

2,395,974

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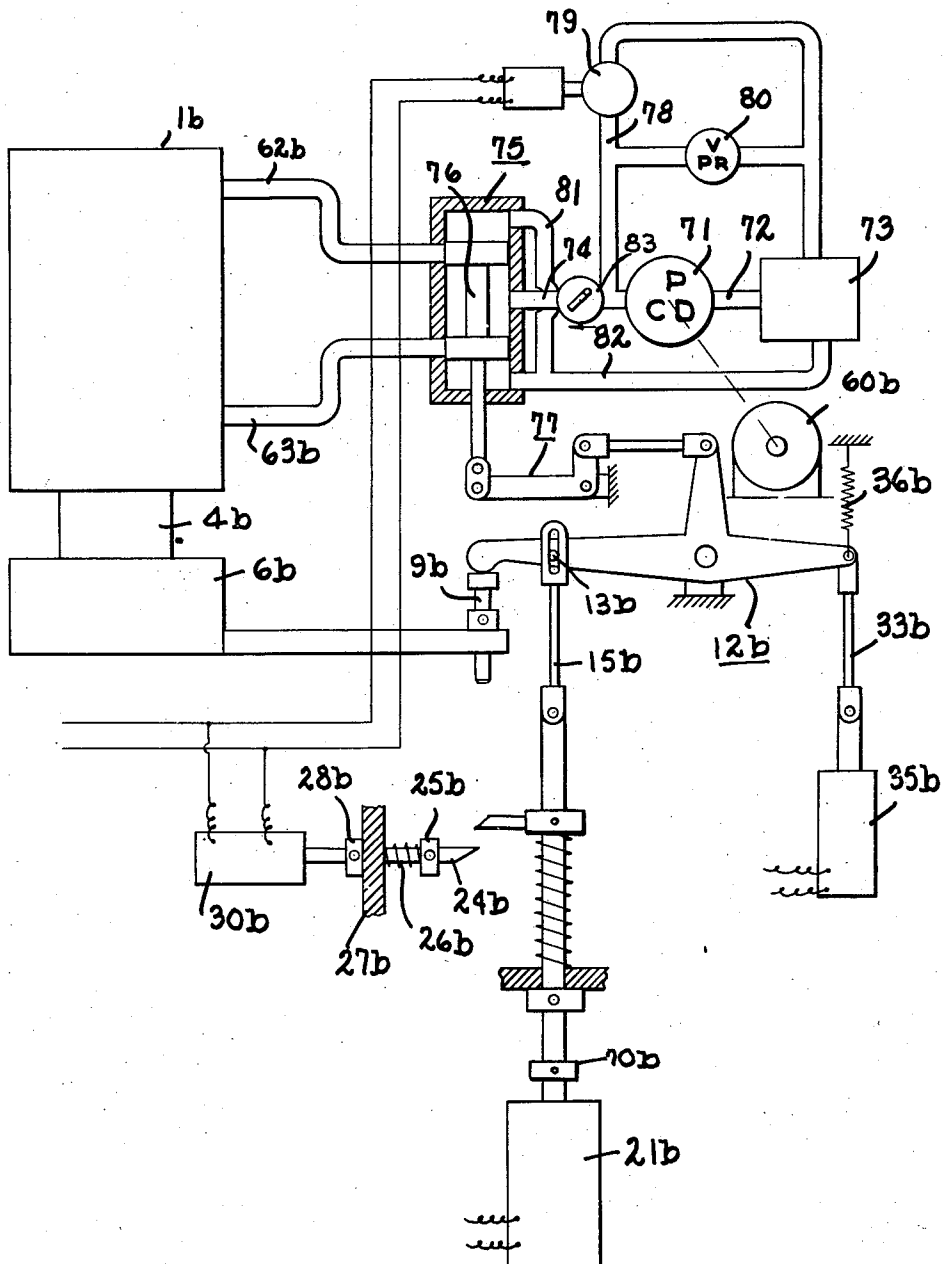
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CONTROL SYSTEM

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FIG. 3



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CONTROL SYSTEM

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4 Claims. (Cl. 103—38)

This invention relates to control systems and, in particular, to control systems for hydraulic circuits.

It is well known that when a hydraulic press stands idle for a relatively long period of time, the press ram gradually slides or creeps downwardly due to leakage around hydraulically operable driving means operatively connected with the press ram. When then the press is to be put into operation, the ram has first to be returned to its retracted or starting position. In case the driving fluid is supplied by a pump of the variable delivery type, it is customary, to positively connect the said pump with an electric motor for driving the pump, so that when the electric motor is started, also the pump is started, while substantially simultaneously the pump is automatically moved into return stroke position, if it does not already occupy the said return stroke position.

Similarly, when the driving fluid is supplied by a pump of the constant delivery type, it is customary, for various reasons, to positively connect the pump with the electric driving motor therefor, so that also in this instance the pump starts delivering pressure fluid to the retracting means for the press ram immediately the electric driving motor is started.

Since, under these circumstances, the electric motor has to start under full load when, after a relatively long period of idleness of the press, the ram has to be returned to its retracted or starting position, special starter means is required to protect the electric motor. Furthermore, the power required for this initial or conditioning operation is relatively high.

It is, therefore, an object of this invention to provide a control system which may be used in connection with hydraulic presses for remedying the above mentioned drawbacks.

It is another object to provide a hydraulic system including a fluid operable plunger and pressure fluid means, driven by and connected to a motor, for supplying pressure fluid to the said plunger, in which the motor and thereby also said pressure fluid means may be brought up to full speed before said pressure fluid means delivers pressure fluid to actuating means for said plunger, to thereby bring about a movement of the said plunger from an intermediate position to one of its end positions.

It is a further object to provide a control system including a variable delivery pump having its shaft rigidly connected to the driving shaft of a prime mover, in which electrically controlled means is adapted to hold the pump in substan-

tially neutral or no delivery position while the prime mover is being brought up to a desired speed.

Still another object of the invention consists in the provision of a control system including a variable delivery pump having its shaft rigidly connected to the driving shaft of a prime mover, in which hydraulically controlled means is adapted to hold the pump in substantially neutral or no delivery position while the prime mover is being brought up to a desired speed.

It is also an object of the invention to provide a control system which may be used in connection with a reciprocable plunger adapted to bring about a reduction in the speed of movement of said plunger at any desired point of its travel in one direction.

It is still another object of the invention to provide a control system for use in connection with hydraulic systems including a fluid operable plunger, a variable delivery pump for supplying pressure fluid to said plunger and a prime mover rigidly connected to said pump, in which the pump linkage is at all times actuated without a sudden shock.

A still further object of the invention consists in the provision of a control system including a fluid operable plunger and a constant delivery pump having its shaft rigidly connected to the driving shaft of a prime mover and adapted to supply pressure fluid to said plunger, in which control means is provided adapted to prevent said pump from delivering actuating fluid to said plunger before said prime mover has reached a predetermined speed.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawings, in which:

Figure 1 diagrammatically illustrates a control system according to the invention in connection with a hydraulic press.

Figure 2 shows a variation of the control system according to the invention.

Figure 3 shows a further embodiment of the invention in connection with an open circuit.

General arrangement

According to the invention, the flow control member of a variable delivery pump is connected through a linkage with two thrusters in such a manner that actuation of one thruster shifts the pump into full stroke delivery position, whereas the other thruster when moved into a first position, causes a reduction of the delivery of the

pump and, when moved into a second position, causes the pump to move into substantially neutral or no delivery position. The thrusters may be controlled in any convenient manner, for instance, electrically or hydraulically.

When the system according to the invention is used in connection with a hydraulic press and the press ram, after a relatively long period of idleness, is to be returned from a position intermediate its end positions to its initial or starting position, the second mentioned thruster is moved into its second position, thereby moving or holding the pump in neutral position, while the prime mover for the pump and, thereby, the pump, is brought up to a desired speed. When this speed has been reached, both thrusters are deenergized whereby the second thruster is made ineffective, while the return mechanism for the first thruster actuates the pump into its return stroke position. The plunger will then, without causing undue load upon the motor and the pump, be returned to its initial or retracted position. The press may then be operated in the conventional manner.

When it is required, at a desired point of travel of the press ram in one direction, to slow down the movement of the ram, limit switch means is actuated, which causes the second thruster to move into its first position.

Structural arrangement

Referring now to the drawings in detail, the press system shown in Figure 1 comprises a press cylinder 1 having reciprocally mounted therein a press ram, generally designated 2, including a piston 3 and piston rods 4, 5.

Connected to the piston rod 4 is a platen 6 with a platen arm 7, which latter is adapted to cooperate with a collar 8 adjustably mounted on a push rod 9. The push rod 9 is guided on the press frame in any conventional manner, not shown in the drawings.

Also adjustably connected to the push rod 9 is a collar 10 for cooperation with an arm 11 of a three arm lever, generally designated 12. The arm 11 carries a pin 13 extending into a slot 14 of a control or thruster rod 15. The control or thruster rod 15 has adjustably connected thereto an abutment 16 engaged by the upper end of a spring 17, the lower end of which engages a portion 18 connected to a stationary member which may, for instance, be the press frame. The rod 15 has also adjustably connected thereto a collar 19 for abutment with the portion 18.

The lower end of the control or thruster rod 15 is pivotally connected to an element 20 pertaining to an electrically controlled thruster 21. The thruster 21 may be of any conventional design, for instance, of the type disclosed in U. S. Patent 1,947,241.

The adjustable abutment 16 has connected thereto an arm 22 with an inclined end surface 23 which is adapted to cooperate with a similarly shaped rod 24. The rod 24 has adjustably mounted thereon an abutment 25 engaged by one end of spring 26, while the other end of this spring engages a stationary element 27. The rod 24 also carries, adjustably mounted thereon, a collar 28 adapted to abut the stationary element 27. The rod 24 has connected thereto an armature 29 controlled by a solenoid 30. The arrangement is such that when the rod 24 occupies its outermost right hand position with regard to Figure 1, it will engage and stop the arm 22 when the latter moves inwardly from the position shown in Figure 1. The three arm lever 12 is shiftable about a

pivot 31 and has its arm 32 pivotally connected to a control or thruster rod 33, which latter is pivotally connected to an element 34 pertaining to the electrically controlled thruster 35, which may be of the same type as the thruster 21 but has less power than the latter. The right hand end of the arm 32 has connected thereto one end of a spring 36, the other end of which is connected to a stationary element 37. The thruster 35 has connected thereto a line 38 adapted, by closure of the switch 39, to be electrically connected with the line 40 which, in its turn, is adapted, by closure of the switch 41, to be connected with the line 42. The line 42 is connected to a line 43, one end of which leads to the solenoid 30, whereas the other end is adapted, by closure of the switch 44, to be connected with a line 45, which latter leads to the line 38. Closure of the switch 44 also establishes electric connection between a line 46 leading to the main supply line 47 with a line 48 leading to the thruster 21.

The thruster 21 has also connected thereto a line 49 leading to a line 50, one end of which is connected to the solenoid 30, whereas the other end of the line 50 is connected to the main supply line 51. The thruster 21 has also connected thereto a line 52 adapted, by closure of the switch 53, to be connected with the line 54. The line 54 is connected to the line 40, which leads to the main supply line 47.

The third arm 55 of the three arm lever 12 is pivotally connected to a link 56, which is pivotally connected to a flow control rod 57, pertaining to a variable delivery pump, generally designated 58, and provided with a servomotor 59. The pump 58 is adapted to be driven by a prime mover 60, such as an electric motor.

The pump 58 has associated therewith a pilot pump 61. The pumps 58 and 61 are driven by one and the same shaft and may be arranged in the manner disclosed in the Ernst Patent No. 2,168,669.

The pump 58 is preferably of the type shown in the Ernst Patent No. 2,184,665, in which fluid from the pilot pump is adapted to shift the flow control member of the pump selectively into forward or return stroke position. Furthermore, centering springs, not shown in the drawings, are provided in a manner similar to that disclosed in the said Ernst Patent No. 2,184,665, which tend to hold the pump in neutral or no delivery position. From the above, it will be clear that when the prime mover 60 is started, also the pumps 58 and 61 are started. The pump 58 has hydraulic connections 62 and 63 respectively leading to the upper and lower portion of the press cylinder 1.

Referring to Figure 2, the control mechanism shown therein differs from that of Figure 1 merely in that the electric control of the thrusters 21 and 35 and the solenoid 30 are replaced by hydraulically operable cylinder-piston-assemblies 64, 65 and 66. Since otherwise the structure fully corresponds to that of Figure 1, the elements of Figure 2, corresponding to similar elements in Figure 1, have been designated with the same reference numerals, however, with the additional letter a.

Operation

It may be assumed that all parts of the system described above occupy the position shown in Figure 1, with the exception that the press piston 3 occupies a position intermediate its uppermost and lowermost positions. It may furthermore

be assumed that the prime mover 60 and the pumps 61 and 58 are at a standstill, while the centering springs associated with the pump 58 hold the latter in substantially neutral or no delivery position.

If it is now desired to put the press into operation, it is necessary first to return the piston 3 to its uppermost position, shown in Figure 1. To this end, the operator starts the prime mover 60, thereby also starting the pumps 58 and 61.

In hydraulic press systems heretofore known, the starting of the pilot pump 61 would immediately cause fluid delivered thereby to shift the pump 58 into retraction stroke position, so that the prime mover 60, which as a rule is an electric motor, would have to be started under full load. This made the provision of special starter means necessary to protect the said motor, while simultaneously causing a high surge of current.

However, according to the present invention, the operator, either before or simultaneously with the starting of the prime mover 60, closes the switch 44, thereby causing current from the main supply lines 47 and 51 to energize the solenoid 30 and the thrusters 21 and 35.

Energization of the solenoid 30 brings about a leftward movement of the rod 24 so as to move the latter out of the path of the arm 22.

Energization of the thruster 35 tends to bring about a downward movement of the control or thruster rod 33. However, this tendency is overcome by the energization of the thruster 21, which is stronger than the thruster 35 and causes a downward movement of the thruster rod 15, so that the upper end of the slot 14 engages the pin 13 and positively holds the arm 11 of the three arm lever 12 in the position shown in Figure 1, at which position the collar 70 abuts the top of the thruster 65. In this position, the flow control rod 57 causes the pump 58 to occupy its neutral or no delivery position.

Therefore, when now the prime mover 60 is started and, thereby, also the pumps 58 and 61, pressure fluid delivered by the pilot pump 61 cannot cause shifting movement of the pump 58 to its retracted position, and is, therefore, bypassed, for instance, through a relief valve of any desired type to an exhaust in a conventional manner.

When the prime mover 60 has reached its desired speed, the pump 58 may be shifted into its return stroke position to bring about the full retraction of the press piston 3. To this end, the operator opens the switch 44, thereby deenergizing the solenoid 30 and thrusters 21 and 35.

The solenoid 30 has associated therewith retarding means, for instance a dashpot (not shown), which prevents the return of the rod 24 into the position shown in Figure 1 before the spring 17 has moved the rod 15 into the position shown in Figure 1.

The spring 36 will then actuate the three arm lever 12 so as to bring about leftward movement of the flow control rod 57, whereupon pressure fluid delivered by the pilot pump 61 moves the pump 58 into its retraction stroke position. Since, at this time, both the prime mover 60 and the pump 58 are at full speed, movement of the pump 58 into its retracted stroke position is carried out smoothly without undue load on the prime mover 60.

Pressure fluid delivered by the pump 58 now passes through conduit 63 into the lower portion of the press cylinder 1, while fluid is withdrawn

from the upper portion of the cylinder 1 by the pump 58. Consequently, the ram 2 now moves upwardly. When the ram, during this upward movement, approaches the position shown in

Figure 1, the platen arm 7 engages the collar 8 and lifts the push rod 9 so that the collar 10 engages the left end of the lever arm 11 so as to move the lever 12 in clockwise direction. When the ram 2 has reached the position shown in Figure 1, the lever 12 is likewise in the position of Figure 1, in which position it has caused the flow control rod 57 to bring about movement of the pump 58 into its neutral or no delivery position. As a result thereof, the press ram is halted in the position shown in Figure 1.

In order to start a pressing cycle of the press ram, the operator closes the switch 39, thereby establishing electric connection between the lines 40 and 38, and energizing the thruster 35. As a result thereof, the three arm lever 12 is shifted in clockwise direction into a position in which the pin 13, carried by the lever arm 11, abuts the upper end of the slot 14 on the rod 15 when the latter occupies the position of Figure 1. This shifting movement of the lever 12 causes a rightward movement of the flow control rod 57, as a result of which the pump 58 moves into full stroke forward position. Pressure fluid delivered by the pump 58 then flows through conduit 62 into the upper portion of the press cylinder 1, while fluid is withdrawn from the lower portion of the press cylinder 1. Consequently, the press ram 2 now moves downwardly.

When the ram is about to approach its work piece engaging position, it is desirable to slow down the movement of the press ram. To carry out such slow down operation, the operator closes the switch 53, thereby energizing the solenoid 21. As a result thereof, the thruster rod 15 moves downwardly until its arm 22 engages the rod 24, at which time the rod 15 comes to a halt. This downward movement of the thruster rod 15 causes a leftward movement of the lever 12, thereby moving the flow control rod 57 toward the left so that the pump 58 moves to a restricted delivery position. Consequently, a smaller quantity of pressure fluid than before is supplied from the pump 58 through conduit 62 to the upper portion of the press cylinder 1 and a corresponding amount of pressure fluid is withdrawn from the lower portion of the press cylinder 1. The press ram 2 now moves downwardly at a reduced speed. Should it be desired to halt the press ram, the switch 41 may also be closed thus withdrawing the rod 24 from the path of the arm 22.

When it is desired to again speed up the movement of the ram, the operator again opens the switch 53 so that the thruster 35, which is still energized, shifts the three arm lever 12 in clockwise direction and causes the pump 58 to again move into full delivery forward stroke position. The ram 2 now gets the full delivery of the pump 58 and, consequently, again advances at high speed.

When the pressing operation has been completed, the operator opens the switch 39, thereby deenergizing the thruster 35 and enabling the spring 36 to impart rotation in anticlockwise direction upon the three arm lever 12. This causes a rightward movement of the flow control rod 57 and, as a result thereof, the pump 58 moves into its full delivery retraction stroke position. Pressure fluid is then delivered by the pump 58 through the conduit 63 into the lower part of the press cylinder 1, while fluid is withdrawn from the upper part of the press cylinder 1 through

the conduit 62. The press ram 2, therefore, moves upwardly.

When the press ram 2 approaches the position shown in Figure 1, the platen arm 8, through the intervention of the push rod 9, lever 12, line 56 and flow control rod 57, moves the pump 58 to neutral or no delivery position, in the manner described above.

When the press ram 2 has reached the position shown in Figure 1, it comes to a halt, and the press is now ready for a new cycle.

If the solenoid 30 and the thrusters 21 and 35 are replaced by the cylinder-piston-assemblies 64, 65 and 66, it will be clear that the ram 2 may be operated in exactly the same manner as described above. The only difference in this instance consists in that the actuation of the rods 24a, 16a and 33a against the thrust of their respective springs 26a, 17a and 36a will be brought about by supplying pressure fluid through the conduits 67, 68 and 69 respectively. The supply of fluid to and withdrawal of fluid from the cylinder-piston-assemblies 64, 65 and 66 may be controlled by four-way valves of any conventional type.

While the control system according to the invention has been described in connection with a reversible variable delivery pump, it is understood that the invention is by no means limited to the use of such pump. It will be obvious that the control system according to the invention may also be used in connection with a one-way variable delivery pump and a four-way valve of conventional design which, in addition to its two service positions, has at least a third position, namely, a neutral or closing position. The valve member will, in such an instance, be connected to the link 56 so as to be controlled thereby in such a manner that in one of its service positions the valve will admit fluid from the one-way delivery pump to one or the other end of the press cylinder 1, whereas, in its neutral position, it will prevent the flow of fluid to and from the press cylinder 1. The delivery of the one-way pump will then be by-passed through a relief valve in the usual manner.

The slowdown effect can be obtained by moving the valve into a throttling position, so that only part of the respective service port of the valve is open.

Referring now to Figure 3, the structure shown therein corresponds in general to that of Figure 1, with the exception that the closed hydraulic circuit of Figure 1 has been replaced by an open circuit. More specifically, the variable delivery pump 58 of Figure 1 has been replaced by a constant delivery pump 71, which has its shaft rigidly connected with the driving shaft of the electric motor 60b. The pump 71 has one end connected through a conduit 72 with a tank or fluid reservoir 73, whereas the pressure side of the pump 71 is connected through a conduit 74 to a four-way valve 75. The valve 75 comprises a valve member 76 connected by a linkage 77 with the three arm lever 12b, which is controlled in a manner similar to that of lever 12.

Branching off from the conduit 74 is a conduit 78 including an electrically controlled normally closed shutoff valve 79 and leading to the tank 73. The shutoff valve 79 may be by-passed by a pressure relief valve 80. The electric control for the valve 79 is arranged in parallel with regard to the solenoid 30b. Furthermore, a check valve 83 is arranged in the conduit 74 between the pump 71 and the valve 75 so as to prevent

the ram 6b from dropping when the pump is being by-passed through valve 79. The remaining parts correspond to those of Figure 1 and carry the same reference numerals as in Figure 1, however, with the additional letter b.

It may now be assumed that the press has been standing idle and that the ram 6b occupies a position intermediate its end positions. If it is now desired to return the ram 6b to its retracted position for starting a pressing cycle, the operator starts the prime mover 60b and, simultaneously therewith or before, energizes the solenoid 30b, the shutoff valve 79 and the thrusters 21b and 35b. In a manner similar to that described in connection with Figure 1, the lever 12b moves into its neutral position, thereby shifting the valve member 76 through the intervention of linkage 77 into its neutral position in which the flow of fluid through conduits 62b and 63b is blocked. Consequently, since the pump 71 was started simultaneously with the prime mover 60b, and since, due to the energization of the electric part of the valve 79, this valve is open, the delivery of the pump 71 is by-passed to the tank 73.

When the prime mover 60b has been brought up to the desired speed, the operator deenergizes the solenoid 30b, the valve 79 and the thrusters 21b and 35b, so that the spring 36b shifts the lever 12b in anti-clockwise direction. This results in an upward movement of the valve member 76 so that, since valve 79 is now closed, pressure fluid from pump 71 passes through conduit 63b into the lower part of the press cylinder 1b, while fluid from the upper part of cylinder 1b, flows through conduit 62b and conduits 81 and 82 into the tank 73. The ram 6b, therefore, moves upwardly.

When the ram approaches the end of its retraction stroke, the lever 12b is returned to its neutral position, in the manner described in connection with Figure 1. Therefore, also valve member 76 returns to the position shown in Figure 3 and the delivery of pump 71 is by-passed through the relief valve 80 into the tank 73. The press now comes to a halt and is ready for a pressing cycle. The pressing cycle itself is performed in a manner similar to that described in connection with Figure 1, the only difference consists in that the valve member 76 is controlled instead of the flow control member of the variable delivery pump 58.

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

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

1. The combination of a variable delivery pump, electric motor means having its driving shaft positively connected with the driving shaft of said pump, yielding means continuously urging said pump toward full stroke position in one direction, opposed electrical thrusters for varying the delivery of said pump, and switch means selectively operable simultaneously to energize both of said thrusters to move and hold said pump in substantially neutral or no delivery position at any time said motor is being started.

2. The combination of a variable delivery pump, electric motor means having its driving shaft positively connected with the driving shaft of said pump, yielding means continuously urg-

ing said pump toward full stroke position in one direction, a first electrical thruster operable to move said pump against the thrust of said yielding means into said full stroke position in the other direction, a second electrical thruster operable to move said pump into neutral or zero stroke position against the thrust of said first thruster, first switch means for energizing both of said thrusters simultaneously for positioning said pump in neutral at any time said motor is being started, and second switch means selectively operable for energizing said thrusters independently.

3. The combination of a variable delivery pump, electric motor means having its driving shaft positively connected with the driving shaft of said pump, a first electrical thruster operable to move said pump into full stroke position in one direction, a second electrical thruster operable to move said pump against the thrust of said first thruster into substantially no delivery position, a stop selectively positionable to stop said second thruster in order to position said pump in reduced stroke position, switch means selectively operable for energizing both of said thrusters simultaneously for positioning said

5 pump in neutral when said motor is being started, or for energizing said first thruster independently, or for energizing said second thruster independently, and means selectively operable for rendering said stop effective or ineffective.

4. The combination of a variable delivery pump, electric motor means having its driving shaft positively connected with the driving shaft of said pump, a first electrical thruster operable to move said pump in full stroke position in one direction, a second electrical thruster operable to move said pump into substantially neutral against the thrust of said first thruster, stop means normally positioned to halt said second thruster to position said pump in reduced stroke position, electrical means associated with said stop for moving it out of its stopping position, first switch means operable simultaneously to energize said thrusters and said electrical means for positioning said pump in neutral, and other switch means selectively operable for energizing said first and second thrusters independently for moving said pump, respectively, into full stroke or reduced stroke position in said one direction.

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