

Dec. 7, 1948.

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2,455,837

PUMP CONTROL MEANS FOR HYDRAULIC SYSTEMS

Filed Nov. 27, 1942

FIG. 1

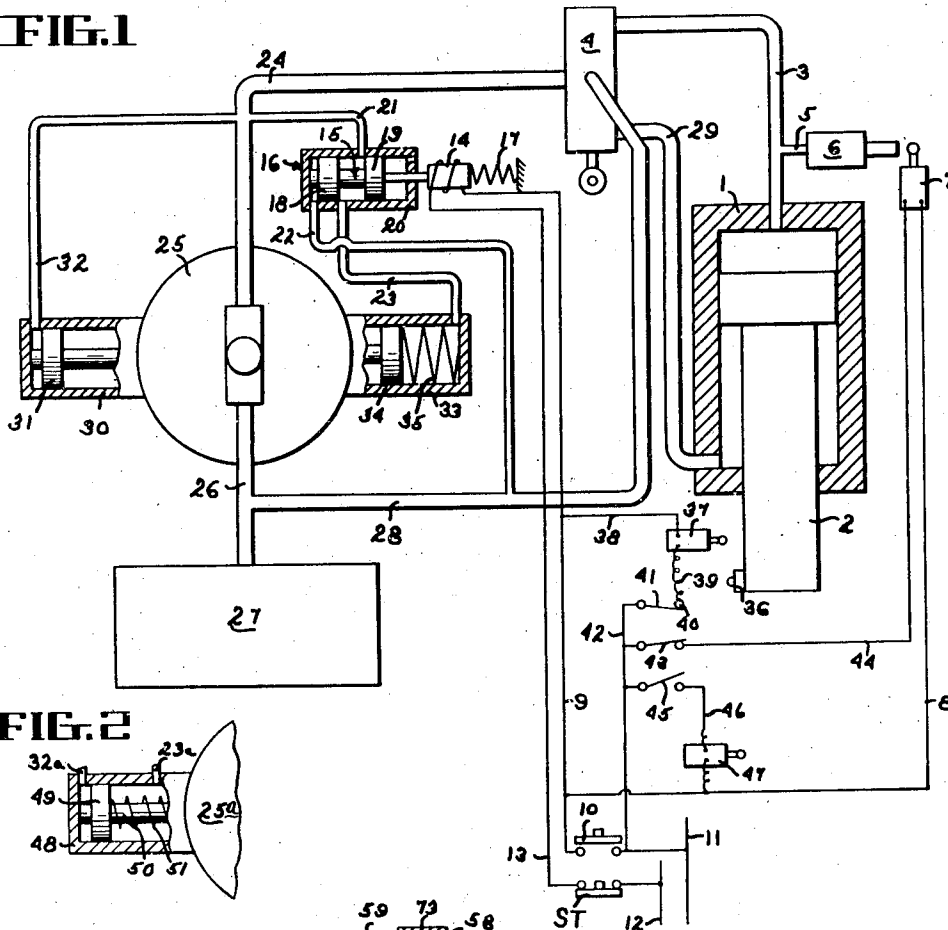


FIG. 2

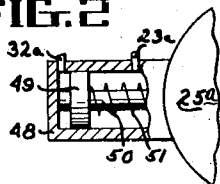
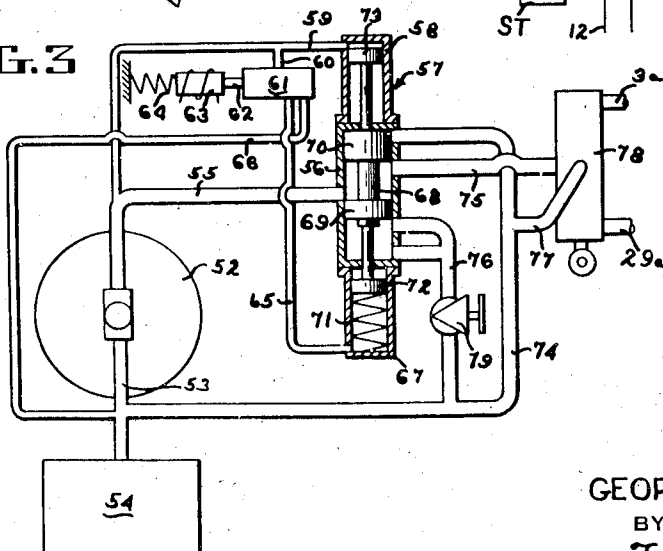


FIG. 3



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2,455,837

PUMP CONTROL MEANS FOR HYDRAULIC SYSTEMS

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Application November 27, 1942, Serial No. 467,273

2 Claims. (Cl. 60—52)

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This invention relates to control systems and, in particular, to control systems for pressure fluid sources, such as pumps.

It is an object of this invention to provide an improved control system in connection with a fluid pressure pump, which will allow the pump to run idle under substantially no load.

It is another object of the invention to provide a hydraulic system including fluid operable motor means and a fluid pressure source for delivering pressure fluid to said motor means, in which the fluid source is provided with control means operable to allow said fluid source to idle under substantially no load.

Another object of the invention consists in the provision of a hydraulic system including hydraulically operable motor means and a variable delivery pump for delivering pressure fluid to said motor means, in which the pump is provided with fluid pressure responsive means operable selectively by fluid delivered by said pump for moving the pump into substantially neutral or no delivery position.

It is a further object of the invention to provide a hydraulic system including a fluid source of constant delivery, in which fluid pressure responsive means is provided operable selectively by fluid delivered by said fluid source for by-passing the delivery of said fluid source.

Still another object of the invention consists in the provision of a hydraulic system including a variable delivery pump for supplying pressure fluid, in which first fluid pressure responsive means is adapted in response to a predetermined pressure to shift the pump into substantially neutral or no delivery position, and in which second fluid pressure responsive means, independent of said first fluid pressure responsive means, is provided for moving said pump into substantially neutral or no delivery position during any time said pump is in operation.

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 first embodiment of the invention in connection with a variable delivery pump.

Figure 2 is a slight modification of a detail in Figure 1 and comprises an additional control feature.

Figure 3 is a further embodiment of the invention in connection with a constant delivery pump.

Referring now to the drawings in detail, 1 designates a press cylinder having reciprocally

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mounted therein a press ram 2. The upper portion of the cylinder 1 communicates with a conduit 3 leading to a four-way valve 4, of any standard design.

Branching off from the conduit 3 is a conduit 5 comprising a tonnage control valve 6 which, in response to a predetermined pressure in the conduit 5, closes a normally open switch 7. The tonnage control valve 6 may be of any standard design, for instance, of the type set forth in U. S. Patent No. 2,224,957.

One terminal of the switch 7 is connected through the line 8 with the line 9, which latter is adapted, by closure of the starter switch 10, to be connected with the main supply line 11. The main supply line 12 is connected through a normally closed starter switch ST and the line 13 with one end of a solenoid 14, the other end of which is connected with the line 9. The solenoid 14 is adapted, when energized, to move the valve member 15 of a three-way valve 16 toward the right with regard to Figure 1. When the solenoid 14 is deenergized, the spring 17 moves the valve member 15 into the position shown in Figure 1. The valve member 15 comprises two interconnected piston portions 18 and 19 reciprocally mounted in the valve cylinder 20 for controlling fluid connection between the conduits 21, 22 and 23.

As will be clear from the drawing, the conduit 21 communicates with the conduit 23, when the valve member 15 occupies the position shown in Figure 1. When the valve member 15 is in its right hand end position, the conduit 23 communicates with the conduit 22, while the fluid connection between the conduits 21 and 23 is interrupted.

The conduit 21 leads into the conduit 24 which connects the pressure side of the variable delivery pump 25 with the valve 4. The pump 25 may be of any standard design, preferably of the radial piston or the radial vane type. The suction side of the pump 25 communicates through the conduit 26 with a fluid reservoir or tank 27. Branching off from the conduit 26 is a conduit 28 leading to the valve 4. Also connected to the valve 4 is a conduit 29 communicating with the lower portion of the cylinder 1.

The valve 4 is adapted to be actuated so as to effect fluid connection between the conduit 24 and the conduit 3, while simultaneously connecting the conduits 28 and 29 with each other. The valve 4 is also operable to effect fluid connection between the conduits 24 and 29, while simultaneously connecting the conduits 3 and 28 with each other.

The pump 25 has connected thereto, on one side thereof, a cylinder 30, in which is reciprocally mounted a plunger 31 connected with the flow control member (not shown) of the pump 25. Movement of the plunger 31 toward the right shifts the flow control member of the pump 25 so as to reduce the delivery of the pump. When the plunger 31 has reached its extreme right hand position, the pump 25 is in substantially neutral or no delivery position. The left hand end of the cylinder 30 is connected through a pilot line 32 with the pressure line 24.

The pump 25 has also connected thereto a cylinder 33 in which is reciprocally mounted a plunger 34, likewise connected with the flow control member of the pump 25 and adapted, when moved toward the left, to shift the pump 25 into position for delivery. The effective area of the plunger 34 equals the effective area of the plunger 31.

Arranged between the plunger 34 and the right hand end of the cylinder 33 is a spring 35, which continuously urges the plunger 34 toward the left, thereby urging the pump 25 into delivery position. The spring 35 need merely be a weak spring, since it is needed only to overcome the friction between the elements moved thereby and the surfaces engaged by the said elements.

The press ram 2 is provided with a cam 36 adapted, in the retracted position of the ram 2, to close a limit switch 37, which latter has one terminal connected through line 38 with the line 9, while the other terminal is connected through line 39 with the terminal 40. The terminal 40 is adapted, by closure of the switch 41, to be connected with the line 42, which latter is connected with the main supply line 11. The line 42 is furthermore adapted, by closure of the switch 43, to be connected with the line 44. Closure of the switch 45 is adapted to effect electric connection between the line 42 and the line 46 leading to one terminal of a switch 47, the other terminal of which is connected to the line 8.

Operation of first embodiment

It may be assumed that all parts occupy the position shown in Figure 1, which is the position immediately following the initiation of a downward stroke of the ram 2. In this position, the pump 25 is on full delivery stroke and the valve member 15 effects fluid connection between the conduits 21 and 23, while the valve 4 connects the conduits 24 and 3 with each other, and establishes fluid connection between the conduits 28 and 29. Pressure fluid from the pump 25, therefore, passes through the conduits 32 and 21 and into the cylinders 30 and 33 respectively, where it acts upon the plungers 31 and 34. However, inasmuch as the areas of these plungers equal each other, these plungers remain in the position shown in Figure 1, into which they were moved by the spring 35.

Pressure fluid from the pump 25 also passes through conduit 24, valve 4 and conduit 3 into the upper portion of the cylinder 1, where it acts upon the ram 2 so as to move the same downwardly. The fluid expelled by the ram 2 from the lower portion of the cylinder 1 passes through the conduits 29 and 28 into the conduit 26 and from there to the suction side of the pump 25.

It may be assumed that the press ram 2 should come to a stop when a predetermined pressure is exerted on the ram 2. In other words, the tonnage control valve 6 and switch 7 should be effective while the limit switch 47 should be in-

effective. To this end, the switch 45 is in open position, while the switch 43 is in closed position.

It will now be clear that when at the end of the pressing stroke, a predetermined pressure builds up in the upper portion of the press cylinder 1, this pressure is conveyed through the conduits 3 and 5 to the tonnage control valve 6 and actuates the latter so as to close the normally open switch 7. As a result thereof, the energizing circuit for the solenoid 14 is closed, which circuit comprises the main supply line 12, starter switch ST, line 13, solenoid 14, lines 9 and 8, now closed switch 7, line 44, switch 43, line 42 and main supply line 11.

Energization of the solenoid 14 causes the valve member 15 to move to its right hand end position in which fluid connection is interrupted between the conduits 21 and 23, while the conduit 23 is connected with the conduit 22. Consequently, since the pump 25 still conveys fluid pressure through conduit 32 into the cylinder 30, while the cylinder 33 is now connected with the tank 27, the pressure acting upon the plunger 31 moves the latter toward the right, thereby shifting the pump 25 into substantially neutral or no delivery position. Therefore, the ram 2 comes to a stop, while the pump 25 idles under substantially no load.

In order to start a retraction stroke of the ram 2, the operator reverses the valve 4 so as to effect fluid connection between the conduits 24 and 29, while connecting the conduits 3 and 28 with each other. This causes a pressure drop in the conduit 24 so that the spring 35 again shifts the pump 25 on stroke. Furthermore, the operator opens the starter switch ST which breaks the energizing circuit for the solenoid 14. As a result thereof, the spring 17 moves the valve member 15 into the position shown in Figure 1. Pressure fluid delivered by the pump 25 now again passes through conduits 32 and 21 and 23 into the cylinders 30 and 33, respectively holding the plungers 31 and 34 in the position shown in the drawing. Furthermore, fluid delivered by the pump 25 passes through the conduits 24 and 29 into the lower portion of the cylinder 1 where it moves the ram 2 upwardly. The fluid expelled from the upper portion of the cylinder 1 passes in part through the conduits 3 and 28 into the suction line 26, and in part to the tank 27.

When the ram 2 has reached its fully retracted position, the cam 36 engages and closes the normally open limit switch 37, thereby establishing an energizing circuit for the solenoid 14, which circuit comprises the main supply line 12, switch ST, which latter immediately closed as soon as it was released by the operator, line 13, solenoid 14, lines 9 and 38, switch 37, line 39, switch 41, line 42 and the main supply line 11. Energization of the solenoid 14 causes the valve member 15 to move toward the right, thereby again interrupting fluid connection between the conduits 21 and 23, while connecting the conduit 23 with the exhaust line 22. In the manner previously described, the pressure prevailing in the conduit 32 moves the pump 25 to substantially neutral or no delivery position. The ram 2, therefore, comes to a stop while the pump idles under substantially no load.

To start another working cycle of the ram 2, it is merely necessary to reverse the valve 4 so as to establish fluid connection between the conduits 24 and 3, while connecting the conduits 28 and 29 with each other and, thereupon, to

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open the starter switch ST for breaking the energizing circuit for the solenoid 14. The spring 17 will then again move the valve member 15 into the position shown in Figure 1, and another working cycle will be performed, as previously described.

If it is desired to bring about energization of the solenoid 14 at the end of the downward stroke of the ram 2 in response to a predetermined position of the ram, rather than in response to a predetermined pressure exerted upon the said ram, it is merely necessary to open the switch 43, while closing the switch 45. It will then be clear that closure of the switch 7 cannot make the energizing circuit for the solenoid 14, whereas closure of the switch 47 by the cam 36 will close the energizing circuit for the solenoid 14.

Referring now to Figure 2, illustrating a modification of the servomotor means 30, 31, 34, 33 of Figure 1, these servomotor means have, according to Figure 2, been replaced by a single cylinder 48 in which is reciprocally mounted a differential piston 49 connected through the piston rod 50 with the flow control member of the pump 25a, corresponding to the pump 25. The larger piston area of the piston 49 is located on the left side thereof, whereas the smaller area is located on the right side of the piston 49. A spring 51 continuously urges the piston 49 into its left hand end position.

The ends of the cylinder 48 are connected with conduits 32a and 23a, corresponding to the conduits 32 and 23 of Figure 1. The conduits 32a and 23a may be hooked up in the same manner as the conduits 32 and 23 are hooked up in Figure 1. The operation of the device of Figure 2 will be substantially the same as the operation of the system shown in Figure 1. However, inasmuch as the left hand area of the piston 49 is larger than the right hand area thereof, the spring 51 has to be stronger than the spring 35, in order to maintain the piston 49 in its left hand end position during the operation as long as the pressure, acting on the left hand area of piston 49, remains below a predetermined value. However, when the pressure on the left hand area of the piston 49 reaches the said predetermined pressure, it will cause the piston 49 to move toward the right, thereby reducing the delivery of the pump and eventually shifting the pump into neutral or no delivery position. In other words, the device of Figure 2, in addition to performing the functions of the system shown in Figure 1, is also adapted to bring about movement of the pump into substantially neutral or no delivery position in response to a predetermined pressure at the pressure side of the pump.

Referring now to Figure 3, the system shown therein differs from that of Figure 1 primarily in that the variable delivery pump 25 has been replaced by a constant delivery pump 52. The suction side of the pump 52 is connected through conduit 53 with the fluid reservoir or tank 54, whereas the pressure side of the pump 52 is connected through the conduit 55 with a cylinder 56 of a control valve, generally designated 57. Connected to the cylinder 56 is a cylinder 58, which is connected with the conduit 55 through a conduit 59. Branching off from the conduit 59 is a conduit 60 leading to a three-way valve 61, corresponding to the three-way valve 16 of Figure 1.

The valve member 62 of the valve 61 is controlled by a solenoid 63 in the same manner as the valve member 15 of Figure 1 is controlled by

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the solenoid 14. A spring 64 continuously urges the valve member 62 toward the right for establishing fluid connection between the conduit 60 and the conduit 65, while preventing fluid connection between the conduit 66 and the conduit 65. When the solenoid 63 is energized, it shifts the valve member 62 toward the left so as to interrupt the fluid connection between the conduits 60 and 65, while connecting the conduit 66 with the conduit 65.

The conduit 65 leads to a cylinder 67 which is connected to the cylinder 56. Reciprocally mounted in the cylinder 56 is a valve member 68 with two piston portions 69 and 70. The valve member 68 is continuously urged into its uppermost position by a spring 71 through the intervention of a piston 72. A piston 73, reciprocally mounted in the cylinder 58 and of the same area as the piston 72, is adapted to be acted upon by fluid pressure in the line 59 for actuating the valve member 68 so as to move the same downwardly with regard to Figure 3.

The piston portions 69 and 70 control the fluid connection between the conduits 74, 75 and 76. The conduit 74 leads into the conduit 53 and is connected through a conduit 77 with a four-way valve 78, corresponding in its structure and function to the valve 4 of Figure 1. Also connected with the valve 78 are the conduit 75 and the service conduits 3a and 29a, corresponding to the conduits 3 and 29 of Figure 1. A choke 79 is provided in the conduit 76, which conduit is connected to the conduit 74.

Operation of second embodiment

It may be assumed that the valve member 68 is in its neutral position, in which the piston portion 70 shuts off the conduit 75, while the conduits 55 and 76 communicate with each other. It may furthermore be assumed that the solenoid 63 is energized so that the conduits 65 and 66 communicate with each other, while the conduit 60 is closed.

In order to start a cycle, the operator shifts the valve 78 into a position corresponding to the forward position of the valve 4, and deenergizes the solenoid 63 so that the spring 64 shifts the valve member 62 toward the right and establishes fluid connection between the conduits 60 and 65. Pressure fluid delivered by the pump 52 will then pass through conduits 59 and 65 into the cylinders 58 and 67 respectively, and, inasmuch as the effective areas of the pistons 72 and 73 are equal, the fluid pressure acting on the pistons 72 and 73 will be equalized. Consequently, the spring 71 will shift the valve member 68 into position for establishing fluid connection between the conduits 55 and 75, as shown in Figure 3. Fluid pressure delivered by the pump 52 will, therefore, pass through the valve 78 into the service line 3a, while fluid exhausted from the service line 29a will pass through the conduits 77 and 74 into the conduit 53.

When a predetermined pressure has built up in the service line 3a, this pressure may be conveyed to a pressure responsive device, corresponding to the device 6 of Figure 1, which will bring about energization of the solenoid 63, thereby causing the valve member 62 to move toward the left. As a result thereof, fluid connection is interrupted between the conduits 60 and 65, while the conduits 65 and 66 are connected with each other.

Inasmuch as now the cylinder 67 is connected to the tank 54 while pressure still prevails in

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the conduit 55, this pressure acts upon the piston 73 and causes the same to move the valve member 68 into its lowermost position, in which the piston portion 70 closes the conduit 75, while the conduit 55 is connected with the conduit 76. The pump 52, therefore, now by-passes its delivery through the conduit 76 into the conduit 53 and no pressure fluid is delivered to the service lines 3a or 29a. In other words, the pump 52 now idles under minimum load, namely the load caused by the restriction of the choke 79, which restriction maintains only sufficient pressure in the conduits 55 and 59 to hold the valve member 68 in its downward position against the thrust of the spring 77.

If it is now desired to supply pressure fluid into the service line 29a, the operator reverses the valve 78 so as to establish fluid connection between the conduits 75 and 29a, while connecting the conduits 3a and 77 with each other. Furthermore, the solenoid 63 is deenergized so that the spring 64 returns the valve member 62 to its right hand position in the manner previously described. The valve member 68 will then be returned to its uppermost position and pressure fluid from the pump 52 will pass through conduit 75 into the service line 29a. The operation of the system will then be effected in the manner described above.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims

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

1. In a hydraulic system, a source of fluid under pressure, control means movable to vary the delivery of said source from zero to maximum, first means connected to respond to pressure from said source to urge said control means toward zero delivery position, second means adapted to be connected to respond to pressure from said source to urge said control means to maximum delivery position against the action of said first means, said first and second means normally exerting equal opposed forces, continuously acting resilient means assisting the action of said second means, a valve movable into a first position to connect said second means to said source and into a second position to exhaust, a reciprocating

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cable ram connected to be actuated by fluid from said source, ram actuated means operable at the ends of the stroke thereof to move said valve into its second position, and manual means selectively operable to counteract said ram actuated means to return said valve to its first position.

2. In a hydraulic system, a variable delivery pump, a fluid motor supplied thereby, control means for said pump movable between full delivery and neutral positions, yielding means continuously urging said control means toward full delivery position, opposed and equal fluid operable areas arranged in association with said control means one to assist said yielding means and the other to oppose, a continuous fluid connection between the discharge side of said pump and said other area, a valve movable into a first position to connect said one area with the discharge side of said pump and into a second position to connect said one area with exhaust, yielding means continuously urging said valve toward its first position, means operable by said motor in a predetermined position thereof for substantially instantaneously moving said valve into its second position, and manual means operable to counteract said last mentioned means.

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