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3,375,658

PUMP CONTROL SYSTEM FOR COTTON PRESS

Filed Jan. 21, 1966

2 Sheets-Sheet 1

Fig. 1

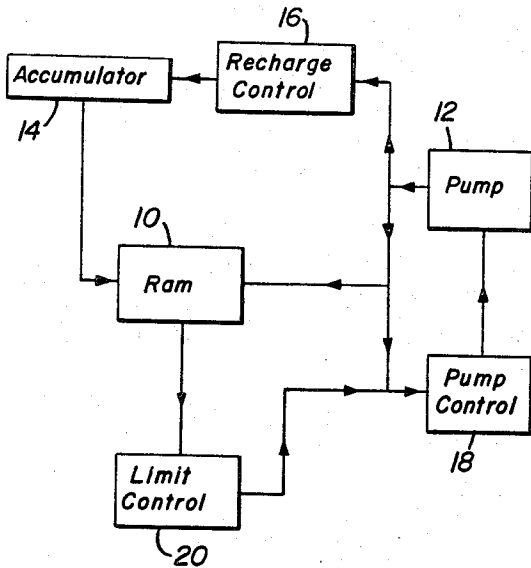


Fig. 2

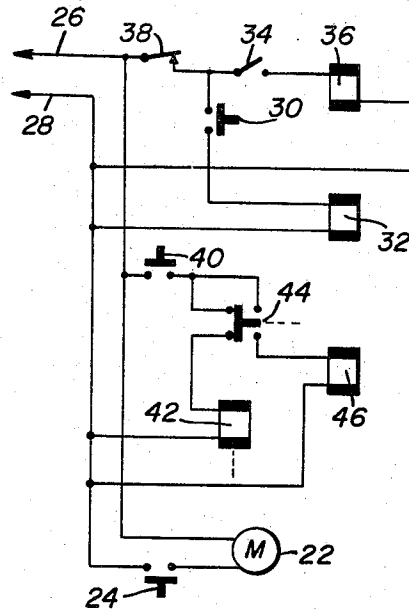
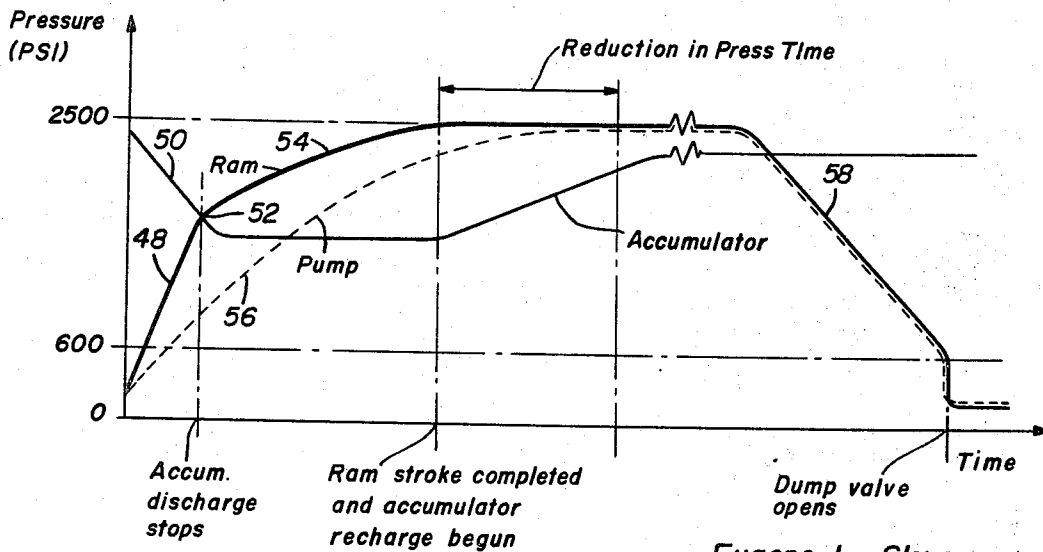


Fig. 4



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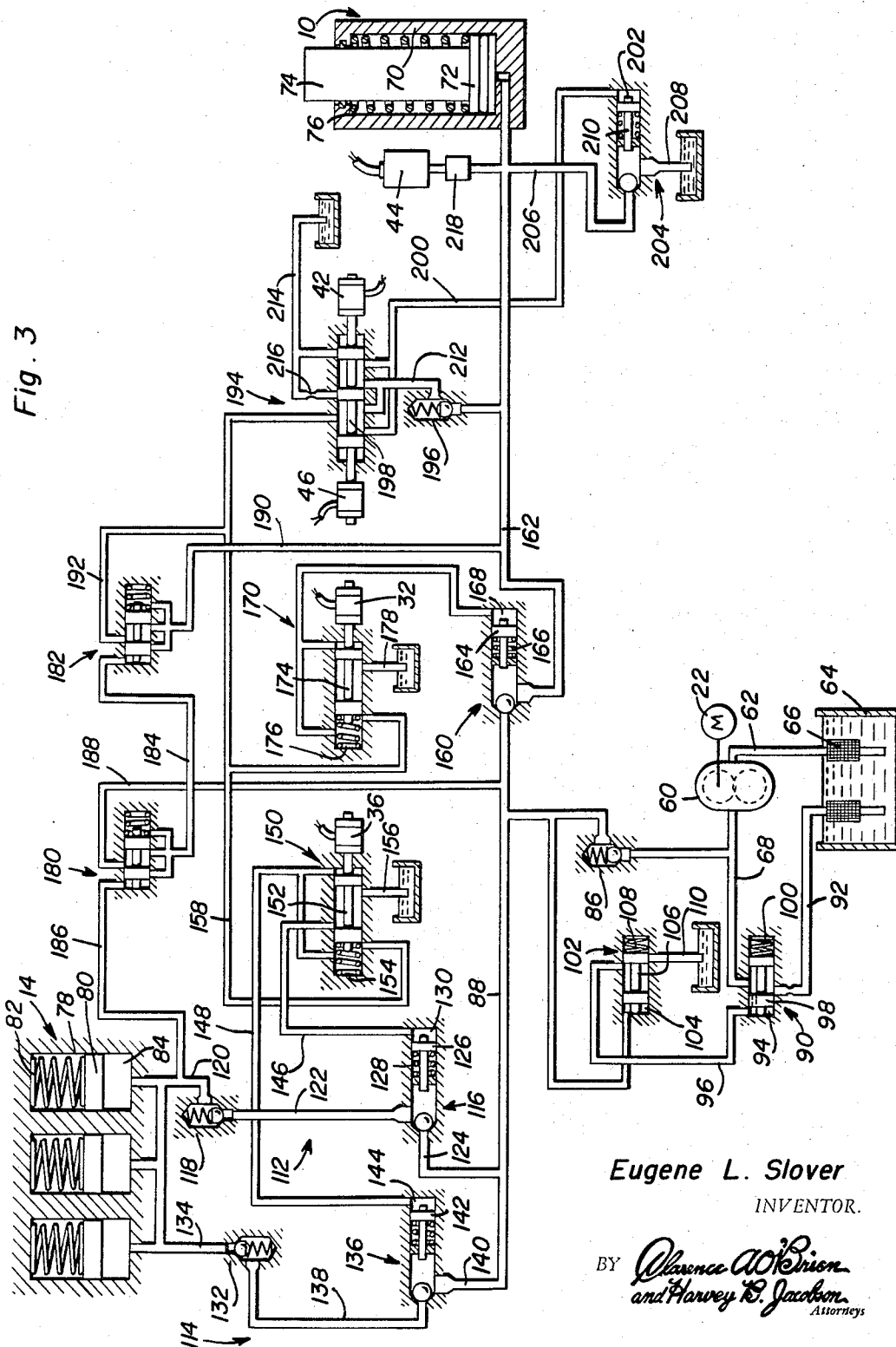
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1

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PUMP CONTROL SYSTEM FOR COTTON PRESS
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Efter Company, a corporation of Texas
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ABSTRACT OF THE DISCLOSURE

An accumulator is charged during idle periods of a continuously operating pump to increase the flow rate of fluid supplied during operating periods to a press. The accumulator is discharged during said operating periods to increase the output from the pump and is disconnected from the pump when its pressure has declined to that of the increasing pump pressure at some value below the maximum output pressure of the pump.

This invention relates in general to a fluid system for controlling the flow rate of fluid under pressure to a fluid operated device and more particularly to a pump control system associated with a bale pressing ram.

The present invention is concerned with improvements in the operation of a cotton gin density press wherein bales of cotton are pressed and tied. In such presses, there are idle pumping periods during which a hydraulic ram that operates the bale pressing tramper is unloaded and the bale tied and removed from the press. Accordingly, it is an important object of the present invention to take advantage of such idle periods in order to increase the displacement rate at which the ram is advanced through its bale pressing stroke beyond the capability of the pump alone.

An additional object of the present invention is to provide a fluid control system for an intermittently loaded ram or fluid displacement device whereby the ram under load is advanced through its stroke at a displacement rate exceeding that associated with the volumetric output of the pump associated with the system by use of fluid accumulators that are charged to capacity during periods when the pump is otherwise idle.

In accordance with the foregoing objects, the fluid control system of the present invention increases the operational speed of bale presses with minimum power and pumps of reduced capacity. Accordingly, the output of the pump need only be sufficient to recharge the accumulators associated with the fluid control system during the bale tying-out phase of operation.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a schematic block diagram illustrating the system of the present invention.

FIGURE 2 is a simplified electrical circuit diagram associated with the system of the present invention.

FIGURE 3 illustrates the fluid circuit associated with the system of the present invention.

FIGURE 4 is a graphical illustration showing the operational characteristics of the system of the present invention.

Referring now to the drawings in detail, it will be noted from FIGURE 1 that the system of the present invention is associated with a fluid operated ram device 10 which may be simultaneously supplied with fluid under pressure from both the pump 12 and an accumulator assembly 14 so that the ram may be displaced at a rate of speed which would exceed the displacement rate otherwise associated

2

with the output of the pump 12 alone. Thus, during those periods when the ram is not pressing any bales, the pump 12 is operative to charge the accumulator 14 through a recharge control 16, operation of the pump being in turn regulated by the pump control 18 dependent upon the output of the pump 12 and the condition of the ram 10. Accordingly, a limit control 20 is associated with the ram for disconnecting the pump therefrom at the end of its operational stroke.

Operation of the fluid control system of the present invention is characterized by intermittent pressing operation of the ram device and continued operation of a relatively low output pump. The pump is accordingly continuously driven by a pump motor 22 as shown in FIGURE 2 upon closing of a pump switch 24 connecting the motor across electrical power lines 26 and 28. When a bale of cotton is to be pressed, operation of the ram is initiated by closing a ram operating switch 30 connecting the ram operating solenoid 32 across the power lines 26 and 28 for energization thereof. Thus, the pressing operation proceeds under supply of fluid to the ram from both the accumulator assembly and the pump at a relatively high flow rate, as soon as initial movement of the ram closes switch 34 connecting the accumulator control solenoid 36 across the power lines 26 and 28. When the ram reaches the end of its stroke, the limit switch 38 is opened so as to open the circuit to both the solenoids 32 and 36 causing de-energization thereof and terminating movement of the ram. Upon de-energization of the solenoids 32 and 36, the accumulator is automatically recharged by the pump which continues to be operated by the motor 22. After the bale has been tied, the "bale out" switch 40 is closed so as to complete an energizing circuit through the bleed control solenoid 42 in series with a pressure switch 44. Thus, the pressure within the ram cavity is slowly reduced as the ram begins its return movement. When the pressure within the ram cavity is reduced by a predetermined amount, the pressure switch is displaced to its other operative position completing an energizing circuit through the dump solenoid 46 and opening the circuit to the bleed solenoid 42 for de-energization thereof. The fluid within the ram cavity is then rapidly vented so that the ram may complete its return stroke at a more rapid rate.

Referring now to FIGURE 4, the foregoing operation of the system is graphically illustrated. It will be noted, that at the beginning of a ram operating cycle, the pressure within the ram cavity increases at a rapid rate depicted by the curve portion 48 in FIGURE 4 while at the same time the pressure within the accumulator which had been charged to a maximum value of 2500 p.s.i., declines as depicted by the curve portion 50. When the pressure in the ram cavity equals the pressure in the accumulator chamber, as shown by the intersection point 52 in FIGURE 4, discharge of the accumulator is terminated so that the pressure within the ram cavity continues to rise at a decreased rate as depicted by the curve portion 54 since the ram cavity is then supplied with fluid by the pump only. The pressure within the ram cavity then rises to the maximum pressure of 2500 p.s.i. or until the ram stroke is completed at which point, recharge of the accumulator is begun. Had the ram been supplied with fluid solely by the pump, the pressure within the ram cavity would have risen at a slower rate as depicted by the dotted line curve 56 so that the duration of the ram stroke would be longer. Accordingly, a substantial reduction in press time is obtained as depicted in FIGURE 4. As also shown in FIGURE 4, after the bale has been tied and the "bale out" switch 40 closed, the pressure within the ram cavity is gradually reduced as depicted by the curve portion 58 until the pressure drops to approximately 600 p.s.i. at which time the pressure within

the ram cavity is dumped so that the ram return stroke may be completed more rapidly.

Referring now to FIGURE 3, the fluid system for accomplishing the foregoing operations is illustrated. The pump motor 22 accordingly drives a relatively low output pump such as a 40 gallon per minute vane pump 60. Fluid is supplied to the intake 62 of the pump from a tank or reservoir 64 through the strainer 66. The pump discharge line 68 thus constitutes a source of pressurized fluid supplied to both the ram device 10 and the accumulator assembly 14. The ram device is of conventional construction and includes a cylinder 70 enclosing the ram cavity on one side of the piston 72 to which the piston shaft 74 is connected, the piston being biased in a return stroke direction by the spring 76. The accumulator assembly 14 on the other hand includes three accumulator cylinders 78 slidably mounting floating pistons 80 which are biased by the springs 82 on one side opposite the accumulator chambers 84 adapted to be charged with fluid to the maximum output pressure of the pump 60.

The discharge line 68 of the pump is connected by a spring-biased, one-way check valve 86 to a pressure supply conduit 88 from which fluid under pressure is supplied to both the ram device 10 and the accumulator assembly 14. Also associated with the pump, is a relief valve 90 through which the discharge line 68 is connected to a return line 92 when the discharge pressure of the pump 60 reaches a maximum value such as 2500 p.s.i. aforementioned. Accordingly, the relief valve includes a pressure chamber 94 to normally hold the valve element 98 in a closed position against the bias of the spring 100. The fluid line 96 connects the chamber 94 to an accumulator unloading valve 102. The unloading valve 102 includes a pressure chamber 104 connected to the supply conduit 88, so that when the pressure within the supply conduit exceeds the maximum value, the valve element 106 is displaced against the spring 108 connecting the line 96 to sump through exhaust line 110. It will become apparent then, that when the accumulators are charged to the maximum pressure by fluid supplied thereto through the supply conduit 88, the unloading valve 102 will be actuated against the bias of its spring 108. The unloading valve is operative through the relief valve 90 to unload the pump by recirculating the fluid discharged therefrom through return line 92. The drop in discharge pressure in line 68 will then cause the one-way check valve 86 to close in view of the higher pressure in the supply conduit 88 and thereby completely disconnect the pump 60 from the supply conduit to prevent return flow of fluid from the conduit 88.

The supply conduit 88 is connected to the accumulator chambers 84 through a fluid charging branch 112 in parallel with an accumulator discharge branch 114. The charging branch 112 conducts fluid in one direction from the supply conduit to the accumulator chambers through the series connected, one-way check valves 116 and 118. The check valve 118 is of the spring-biased type and includes an outlet conduit 120 connected in parallel to the accumulator chambers. The inlet to the check valve 118 is connected by the connecting passage 122 to the outlet of the check valve 116 having an inlet 124 connected to the supply conduit 88. The check valve 116 also includes a signal pressure operated element 126 adapted to be displaced against the bias of a spring element 128 in order to hold the check valve closed when signal pressure is supplied to the pressure chamber 130 thereof. Except for the direction of flow, the accumulator discharge branch 114 is similar to the charging branch 112 in that it includes a spring-biased check valve 132 connected by the conduit 134 to the accumulator chambers and a signal pressure controlled check valve 136 connected in series therewith by the connecting passage 138. Thus, the signal pressure operated check valve 136 includes an outlet connection 140 connected to the supply conduit 88 and a signal pressure operated element 142

adapted to hold the valve closed when signal pressure is supplied to the pressure chamber 144.

The signal pressure chambers 130 and 144 associated with the signal pressure controlled check valves 116 and 136, are respectively connected by lines 146 and 148 to an accumulator control valve assembly 150 with which the accumulator control solenoid 36 is associated. With the solenoid 36 de-energized as shown in FIGURE 3, the valve element 152 is held in one position under the bias of spring 154 venting the signal pressure chamber 130 through exhaust conduit 156 while the signal pressure chamber 144 is connected to the signal pressure line 158 so that when the signal pressure line is pressurized, the element 142 will be displaced against the bias of its spring to hold the check valve 136 closed. On the other hand, when the solenoid 36 is energized, the signal pressure chamber 144 will be vented and the signal pressure chamber 130 pressurized in order to hold the check valve 116 closed. It will therefore be apparent, that as long as the solenoid 36 is de-energized, the pump 60 may charge the accumulator chambers 84 through the charging branch 112, discharge through the branch 114 being prevented at this time. Upon energization of the solenoid 36, the charging branch 112 is closed through the check valve 116 while the branch 114 is opened so that the accumulator assembly may then discharge into the supply conduit 88.

The supply conduit is connected to the ram cavity of the ram device 10 through a supply check valve 160 having an outlet conduit 162 connected to the ram cavity. Also associated with the check valve 160, is a pressure operated element 164 adapted to be displaced against the bias of its spring 166 by signal pressure within the pressure chamber 168 in order to hold the check valve closed. The pressure chamber 168 is therefore adapted to be connected to the pressure signal line 158 through the ram operating valve assembly 170. The valve assembly 170 is associated with the ram operating solenoid 32 so that when it is de-energized as shown in FIGURE 3, the valve element 174 will be biased to one position by the spring 176 connecting the pressure chamber 168 to the pressure signal line 158 thereby holding the supply valve 160 closed. Only when the solenoid 32 is energized will the valve element 174 be shifted to its other operative position against the bias of the spring 176 connecting the pressure chamber 168 to the exhaust line 178 permitting the check valve 160 to open. Thus, energization of the solenoid 32 will connect the supply conduit 88 to the ram cavity through the supply check valve 160 in order to initiate movement thereof.

Signal pressure within the signal pressure line 158 is derived either from the supply conduit 88 or the accumulator 14 dependent upon the pressure condition of the accumulator chambers relative to the conduits 88 and 162. Accordingly, a pair of shuttle valves 180 and 182 are provided, the shuttle valves being interconnected in series by the connecting passage 184. When the accumulator chambers are fully charged, the shuttle valve 180 is displaced against the bias of its spring by means of the fluid under pressure supplied thereto by line 186. On the other hand, the supply conduit 88 is connected to the shuttle valve through line 188 so as to augment the spring pressure biasing the shuttle valve to the position illustrated in FIGURE 3. It will therefore be apparent that either the accumulator pressure or the pressure within the supply conduit 88 dependent upon which is greater, will be applied through conduit 184 to the shuttle valve 182 to which the outlet conduit 162 is connected by the line 190. The higher of the two pressures within lines 184 and 190 will therefore be operative to connect either line 182 or line 180 to the signal pressure line 158 by means of the shuttle valve outlet line 192. Thus, a relatively constant signal pressure will be maintained in the signal pressure line 158 regardless of the changing pressure conditions within the fluid control system. This signal pressure will therefore be available to close any of the

5

check valves 116, 138 and 160 as aforementioned in order to control charging, or discharging of the accumulators and supply of fluid to the ram cavity.

Also associated with the fluid control system as shown in FIGURE 3, is a return stroke control valve assembly 194 operative to regulate the return stroke of the ram device as hereinbefore described. The control valve assembly 194 is connected to the outlet conduit 162 connecting the supply valve 160 to the ram cavity by means of a spring-biased check valve 196. The control valve assembly 194 includes a three-position valve element 198 displaceable from the neutral position illustrated in FIGURE 3 by energization of either the bleed solenoid 42 or the dump solenoid 46. In the neutral position illustrated, the valve element 198 is in a position connecting the signal pressure line 158 to the signal pressure line 200 which in turn is connected to the signal pressure chamber 202 associated with a dump check valve 204. The dump check valve is connected by the conduit 206 to the ram cavity so that when the check valve 204 is opened, it may rapidly vent the fluid within the ram cavity through the exhaust passage 208. However, during the pressing operation of the ram, signal pressure is supplied to the pressure chamber 202 so as to hold the check valve 204 closed by means of the pressure-actuated element 210. After completion of the ram stroke the bleed solenoid 42 is energized shifting the valve element 198 in one direction as illustrated in FIGURE 3. The pressure chamber 202 within the dump valve 204 remains pressurized but the outlet conduit 212 associated with the check valve 196 is then connected to the exhaust passage 214 through restriction 216 so that fluid within the ram cavity may flow at a reduced rate to sump through the check valve 196. When the pressure within the ram cavity reaches a predetermined value, it is sensed by the pressure switch 44 connected to the ram cavity through a surge dampener device 218 as shown in FIGURE 3. The pressure switch 44 is operative as aforementioned to energize the dump solenoid 46 and de-energize the bleed solenoid 42. The valve element 198 associated with the control valve assembly 194 is then shifted to its other operative position connecting the signal pressure line 200 to the exhaust passage 214 causing the dump valve 204 to open. The fluid remaining within the ram cavity is then rapidly vented so as to complete the return stroke.

Summarizing operation of the system, it will be recalled that the pump 60 is set into continuous operation upon energization of the pump motor 22. Fluid at a rising discharge pressure is supplied through the check valve 86 to the supply conduit 88 so that with all of the solenoids de-energized, fluid is conducted in one direction through the series connected check valves 116 and 118 of the accumulator charging branch 112. The accumulators are thereby charged to a maximum pressure. When the maximum pressure is attained, it is sensed by the unloading valve 102 operative through the relief valve 90 to sharply reduce the discharge pressure of the pump so that the discharge pressure line 68 is disconnected from the supply conduit 88 by closing of the check valve 86.

Displacement of the ram is begun by closing of the switch 20 causing energization of the solenoid 32 in order to actuate the valve assembly 170 opening the supply valve 160 so that fluid under pressure from the supply conduit 88 may be conducted to the cavity of the ram device. Initial movement of the ram piston is then operative through the switch 34 to energize the solenoid 36 of the accumulator control valve assembly 150. When the control valve assembly 150 is actuated, the check valve 116 in the accumulator charging branch 112 is closed so as to prevent any further charging of the accumulator chambers while the check valve 136 in the branch 114 is opened so as to permit discharge from the accumulators into the supply conduit 88. Also, as soon as the supply valve 160 is opened, the ensuing drop in pressure within the supply conduit 88 is sensed by the unloading valve 102 where-

6

upon the pump 60 is again connected to the supply conduit so that it may supply fluid under pressure to the ram cavity at the same time that it is supplied with fluid under pressure by discharge from the accumulator chambers 84. The ram is therefore displaced at a rapid rate in view of the increased volume of fluid supplied thereto from both the accumulators and the pump. It will also be apparent, that as the pressure within the ram cavity increases, the pressure within the accumulator chambers 84 decreases. When the pressures in the accumulator chambers and the ram cavity are substantially equal, the check valve 132 closes so as to prevent any further discharge from the accumulator chambers. Movement of the ram then continues at a slower rate since it is then supplied with fluid only from the pump until the maximum discharge pressure of the pump is attained. When the ram reaches the end of its stroke completing the pressing of a cotton bale, a limit switch 38 is opened so as to de-energize the solenoids 32 and 36 whereupon the supply valve 160 closes so as to discontinue supply of fluid to the ram cavity. Recharging of the accumulators then begins in view of the opening of the check valve 116 and closing of the check valve 136 upon de-energization of the solenoid 32. Thus, the accumulators are recharged in preparation for the next pressing operation.

After the pressed bale is tied, closing of the "bale out" switch 40 energizes the solenoid 42 so as to actuate the control valve assembly 194 in one direction bleeding fluid from the ram cavity in order to initiate the return stroke of the ram at a relatively slow displacement rate. When the pressure within the ram cavity reaches a predetermined value, the pressure switch 44 is operative to energize the dump solenoid 46. The control valve assembly 194 is then shifted to its other extreme position causing the dump valve 204 to open so as to rapidly vent the ram cavity in order to complete the return stroke of the ram. The pump control system is then in condition for the next operational cycle.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. In combination with a press having a ram intermittently operated under load by fluid supplied thereto under pressure by a pump having a maximum pressure, a fluid accumulator, charge control means operatively connecting said pump to the accumulator for charging thereof only during idle periods when the pump is unloaded, load responsive means connecting the ram to both the pump and the accumulator for sequentially supplying a fluid at a relatively rapid flow rate and a relatively slower flow rate, means responsive to equalization of increasing pressure in the ram with declining pressure in the accumulator for disconnecting the accumulator from the ram to terminate supply at said rapid rate below said maximum pressure of the pump, and pump unloading means for disconnecting the pump from the ram following continued supply of fluid thereto at a relatively slower flow rate from the pump alone.

2. In combination with a continuously operating pump and a selectively controlled device pressurized by said pump during spaced operating periods, means for increasing the flow rate of fluid to the device during each of said operating periods comprising an accumulator, means connecting the pump to the accumulator for charging thereof between said operating periods, means connecting the device to the accumulator for discharge of the accumulator simultaneously with said pressurization of the device by the pump, and pressure responsive means for disconnecting the accumulator from the pump and the device to

prevent charging of the accumulator during said operating periods.

3. In combination with an intermittently operated fluid displacement device and a continuously operating pump, a fluid control system for controlling the flow rate of fluid supplied to the fluid displacement device from the pump comprising a fluid supply conduit operatively connected to the pump, unloading means responsive to development of a maximum pressure in the supply conduit for disconnecting the pump therefrom, a fluid accumulator, one-way valve means operatively connecting said accumulator to the supply conduit for conducting fluid to the accumulator until the pressure therein substantially equals said maximum pressure, signal means operatively connected to the one-way valve means for selectively directing flow of fluid from the accumulator to the supply conduit until the pressures within the accumulator and the supply conduit are substantially equal, supply valve means operatively connecting the supply conduit to the fluid displacement device for conducting fluid thereto during said flow of fluid from the accumulator to the supply conduit, pressure responsive valve means connected to the unloading means for connecting the pump to the supply conduit in response to flow of fluid through said supply valve means to continuously supply fluid to the fluid displacement device during and after flow of fluid from the accumulator has stopped, and limit means connected to the signal means and responsive to movement of the fluid displacement device by a predetermined amount for rendering the one-way valve means operative to recharge the accumulator.

4. The combination of claim 3 including a dump valve connected to the fluid displacement device, selectively controlled valve means operatively connecting the signal means to the dump valve for bleeding fluid from the fluid displacement device at a slow rate, and reduced pressure responsive switch means operatively connected to the selectively controlled valve means for venting fluid at a rapid rate from the fluid displacement device through the dump valve.

5. The combination of claim 4 wherein said one-way valve means comprises, two pairs of series connected check valves connected in parallel branches between the supply conduit and the accumulator respectively conducting flow of fluid in opposite directions, and pressure operated means connecting the signal means to one of the check valves in each of said branches for alternatively blocking flow of fluid through one of said branches.

6. The combination of claim 5 wherein said signal means comprises, a charge controlling valve assembly connected to said one-way valve means, a signal pressure conduit connected to said valve assembly for supply of signal pressure fluid to the one-way valve means, an opera-

tion controlling valve assembly connecting said signal pressure conduit to the supply valve means and shuttle valve means alternatively connecting the supply conduit and the fluid accumulator to the signal pressure conduit in accordance with the pressure in the accumulator.

7. The combination of claim 3 wherein said one-way valve means comprises, two pairs of series connected check valves connected in parallel branches between the supply conduit and the accumulator respectively conducting flow of fluid in opposite directions, and pressure operated means connecting the signal means to one of the check valves in each of said branches for alternatively blocking flow of fluid through one of said branches.

8. The combination of claim 7 wherein said signal means comprises, a charge controlling valve assembly connected to said one-way valve means, a signal pressure conduit connected to said valve assembly for supply of signal pressure fluid to the one-way valve means, an operation controlling valve assembly connecting said signal pressure conduit to the supply valve means and shuttle valve means alternatively connecting the supply conduit and the fluid accumulator to the signal pressure conduit in accordance with the pressure in the accumulator.

9. The combination of claim 3 wherein said signal means comprises, a charge controlling valve assembly connected to said one-way valve means, a signal pressure conduit connected to said valve assembly for supply of signal pressure fluid to the one-way valve means, an operation controlling valve assembly connecting said signal pressure conduit to the supply valve means and shuttle valve means alternatively connecting the supply conduit and the fluid accumulator to the signal pressure conduit in accordance with the pressure in the accumulator.

10. The combination of claim 9 including a dump valve connected to the fluid displacement device, selectively controlled valve means operatively connecting the signal means to the dump valve for bleeding fluid from the fluid displacement device at a slow rate, and reduced pressure responsive switch means operatively connected to the selectively controlled valve means for venting fluid at a rapid rate from the fluid displacement device through the dump valve.

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