

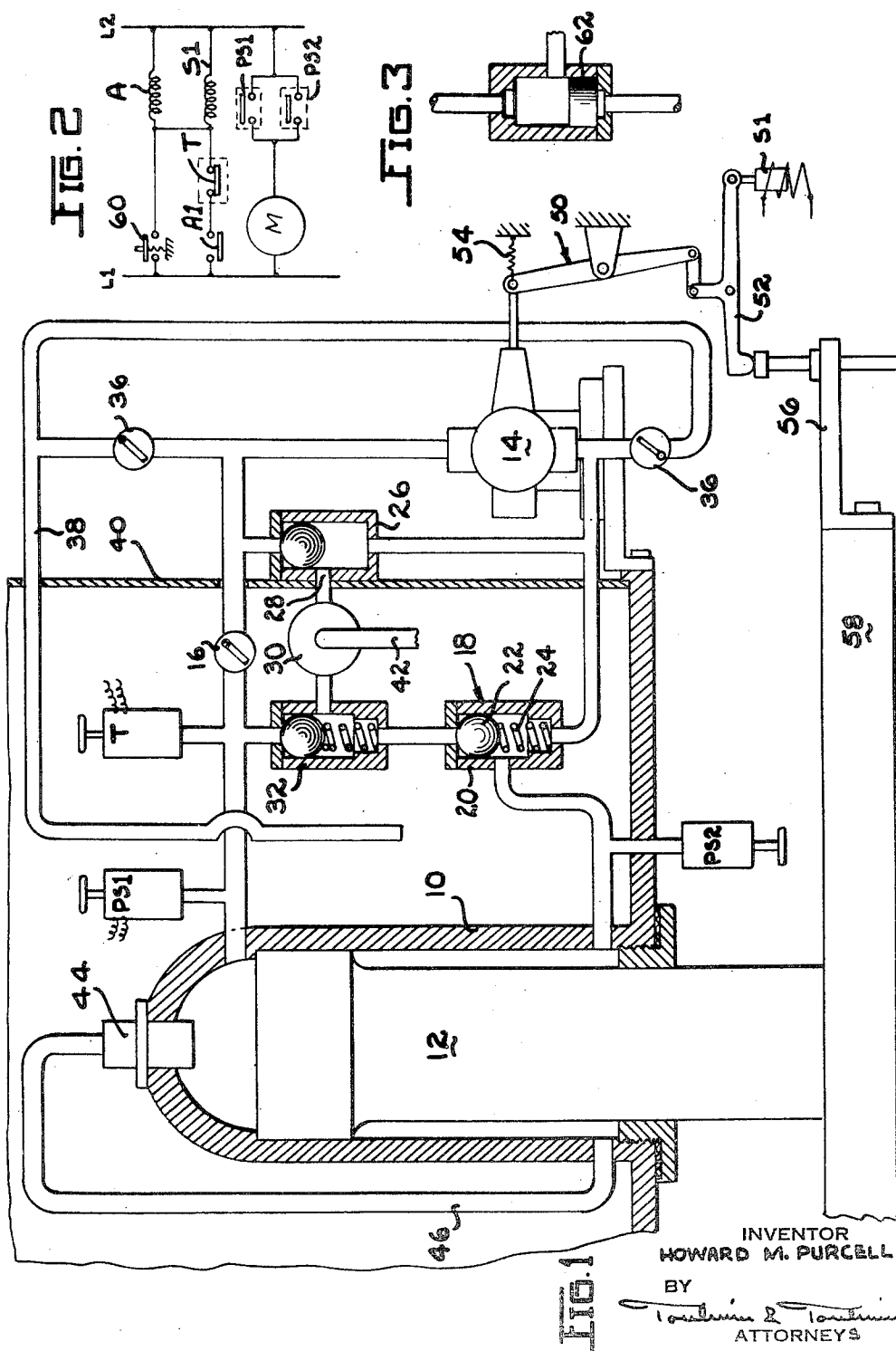
June 13, 1950

H. M. PURCELL
HYDRAULIC PRESS CONTROL CIRCUIT EMBODYING
FLUID PRESSURE INTENSIFYING MEANS

2,511,541

Filed July 8, 1947

2 Sheets-Sheet 1



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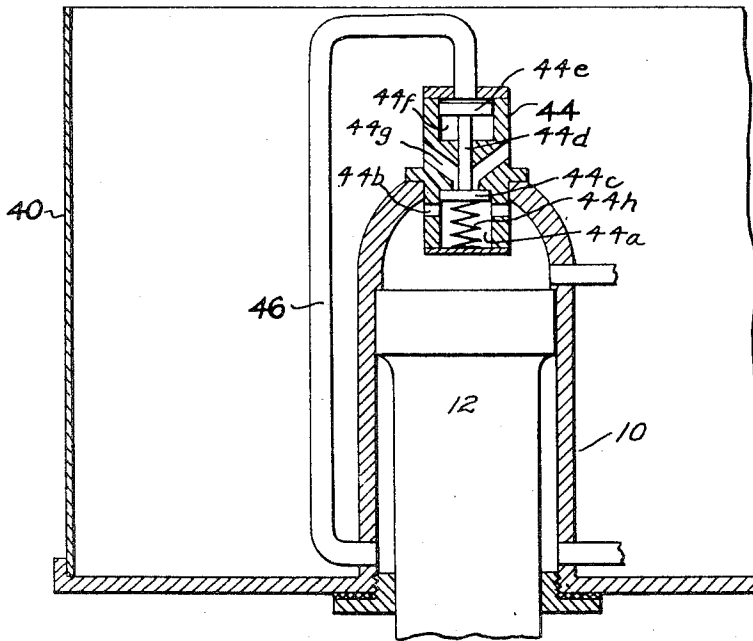


FIG. 4

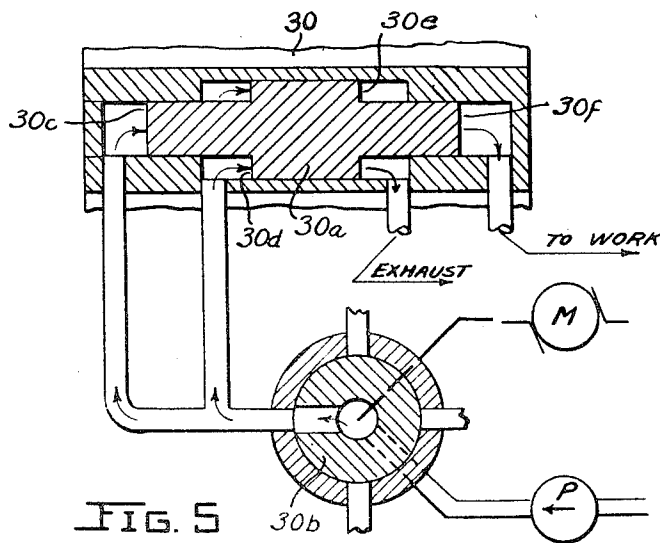


FIG. 5

Inventor
HOWARD M. PURCELL

By *W. S. McDowell*

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HYDRAULIC PRESS CONTROL CIRCUIT EMBODYING FLUID PRESSURE INTENSIFYING MEANS

Howard M. Purcell, Philadelphia, Pa., assignor to H-P-M Development Corporation, Wilmington, Del., a corporation of Delaware

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8 Claims. (Cl. 60—52)

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This invention relates to hydraulic press actuating systems, and especially to such systems characterized by high pressures.

The particular object of this invention is to provide an improved high pressure actuating circuit for a hydraulic press.

It is another object of this invention to provide a high pressure actuating circuit for a hydraulic press which employs a minimum of valves.

Another object of this invention is to provide a press actuating circuit including a hydraulic intensifier which may be made operative in either direction of movement of the press ram.

Still another object is to provide a hydraulic press actuating circuit in which the press ram is normally operated by the discharge from a pump and in which there is an intensifier which becomes operative automatically at a predetermined pressure in either direction of movement of the press ram.

A still further object is to provide a press operating circuit including a pressure intensifier in which the shift over from low to high operating pressures is accomplished smoothly and positively.

These and other objects and advantages 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 operating circuit according to this invention;

Figure 2 is a diagrammatic wiring diagram of the electric control circuit for the press of Figure 1;

Figure 3 is a fragmentary view showing another form of check valve which may be used in the circuit of Figure 1;

Figure 4 is a diagrammatic view showing the relationship between the press-actuating ram and the surge valve and fluid reservoir therefor; and

Figure 5 is a diagrammatic illustration of the operating principle of the fluid-pressure intensifier employed in the present press-operating circuit.

General arrangement

This invention generally is concerned with a hydraulic press actuating circuit in which there is a pump connected to supply either the advancing or the retracting side of a press ram. This pump is preferably a reversible type pump but it will be understood that a one way delivery pump and a reversing valve could be employed in place of a reversible pump if desired.

The aforementioned reversible pump is connected between the advancing and retracting means and there is preferably a solenoid which

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may be energized to bring about the delivery of the said pump to the advancing means. Upon de-energizing the said solenoid, the delivery of the pump is automatically reversed to bring about a supply to the retracting means of the press ram. Connected between the opposite ports of the pump is a check valve which has therein a movable member. The check valve also comprises a third port and in response to a pressure at either of the first two ports the movable valve member of the check valve moves to connect the third port therewith. In this manner, the discharge side of the pump is always connected with the third port of the check valve.

The aforementioned third port is connected with the inlet of a hydraulic intensifier which discharges to a valve that is automatically operable to direct the said discharge either to the advancing means of the press ram or the retracting means thereof, depending upon which direction the press ram is moving. A motor is connected with the intensifier and is selectively operable to drive the intensifier for making it effective in response to a predetermined pressure acting on which ever of the advancing or retracting means of the press ram the pump is supplying at the time. A hydraulic intensifier of this nature is fully shown and described in the U. S. Patent to Warren R. Tucker, No. 2,486,079, issued October 25, 1949, and assigned to the same assignee as the instant application.

The arrangement briefly described above includes no shiftable valves except for the check valves which are directly responsive to pressures in the conduits connected therewith. These valves are of simple construction and there is little likelihood that they will warp and bind under the high pressures passing therethrough as is the case with ordinary operating valves such as four-way piston type valves, or rotary valves.

Structural arrangement

Referring more particularly to the drawings, there is shown a press cylinder at 10 within which there is reciprocable a double acting ram 12. The ram forms with the cylinder the larger advancing means above the same ram and the smaller retracting means beneath the said ram. A fluid source of reversible delivery at 14 has one port thereof connected with the advancing side of the ram 12 through a check valve 16 opening toward the said advancing means. The other side of the pump 14 is connected through a valve generally indicated at 18 with the retracting side of the ram.

The valve 18 comprises a body portion 20 hav-

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ing ports opening from the top and bottom thereof, and also having a port opening from the side intermediate the said top and bottom ports. Within the valve body 20 there is a valve member 22 which, as shown, may comprise a ball. The valve member 22 is movable toward either end of the body 20 to disconnect the port at that end from the port opening from the side of the valve and to connect the said side opening port with the port in the other end of the valve body. As shown there is a spring 24 which normally urges the ball upwardly to seat against the port in the upper end of the body 20.

Connected between the two ports of the pump 14 there is another valve 26 which has a side opening port 28 therein connected with the inlet of the pressure intensifier 30. The valve 26 is provided with a valve member or ball which is movable within the valve in response to positive pressures at either of the ports of the pump 14 to connect the pressure port of the pump with the inlet of the intensifier 30. The discharge port of the intensifier 30 is connected with the side opening port of a third valve 32 which is constructed similarly to the valves 18 and 26. The upper port of the valve 32 is connected to the discharge side of the check valve 16 while the lower port is connected with the upper port of the valve 18.

For supplying make-up fluid to the pump 14 in either direction of delivery thereof there are a pair of check valves 36 which have their outlets connected with opposite sides of the ram 12 by way of valves 16 and 18 and their inlets connected by a conduit 38 with the reservoir 40.

The exhaust conduit 42 of the intensifier 30 also discharges directly into the reservoir 40.

The advancing side of the press ram is adapted for being connected directly with the reservoir 40 by means of a surge valve 44. This valve is normally closed but may open by suction in the advancing means for permitting fluid to flow thereto from the reservoir 40, or will open in response to predetermined pressure conducted thereto by the conduit 46 leading to the retracting means for the ram 12.

As shown in more detail in Fig. 4, the surge valve 44 has formed therein a lower chamber 44a which communicates with the advancing area of the ram by way of the ports 44b. Slidably carried within the lower chamber 44b of the valve is the lower head 44c of a movable valve member 44d which is also provided with an upper enlarged head member 44e. The upper head 44e of the valve member is reciprocable in a second chamber 44f formed in the upper end of the valve casing. Communicating with the upper end of the chamber 44f is one end of the conduit 46 which, as beforementioned, has its opposite end connected with the retracting area of the ram 12. Extending through the valve casing and communicating with the interior of the reservoir 40 is a Y-shaped channel or port 44g which is also adapted to communicate with the lower chamber 44a of the valve.

In operation, the lower head 44c of the movable valve member normally closes the channel 44g with respect to the lower chamber 44a and the advancing area of the ram 12, due to the action of the compression spring 44h which is mounted between the lower wall of the chamber 44a and the under side of the lower head 44c. During an advancing stroke, where the weight of the ram and press aid the pump discharge, there often times occurs a suction within the

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advancing area of the ram, and in response to such a suction, the lower head 44c of the valve 44 is displaced from its normal position of closure with respect to the channel 44g to permit make-up fluid to enter the advancing area of the ram. Thereafter, as the press platen meets the work and pressure within the advancing area builds up, the valve will once again close and permit pump pressure to work upon the ram. As mentioned before, the surge valve 44 is also effective upon a retraction stroke to open the advancing area of the ram to the reservoir. This latter opening of the valve is effected by a predetermined pressure build-up within the retracting area of the ram, which pressure is transferred through the conduit 46 to act upon the upper head 44c of the valve member and thereby to displace the same downwardly and unseat the lower head 44c. This provision is made for the purpose of rapidly exhausting fluid from the relatively larger ram-advancing area during the introduction of pressure fluid within the smaller ram-retracting area thereof.

Connected with the conduit between the check valve 16 and the advancing means of the ram 12 there is a pressure switch indicated as PS1 and which is operable in response to a predetermined pressure to close a pair of contacts. Similarly, there is also a pressure switch PS2 connected with the conduit leading from the valve 18 to the retracting means of the ram 12 and also operative in response to a predetermined pressure to close a pair of contacts. Still a third pressure operated switch indicated at T is connected with the advancing means of the ram 12 and is operative to open a pair of contacts in response to a predetermined pressure in the ram advancing means.

As mentioned before, the intensifier 30 must be driven in order to be operative. This is due to the fact that the intensifier includes a plurality of intensifying pistons 30a, one of which is shown in Fig. 5, to which fluid is directed in succession by a movable valve member 30b within the intensifier. When the valve member 30b is not driven the pistons 30a bottom in their respective cylinders and there is no passage of fluid through the intensifier. Thus, there is a motor M connected with the valve member of the intensifier and which, when energized, brings about a transfer of fluid from the side port of the valve 26 at one pressure to the side port of the valve 32 at an intensified pressure.

The operating principle of the intensifier 30 is diagrammatically illustrated in Figure 5, wherein only one of a plurality of the pressure-intensifying pistons 30a contained in the intensifier is shown in relation to the driven rotary valve member or distributor 30b. In operation, rotation of the distributor 30b, upon energization of the motor M, is effective to alternately direct fluid under pressure of the pump 14 against the two pressure areas 30c and 30d of the piston 30a while at the same time connecting the opposite area 30e with exhaust and the smaller opposite area 30f with the work. Thus, pump pressure applied to two faces of the piston causes fluid discharged from the one smaller area 30f to be more highly pressurized as the single area 30f is absorbing the total force produced by the pump pressure acting upon the opposite two faces 30c and 30d. It will be understood, that the interconnecting of the separate pressure faces 30c, d, e and f of the various pistons of the intensifier with the pump inlet, work outlet and exhaust

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ports, respectively, is accomplished solely by means of a suitable system and arrangement of ports within the rotary fluid distributor 30b in connection with a system of channels or passages within the housing of the intensifier leading to the separate intensifier pistons 30a, and that the proper distribution of fluid to and from the pistons is accomplished entirely within the intensifier casing and thence to the respective work and exhaust outlets thereof.

It will further be understood that the illustration of the intensifier as shown in Figure 5 is intended only as a graphic illustration of only one cycle in the operation of one of a plurality of identical piston stages, and that the intensifier during operation is capable of constantly discharging fluid at a higher-than-pump pressure, but at a reduced volume due to the loss of fluid to exhaust.

The pump 14 has connected therewith any suitable linkage for reversing its delivery. As shown there is a linkage 50 which includes a lever 52 having a solenoid S1 connected therewith which, when energized will actuate the linkage to shift the pump to bring about the delivery therefrom to the advancing means of the ram 12. When the solenoid S1 is de-energized the spring 54 brings about the delivery of the pump to the retracting means of the ram 12. When the ram has retracted a predetermined amount an arm 56 on the platen 58 connected with the ram 12 actuates the linkage 50 to place the pump in neutral delivery position thereby to halt the press ram and platen.

The electrical circuit for controlling the energization of the solenoid S1 and the motor M connected with the intensifier valve member is shown in Figure 2. Between the power lines L1 and L2 and in series with the normally opened push button station 60 there is a contactor coil A. Bypassing the push button 60 there is a pair of normally opened contacts adapted for being connected by actuation of the blade A1 by energization of the contact coil A and the normally closed pressure switch T. Parallel with coil A is the pump shifting solenoid S1. Also connected between the power lines L1 and L2 is the motor M in series with the paralleled and normally open pressure switches PS1 and PS2. Upon closure of either of these pressure switches the motor M will be energized to drive the intensifier 30 and thereby to make the same effective.

In Figure 3 there is illustrated another type of check valve which may be used in place of any of the valves 18, 26 or 32. The valve shown in Figure 3 is essentially identical with the aforementioned check valves but includes a cylindrical valve member 62 rather than a ball.

Operations

In operation, the advancing stroke of the ram 12 is commenced by closing the push button 60 whereupon the contactor coil A and the solenoid S1 are energized and a holding circuit therefor is established by the contactor blade A1. The pump now delivers through the check valve 16 to the advancing side of the ram 12. The retracting side of the ram 12 discharges through the valve 18 to the lower port of 14. The initial movement by the ram 12 takes place as rapidly as the pump 14 withdraws fluid from beneath the ram 12 and the advancing means is partially filled through the surge valve 44. When the ram engages the work further movement thereof takes place by the delivery of the pump 14 to

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the advancing means thereof and at this time make-up fluid enters the pump through the lower of the check valves 36.

When pressure rises on the advancing means of the ram sufficiently to close the pressure switch PS1, the motor M commences to operate and the intensifier 30 delivers high pressure fluid to the side port of the valve 32. It will be noted that at this time the valve member of the valve 32 is in its lowermost position so that the pressure fluid supplied by the intensifier flows directly to the ram advancing means.

Upon the accomplishment of a predetermined higher pressure on the ram advancing means, the switch T opens and de-energizes the coil A and the solenoid S1. This permits the spring 54 to move the pump to deliver to the retracting means of the press ram.

The ram 12 now moves upwardly with fluid being delivered thereto from the lower port of the pump 14 through the valve 18, and with the advancing means thereof exhausting through the surge valve 44 which is piloted open by pressure conducted thereto through the conduit 46.

Should the press ram meet resistance during its retracting movement, the pressure switch PS2 will close and again make the intensifier 30 effective to deliver a high pressure fluid to the side port of the valve 32. At this time, the valve member of the valve 32 is in its uppermost position and the high pressure fluid thus flows to the upper port of the valve 18. This moves the valve member 22 thereof downwardly and directs the said high pressure fluid to the ram retracting means. Should the resistance encountered by the ram drop, then the pressure switch will open and the ram will continue its retracting movement under the delivery from the pump.

The circuit described above provides a high pressure actuating circuit for a press with a lower pressure higher speed phase and a shift over from one phase to the other without a complex system of shift over valves. This circuit further employs a single intensifier for supplying both the advancing and retracting means of the press ram.

As a modified arrangement, the springs shown in the check valves 18 and 32 could be eliminated by so positioning the valves that the valve members thereof were normally positioned by gravity toward the end to which they are biased by their respective springs as shown in the drawings.

It will be understood that this invention is susceptible to modification in order to adopt it to different usages and conditions and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

I claim:

1. In a hydraulic circuit; a fluid motor having a pair of ports; a reversible source of pressure fluid connected to supply pressure fluid to either of the ports of said motor; a fluid pressure intensifier having an inlet and an outlet and operable to receive fluid at the said inlet and to redischarge it from said outlet at increased pressure; valve means connected between the inlet of said intensifier and the opposite sides of said source and operable to connect said inlet with the delivery side of said source; a second valve means connected between the discharge side of said intensifier and the ports of said motor and operable to connect the said discharge side with

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whichever of said ports is under pressure; and means responsive to the accomplishment of a predetermined pressure at either of said motor ports for bringing about the delivery of high pressure fluid thereto from said intensifier.

2. In a hydraulic circuit; a fluid motor having a pair of ports; a reversible pump connected between said ports; a fluid pressure intensifier having an inlet and an outlet and also having a valve member which must be driven to make said intensifier effective; a first valve responsive to pressure at either side of said pump for connecting that side with the inlet of said intensifier; other valve means responsive to pressure at either of said motor ports for connecting that port with the discharge side of said intensifier; and means responsive to a predetermined pressure developed at the motor port with which the discharge side of said intensifier is connected for actuating said drivable valve member to make said intensifier effective.

3. In a hydraulic circuit; a fluid motor having a pair of ports; a reversible pump connected between said ports for supplying fluid pressure thereto; a fluid pressure intensifier having an inlet and an outlet and also having a valve member which must be driven to make said intensifier effective; a shuttle valve connected between the opposite sides of said pump and the inlet of said intensifier and operable automatically for connecting said inlet with the pressure side of said pump; other valve means operable to connect the outlet of said intensifier with whichever port of said motor is under pressure, and to disconnect said pump therefrom; and means responsive to the accomplishment of a predetermined pressure at the port of the motor connected with the outlet of said intensifier for actuating said drivable valve member thereby to make said intensifier effective.

4. In combination; a reversible delivery source of pressure fluid; a fluid pressure intensifier having a low pressure inlet and a high pressure outlet; and a shuttle valve connected between the opposite sides of said source and the inlet of said intensifier and including a valve member responsive to pressure at either of said sides for connecting the said side with the inlet of said intensifier.

5. In combination; a reversible delivery pump; a fluid pressure intensifier having a low pressure inlet and a high pressure outlet; a valve connected between the opposite sides of said pump and said inlet; and a valve member in said valve responsive to pressure at either side of said pump for connecting that side with said inlet while simultaneously interrupting communication between said inlet and the other side of said pump.

6. In a hydraulic circuit; a fluid motor having a pair of ports; a reversible source of pressure fluid connected between said ports for supplying actuating fluid to said motor; a fluid pressure

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intensifier having an inlet and an outlet and adapted for receiving fluid at the said inlet and redischarging it from said outlet at increased pressure; means responsive to the accomplishment of a predetermined pressure at either of said motor ports for bringing about the delivery of high pressure fluid from said intensifier, and means responsive to the accomplishment of a predetermined higher pressure at one of said motor ports for reversing the source of pressure fluid.

7. In a hydraulic circuit; a fluid motor having a pair of ports; a reversible source of pressure fluid connected between said ports for supplying actuating fluid to said motor; a fluid pressure intensifier having an inlet and an outlet and adapted for receiving fluid at the said inlet and redischarging it from said outlet at increased pressure; means responsive to the accomplishment of a predetermined pressure at either of said motor ports for bringing about the delivery of high pressure fluid from said intensifier, means responsive to the accomplishment of a predetermined higher pressure at one of said motor ports for reversing the source of pressure fluid, said fluid motor having a ram, and means carried by the ram to place the source of fluid pressure in neutral when the ram is retracted a predetermined amount.

8. In a hydraulic control circuit; a fluid motor having a pair of ports; a reversible source of pressure fluid connected between said ports for supplying actuating fluid to said motor; a driven fluid pressure intensifier having an inlet and an outlet and operable when driven to receive fluid at the said inlet and redischARGE at least a part of said fluid from said outlet at increased pressures; a first valve means connected between said source and the inlet of said intensifier for directing pressure fluid discharged from said source to the inlet of said intensifier; other valve means connected between the outlet of said intensifier and the ports of said motor for establishing communication between the outlet of said intensifier and whichever of said ports is receiving pressure from said source during operation of said intensifier; and means responsive to a given maximum pressure at either of the ports of said motor for bringing said intensifier into operation.

HOWARD M. PURCELL.

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