereinafter discussed in connection with the operation of the press, to prevent shock and noise which would otherwise result from the sudden release of pressure within the advance chamber 10 after completion of the working stroke of the motor 2. It may be noted in this connection that when the selector valve 38 is actuated to either the advance or return position thereof, pressure in the supply line 36 closes the check valve 98 to positively prevent flow of hydraulic fluid through the relief line 94.

In operation of the above-described circuit, the rapid advance phase of the motor 2 is initiated by actuation of the stem 44 of the selector valve 38 to the advance or lowermost position thereof, designated in Figure 1, the valves 64 and 86 being open inasmuch as the pilot valve 80 is actuated to exhaust the passage 74 of these valves to the discharge line 58. Thus the pressure fluid delivered by the pump 32 to the advance line 50 is urged through the valve 86 into the branch line 82 and thence into the advance chamber 10 of the hydraulic motor 2, as the ram 6 is urged by gravity on the rapid advance stroke thereof to the work. Under these conditions the

return chamber 12 is exhausted through the port 68, the valve 64, and the selector valve 38 into the discharge line 58; and the prefill valve 16 is open accommodating flow of hydraulic fluid from the reservoir 22 into the advance chamber 10 inasmuch as the gravity advance stroke of the ram 6 to the work is faster than the capacity of the pump 32 to deliver hydraulic fluid to the chamber 10. The valve 88, as above noted, is effective at this time to create a back pressure in the branch line 84, thereby insuring delivery of fluid from the valve 86 to the advance chamber 10.

As the ram 6 approaches the end of the advance stroke thereof, the pilot valve 80 is actuated to close the passages 74 from communication with the discharge line 58, whereupon the stems 72 of the valves 64 and 86 are closed. Thus the descent of the ram 6 is checked by the valve 64 until the pressure within the return chamber 12 is sufficient to open the spring-pressed valve element 76 of the valve 64, thereby exhausting the passage 74 thereof and accommodating opening of the stem 72. This action results in throttling of the flow of fluid through the valve 64 at the end of the rapid advance stroke of the ram 6, thereby slowing down the approach of the ram 6 prior to engagement of the associated platen (not shown) with the work. Under these conditions, with the valve 86 closed to prevent flow of fluid from the port 60 to the advance chamber 10, the hydraulic fluid from the advance line 50 is delivered to the branch line 84 until sufficient pressure is developed to open the holding valve 88, whereupon the hydraulic fluid is delivered to the sub-branch lines 90 and 92, the holding valve 93 being effective at this time to develop sufficient back pressure in the line 90 to act upon the larger diameter portion 26 of the prefill valve stem 24, thereby urging the same to the closed position thereof. After the prefill valve 16 has closed, pressure within the sub-branch line 92 opens the holding valve 93, which thus accommodates flow of fluid into the advance chamber 10 to urge the ram 6 on the working stroke thereof against the work, the fluid from the return chamber 12 being throttled, as above described, by the valve 64.

It may be noted that during the working stroke of the ram 6 the pressure against the portions 26 and 28 of the prefill valve 16 is approximately equal; however, the stem 24 is maintained in its closed position inasmuch as the pressure acting against the larger diameter portion 26 thereof is effective to urge the same downwardly to the closed position thereof.

It may be also noted at this point that the spring pressure against the valve element 76 of the dumping valve 86 is adjusted so that the element 76 opens under a predetermined maximum pressure within the advance chamber 10 which is under these conditions connected to the advance line 50 through the sub-branch line 84 and the valve 86. Thus the valve element 76 of the valve 86 functions as a safety relief valve to prevent the building up of dangerous pressures within the system on the working stroke of the ram 6.

The return stroke of the ram 6 is initiated with the valves 64 and 86 preferably closed by actuation of the selector valve 38 first to the neutral position and then to the return position indicated in Figure 1. In the neutral position of the valve 38 the ports 48 and 52 are blocked and the supply line 36 is connected to the discharge line 58, thereby relieving pressure within the line 36

and accommodating gradual throttled flow of fluid from the top of the prefill valve casing 18 through the sub-branch line 90 into the branch line 94 and thence into the supply line 36 which is connected to exhaust. Thus the prefill valve 16 is gradually opened accommodating gradual release of pressure within the advance chamber 10 to prevent the shock and noise which would otherwise result upon uncontrolled opening of the prefill valve 16. It may be noted in this connection that the holding valve 88 is incapable of opening in response to pressure within the sub-branch lines 90 and 92 and the holding valve 93 is incapable of opening in response to pressure within the chamber 10. Thus in the neutral position of the valve 38 the flow of fluid from the prefill valve 16 is through the relief line 94.

After the prefill valve 16 has opened, the selector valve 38 is actuated to the return position thereof, indicated in Figure 1, whereupon pressure fluid is directed from the supply line 36 to the return line 54, and the advance line 50 is exhausted to the discharge line 58. Flow of pressure fluid through the return line 54 bypasses the valve 64 and passes freely through the check valve 70 into the return chamber 12 of the hydraulic motor 2, urging the ram 6 upwardly on the return stroke thereof. Fluid within the chamber 10 is urged into the reservoir 22 through the prefill valve 16 under these conditions. When the ram 6 reaches the end of its return stroke, the valve stem 44 is moved to the neutral position thereof, and the ram 6 is locked in its return position inasmuch as the valve 64 is still closed to resist flow of fluid from the return chamber 12.

For the purpose of convenience, the above discussion assumes that the valves 38 and 80 are manually controlled; however, it will be readily understood by those skilled in the art that these valves may be automatically actuated in response to the position of the ram or the hydraulic pressures within the cylinder 4, or by any desired combination of position or pressure-responsive devices commonly utilized for this purpose.

Referring now to Figure 2, a modification of the novel circuit is illustrated wherein the hydraulic motor is provided with a positive drive for urging the ram on the rapid advance stroke thereof to the work. The circuit of Figure 2 is otherwise similar to that shown in Figure 1 and corresponding parts are identified by corresponding numerals to simplify the description.

In Figure 2 the hydraulic motor 2 comprises a rapid advance chamber 102 within the ram 6 and a rapid advance conduit or pipe 104 carried by the cylinder 4 and slidably fitted within a complementary fluid-tight opening within the ram head 8 communicating with the rapid advance chamber 102. The pipe 104 is connected to the branch line 82 of the advance line 50 which is connected to a port 66 of the dumping valve 86, only one port 66 being utilized in this arrangement. The port 60 of the valve 86 is connected to the other branch line 84 of the advance line 50, and the holding valve 88 is eliminated inasmuch as the valve 86 in this embodiment is closed to positively prevent flow of fluid into the branch line 84 on the rapid advance stroke of the motor 2, as hereinafter described.

Also in the embodiment of Figure 2, the check valve 70 is eliminated, and independent solenoid-operated pilot valves 80*a* and 80*b* are provided for the respective dumping valves 86 and 64 for the purposes hereinafter described in connection with the operation of this circuit. The selector valve 38, the throttle valve 93 and the pilot valves 80*a* and 80*b* are shown in elevation inasmuch as their construction is identical with that of the corresponding valves of the embodiment illustrated in Figure 1.

In the operation of the circuit shown in Figure 2, the advance stroke of the ram 6 is initiated by actuation of the selector valve 38 to direct pressure fluid from the supply line 36 to the advance line 50 and to direct fluid from the return line 54 to the discharge line 58. At this time the pilot valve 80*a* is closed thereby closing valve 86 to direct flow of fluid from the advance line 50 into the branch line 82 which is connected through the pipe 104 to the rapid advance chamber 102, thus delivering fluid to this chamber to drive the ram 6 on its advance stroke. At the same time, the pilot valve 80*b* is also closed so that fluid passing from the return chamber 12 must overcome the resistance of the adjustably spring-pressed valve element 76 to pass through the valve 64. The flow from the return chamber 12 through the valve 64 is thus throttled so that the ram 6 can move on its advance stroke only as fast as it is driven by the pressure of the fluid within the rapid advance chamber 102. It may be noted in this connection that if desired the valve 80*b* may be opened to accommodate unrestricted flow of fluid from the return chamber 12 through the valve 64 until the ram 6 reaches the end of its rapid advance stroke just prior to contact of the associated platen (not shown) with the work, whereupon the valve 80*b* may be closed to throttle further flow of fluid through the valve 64, as above described. When the ram 6 reaches the end of its rapid advance stroke with the pilot valve 80*b* closed, the pilot valve 80*a* is opened, thereby opening the valve 86 and accommodating flow of fluid through the port 60 into the branch line 84 and thence into the sub-branch line 90 to close the prefill valve 16 against the resistance of its spring 30. After the prefill valve 16 has closed, the holding valve 93 is opened by the pressure in the line 84 to admit pressure fluid through the sub-branch line 92 to the advance chamber 10 of the cylinder 4, thereby urging the ram 6 on the working advance stroke thereof.

The return stroke of the ram 6 is effected under these conditions by first moving the valve stem 44 of the selector valve 38 to the neutral position and then to the return position, shown in Figure 2. In the neutral position of the stem 44, the prefill valve is gradually opened by the throttled flow of fluid through the sub-branch line 90, the branch line 84, and the prefill valve relief line 94 to the supply line 36 which is, under these conditions, relieved of pressure inasmuch as it is connected by the valve 38 to the discharge line 58. Thus the prefill valve 16 gradually opens to dissipate the high pressure within the advance chamber 10. The selector valve stem 44 is then actuated to its return position and the pilot valve 80*b* is opened to open the valve 64, thereby freely admitting presure fluid from the supply line 36 to the return line 54 and accommodating flow of fluid from the advance line 50 to the discharge line 58. It will be understood that as the ram 6 moves on its return stroke the hydraulic fluid within the chamber 10 is urged through the prefill valve 16 into the reservoir 22, and the fluid within the rapid advance chamber 102 is urged through the branch line 82 and

the advance line 50 into the discharge line 58. When the ram 6 reaches the end of its return stroke, the valve 80*b* is closed to close the valve 64, and the selector valve 38 is actuated to its neutral position, thereby locking the ram in its return position prior to initiation of another advance stroke thereof.

It may be noted that in the embodiment of Figure 2, as in the embodimeint of Figure 1, the valves 80*a* and 80*b* and the valve 38 may be manually controlled or may be automatically controlled by pressure or position responsive means or by a combination of such means, as will be readily apparent to those skilled in the art.

It is to be understood that I do not wish to be limited by the exact embodiments of the device shown which are merely by way of illustration and not limitation as various and other forms of the device will, of course, be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

I claim:

1. In an hydraulic circuit for an hydraulic press comprising advance and return chamber means and ram means reciprocal therein presenting at least one advance area and a return area to be acted upon by hydraulic pressure, the combination of a reservoir of hydraulic fluid, prefill valve means for opening and closing said reservoir with respect to said advance chamber means, pump means having the suction side thereof connected to said reservoir, selector valve means connected to the discharge side of said pump means, said selector valve means being connected to said return chamber means, to said reservoir, and to an advance line having two branches independently connected to said advance chamber means, said selector valve means being adapted in the neutral position thereof to direct flow of fluid from said pump means to said reservoir, said selector valve means being adapted in the advance position thereof to accommodate flow of fluid from said pump means to said advance line and to accommodate flow of fluid from said return chamber means to said reservoir, and said selector valve means being adapted in the return position thereof to direct flow of fluid from said pump means to said return chamber means and to accommodate flow of fluid from said advance line to said reservoir, dumping valve means operable in one position thereof when said selector valve means is in the advance position thereof for directing flow of pressure fluid into one of said branches to act on an advance area of said ram means during the rapid advance stroke of said ram means to associated work, said dumping valve means being adapted in another position thereof to direct flow of fluid into the other branch after said ram means has completed the rapid advance stroke thereof, said other branch being connected independently of its connection with said advance chamber means to said prefill valve means, holding valve means in the connection between said other branch and said advance chamber means for resisting flow of fluid thereto until said prefill valve means has closed under the pressure of the fluid in said other branch, a prefill valve pressure relief line connected to said other branch upstream of said holding valve means and connected to the discharge side of said pump means upstream of said selector valve means, one-way check valve means in said relief line actuating flow of fluid from said other branch to the discharge side of said pump in the neutral position of said selector valve means, and a throttle in said relief line for throttling flow of fluid therethrough.

2. In an hydraulic circuit for an hydraulic motor comprising cylinder means and ram means reciprocal therein defining advance and return chambers therein, the combination of a reservoir of hydraulic fluid, prefill valve means for opening and closing said reservoir with respect to said advance chamber, a discharge line connected to said reservoir, an advance line, selector valve means adapted in a neutral position thereof to direct hydraulic fluid to said discharge line, said selector valve means being adapted in the advance position thereof to direct fluid from said return chamber to said discharge line and to direct fluid to said advance line, said selector valve means being adapted in a return position thereof to direct fluid to said return chamber and to direct fluid from said advance chamber to said discharge line, pump means connected to said selector valve means for delivering fluid under pressure thereto, said advance line having branch lines connected independently to said advance chamber, dumping valve means connected to said branch lines, and adapted in one position of said dumping valve means to direct fluid from said selector valve means to one of said branch lines until the ram means encounters the resistance of the associated work, said dumping valve means being adapted in another position thereof to direct fluid to the other branch line to urge the ram means on the working stroke thereof, said other branch line having two sub-branch lines, one connected to said prefill valve means and the other connected to said advance chamber, a holding valve in said other sub-branch line for resisting flow of fluid into said advance chamber, thereby developing pressure in said prefill valve means to close the same before pressure fluid enters said advance chamber through said other sub-branch line, a connection upstream of said dumping valve means between said one sub-branch line and the discharge side of said pump means at a point upstream of said selector valve means, valve means in said last-mentioned connection for accommodating and throttling flow of fluid from said one sub-branch line and for positively preventing flow of fluid from said pump means to said one sub-branch line, and operating means for said selector valve means and said dumping valve means.

3. In an hydraulic circuit for actuation of an hydraulic motor including cylinder means and ram means reciprocal therein, said ram means comprising advance and return areas to be acted upon by hydraulic fluid, the combination of a source of hydraulic pressure fluid, selector valve means connected thereto, advance and return lines connected to said selector valve means, said return line being connected to said cylinder means at a point therein to deliver hydraulic fluid to act on a return area of said ram means, said advance line comprising a rapid advance branch line and a working advance branch line, the rapid advance branch line being connected to said cylinder means at a point therein to convey hydraulic fluid to act on an advance area of said ram means, the working advance branch line being divided into two sub-branches, a reservoir of hydraulic fluid connected to said cylinder means to convey hydraulic fluid to a portion of said cylinder means containing an advance area of said ram means, prefill valve means for opening

and closing the connection between said reservoir and said cylinder means, one of said sub-branch lines being connected to said prefill valve means to convey hydraulic pressure fluid thereto to close the same, and the other of said sub-branch lines having a connection to said cylinder means to act on the area of said ram means within said portion of said cylinder means, said selector valve means being adapted in an advance position thereof to direct fluid from said source to said advance line and to exhaust fluid within said return line, said selector valve means being adapted in a return position thereof to direct fluid from said source to said return line and to exhaust fluid within said advance line, said selector valve means being adapted in a neutral position thereof to exhaust pressure fluid from said source, and a pressure relief line connected to said one sub-branch line and connected to said source at a point upstream of said selector valve means, said relief line comprising a one-way check valve accommodating flow of fluid to exhaust when said selector valve means is in the neutral position thereof, and said relief line comprising throttle valve means between said check valve and said one sub-branch line.

4. In an hydraulic circuit for actuation of an hydraulic motor including cylinder means and ram means reciprocal therein, said ram means comprising advance and return areas to be acted upon by hydraulic fluid, the combination of a source of pressure fluid, selector valve means connected thereto, advance and return lines connected to said selector valve means, said return line being connected to said cylinder means at a point to convey hydraulic fluid to act on a return area of said ram means, said advance line being divided into a rapid advance branch line and a working advance branch line, the rapid advance branch line being connected to said cylinder means at a point to convey fluid to act on an advance area of said ram means, the working advance branch line being divided into two sub-branches, a reservoir of hydraulic fluid connected to said cylinder means to convey hydraulic fluid to an advance area of said ram means, prefill valve means for opening and closing the connection between said reservoir and said cylinder means, one of said sub-branch lines being connected to said prefill valve means to convey hydraulic pressure fluid thereto for closing the same, and the other of said sub-branch lines having a connection to said cylinder means to convey hydraulic pressure fluid to act on the area of said ram means supplied by said prefill valve means, said last-mentioned connection comprising holding valve means for developing a predetermined back pressure in said one sub-branch line before opening to admit pressure fluid to said cylinder means through said other sub-branch line, dumping valve means in said advance line adapted in one position thereof to accommodate flow of hydraulic fluid into said rapid advance branch line, said dumping valve means being adapted in another position thereof to accommodate flow of fluid to said working advance branch line, said selector valve means being adapted in an advance position thereof to direct flow of fluid from said source to said advance line and to direct flow of fluid from said return line to exhaust, and said selector valve means being adapted in a return position thereof to direct flow of fluid from said source to said return line and to direct flow of fluid from said advance line to exhaust, and means for terminating the rapid advance stroke of said ram means when said dumping valve means is actuated to said other position thereof, said terminating means comprising normally open valve means in the connection between said return line and said cylinder means, said last-mentioned valve means being adapted at all times to accommodate flow of fluid from the return line to said cylinder means and being adapted in closed position to throttle flow of fluid from said cylinder means to said return line, and being adapted in open position to accommodate substantially unthrottled flow of fluid from said cylinder means to said return line, and actuating means for closing said last-mentioned valve means when said dumping valve means is actuated to said other position thereof.

5. In an hydraulic circuit for an hydraulic motor comprising cylinder means including advance and return chambers and ram means reciprocal therein presenting advance and return areas to be acted upon by hydraulic fluid in respective chambers, the combination of a reservoir of hydraulic fluid, prefill valve means for opening said reservoir to communication with said advance chamber on a rapid advance stroke of said ram means to associated work and on a return stroke of the ram means therefrom, and for closing said reservoir from communication with said advance chamber on a working advance stroke of said ram means against said work, pump means having the suction side thereof connected to said reservoir, a selector valve connected to the discharge side of said pump means, a discharge line, an advance line, and a return line connected to said selector valve, the discharge line being connected to said reservoir, the advance line being connected to said advance chamber, and the return line being connected to said return chamber, dumping valve means in said advance line for directing flow of fluid into said cylinder to act on an advance area of said ram means during the rapid advance stroke thereof and for thereafter directing flow of fluid into a portion of said advance line connected independently to said prefill valve means and to a portion of said cylinder means containing an advance area of said ram means, operating means for said dumping valve means, holding valve means in said portion of said advance line between said prefill valve means and said cylinder means for developing a predetermined back pressure in said prefill valve means to close the same before fluid enters said portion of said cylinder means through said holding valve means, and dumping valve means in said return line adapted in one position to freely accommodate flow of fluid from said return chamber, and adapted in another position to throttle flow of fluid from said return chamber until a predetermined pressure value has been developed therein, and means for actuating the second-mentioned dumping valve means to said other position thereof thereby checking advance movement of said ram means at the end of its rapid advance stroke.

6. In an hydraulic circuit for an hydraulic motor comprising cylinder means and ram means reciprocal therein defining advance and return chambers therein, the combination of a reservoir of hydraulic fluid, prefill valve means for opening and closing said reservoir with respect to said advance chamber, a discharge line connected to said reservoir, an advance line, selector valve means adapted in a neutral position thereof to deliver hydraulic fluid to said discharge line,

said selector valve means being adapted in the advance position thereof to direct fluid from said return chamber to said discharge line and to direct fluid to said advance line, said selector valve means being adapted in a return position thereof to direct fluid to said return chamber and to deliver fluid from said advance chamber to said discharge line, pump means connected to said selector valve means for directing fluid under pressure thereto, said advance line having branch lines connected independently to said advance chamber, dumping valve means connected to said advance line for directing fluid in the advance position of said selector valve means first to one of said branch lines until the ram means encounters the resistance of the associated work and then to the other branch line to urge the ram means on the working stroke thereof, said other branch line having sub-branch lines, one connected to said prefill valve means and another connected to said advance chamber, a holding valve in said other sub-branch line for resisting flow of fluid into said advance chamber, thereby developing pressure in said prefill valve means to close the same before pressure fluid enters said advance chamber through said other sub-branch line, operating means for said selector valve means and said dumping valve means, and means for checking the advance stroke of said rams means, said checking means comprising normally open valve means in the connection between said return chamber and said selector valve means, said normally open valve means being adapted at all times to accommodate flow of fluid from the selector valve means to the return chamber and being adapted in closed position to throttle flow of fluid from the return chamber to the selector valve means, and being adapted in open position to accommodate substantially unthrottled flow of fluid from the return chamber to the selector valve means, and actuating means for actuating said normally open valve means to closed position thereof when said dumping valve means is directing fluid to said other branch line.

7. An hydraulic circuit according to claim 4 wherein said selector valve means is adapted in a neutral position thereof to direct flow of fluid from said source to exhaust, and a pressure relief line is connected to said one sub-branch line upstream of said holding valve means and is connected to said source upstream of said selector valve means, and valve means are provided in said relief line for throttling flow of fluid from said one sub-branch line when said selector valve means is in the neutral position thereof and for positively preventing at all times flow of fluid from source to said one sub-branch line.

8. In an hydraulic circuit for an hydraulic motor having cylinder means and ram means presenting advance and return areas therein; the combination of advance and return lines connected to respective areas, prefill valve means adapted in open position to deliver fluid to the advance area from an associated reservoir and adapted to closed position to cut off communication between said reservoir and said advance area, operating valve means adapted in neutral position to direct fluid from an associated high pressure source to exhaust and being adapted in advance position to direct fluid from said source to said advance line and to exhaust fluid from said return line, and being adapted in return position to direct fluid from said source to said return line and to exhaust fluid from said

advance line, a dumping valve having a chamber connected to the advance line and having ports independently connected with said cylinder means to direct fluid to at least one advance area of said ram means, a stem in said chamber adapted in closed position to close one of the ports and adapted in open position to open said port, said advance line being at all times in communication with the other port, said stem having a larger diameter portion slidably fitted in said chamber and having a throttle port through said portion, a control port connected to the chamber at the side of said portion remote from said one port, spring means for urging said stem to closed position, a normally closed control valve adapted in open position to exhaust said control port thereby accommodating movement of said stem to open position, one of said chamber ports being connected to a closing area of said prefill valve means and being connected to the cylinder means by holding valve means adapted to create back pressure against said closing area thereby closing said prefill valve means before delivery of fluid to the cylinder means.

9. An hydraulic circuit, according to claim 8, wherein the control port is provided with relief valve means adapted to exhaust the control port upon the development of a predetermined maximum pressure against the advance area of the ram means.

10. In an hydraulic circuit for an hydraulic motor including a cylinder and a ram having a head dividing the cylinder into advance and return chambers; the combination of advance and return lines connected to respective chambers, a reservoir of hydraulic fluid, prefill valve means adapted to open and close said reservoir with respect to said advance chamber, operating valve means connected to respective lines and adapted to alternately direct high pressure fluid to one line while exhausting the other, said operating valve means being adapted in neutral position to direct pressure fluid to exhaust, dumping valve means including a valve chamber connected to the advance line, a port connecting the valve chamber to the advance chamber, another port connecting the valve chamber to a closing area of the prefill valve means and to the advance chamber, holding valve means in the last-mentioned connection for developing a predetermined back pressure against said closing area before delivery of fluid to the advance chamber, a valve stem having a larger diameter portion with a throttled port therethrough, said portion being fitted in said valve chamber, said stem being adapted in closed position to close the first mentioned port, spring means for urging the stem to closed position, and a control port connected to said chamber at the side of said portion remote from the first mentioned port, a second dumping valve means including a valve chamber with a first port connected to the return line and a second port connected to the return chamber, a valve stem having a larger diameter portion slidably fitted in the second-mentioned valve chamber, said last-mentioned stem being adapted in closed position to close the first port, a throttle port through the last-mentioned stem portion, spring means for urging the last-mentioned stem to closed position, a control port connected to the last-mentioned valve chamber at the side of the last-mentioned stem portion remote from said first port, control valve means connected to said control ports and adapted in closed position to close said control ports and adapted in open position to ex-

haust said control ports, and a one-way check valve in said return line downstream of said first port accommodating flow of fluid to the return chamber.

11. An hydraulic circuit, according to claim 10, wherein each of said control ports is provided with relief valve means for exhausting the same upon development of a predetermined maximum pressure value within the control port.

12. In an hydraulic circuit for an hydraulic motor having cylinder means with advance and return chambers and ram means presenting advance and return areas in respective chambers and having a rapid advance motor operatively associated with said ram means; the combination of advance and return lines, the advance line being connected to said rapid advance motor, a reservoir of hydraulic fluid, prefill valve means for opening and closing said reservoir with respect to said advance chamber, operating valve means adapted to alternately direct pressure fluid to one of said lines while exhausting the other, dumping valve means having a chamber connected to the advance line and having a port connected to a closing area of the prefill valve means and connected to the advance chamber, holding valve means in the last-mentioned connection for developing a predetermined back pressure against said closing area thereby closing said prefill valve means before delivery of fluid to the advance chamber, a stem having a larger diameter portion fitted in the valve chamber and adapted in closed position to close said port, a throttle port through said portion, spring means for urging the stem to closed position, and a control port connected to said chamber at the

side of said portion remote from said first mentioned port, a second dumping valve means including a valve chamber having a first port connected to the return line and a second port connected to the return chamber, a valve stem having a larger diameter portion fitted in the last-mentioned chamber and adapted in closed position to close the first port, a throttle port through said last-mentioned portion, spring means for urging the last-mentioned stem to closed position, a control port connected to the last-mentioned valve chamber at the side of the last-mentioned stem portion remote from said first port, and independent control valves, each of said valves being connected to one of the control ports for closing the same and for opening the same to exhaust.

13. An hydraulic circuit, according to claim 12, wherein a relief valve is associated with each control port and is entirely independent of the related control valve, said relief valve being adapted to exhaust the associated control port upon development therein of a predetermined maximum pressure.

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