Jan. 25, 1955 W. H. SCHMITT 2,700,339

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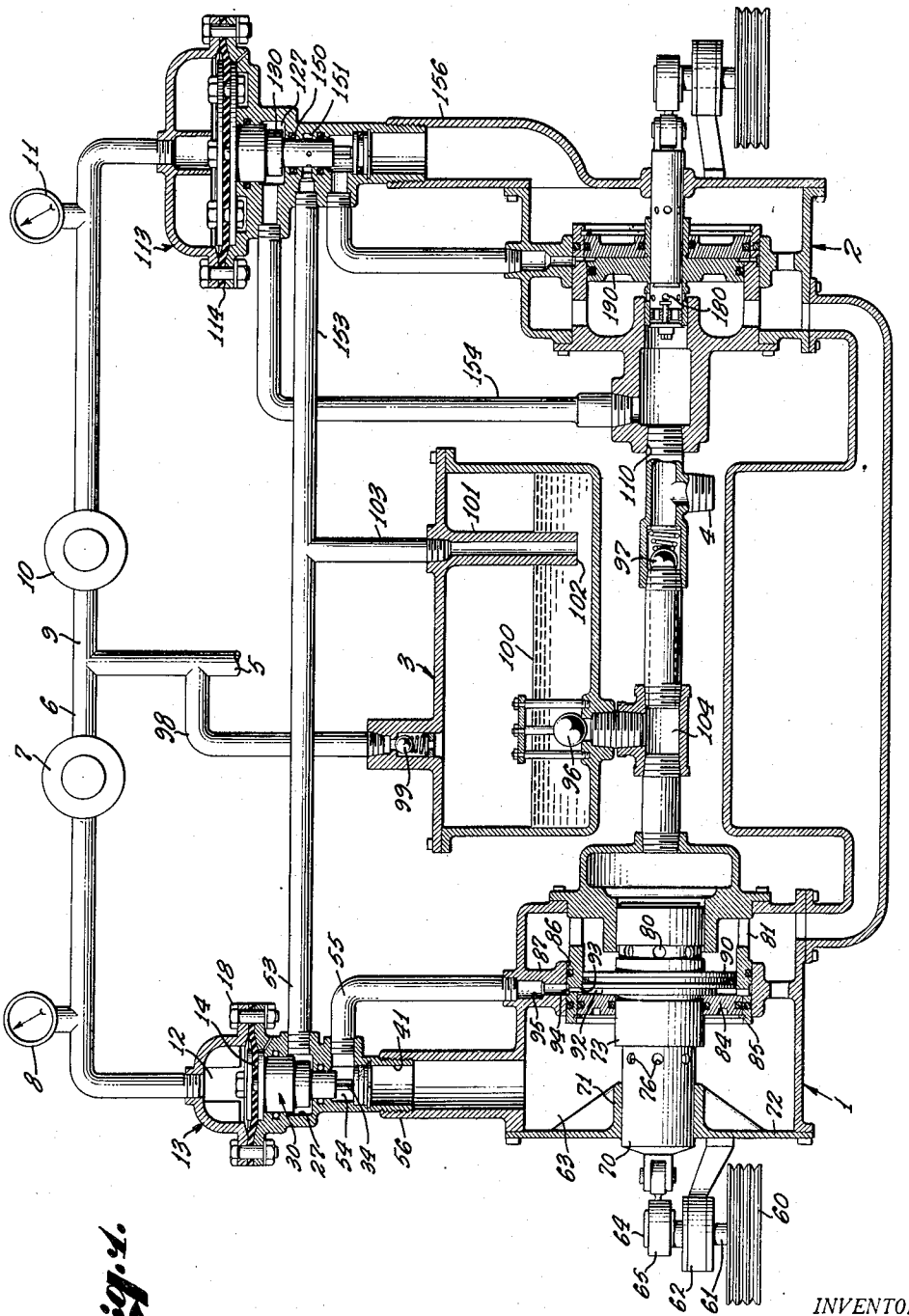


Fig. 1.

INVENTOR:
WILLIAM H. SCHMITT.

BY W. E. Beatty

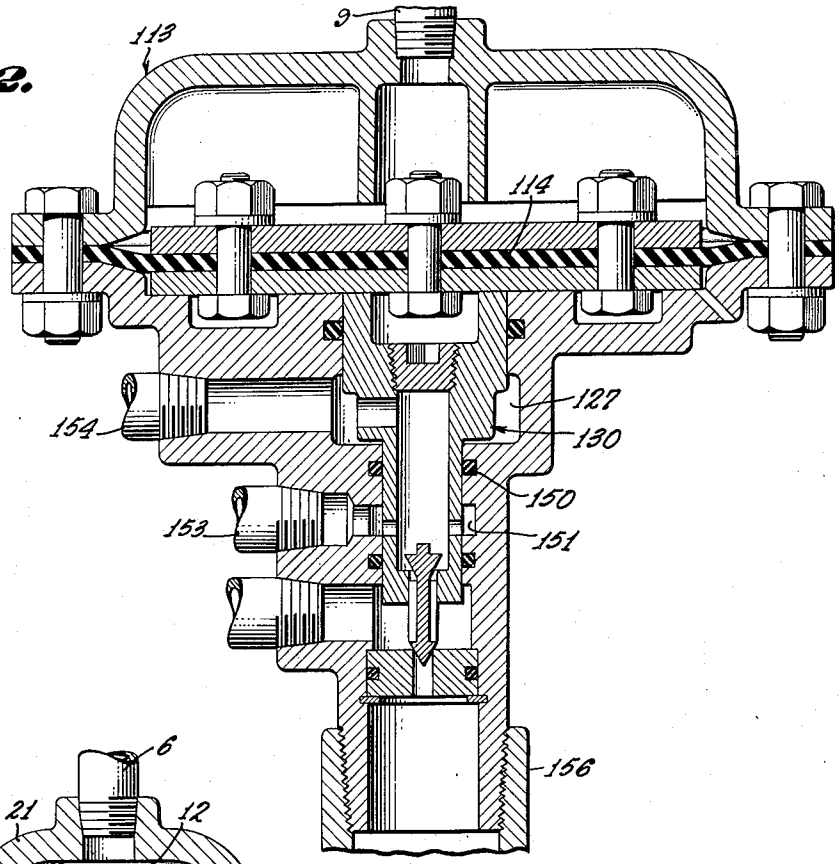
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Fig. 2.



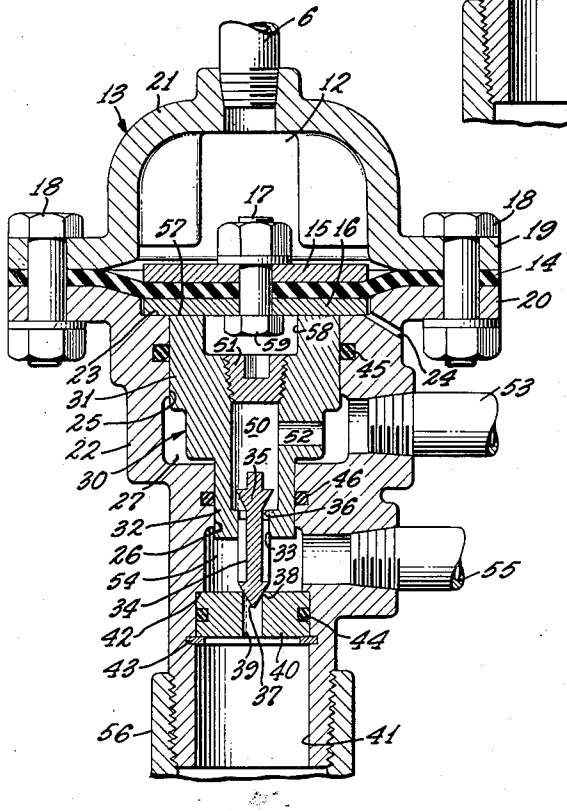


Fig. 3.

INVENTOR:
WILLIAM H. SCHMITT.

BY W. H. Beatty

ATTORNEY.

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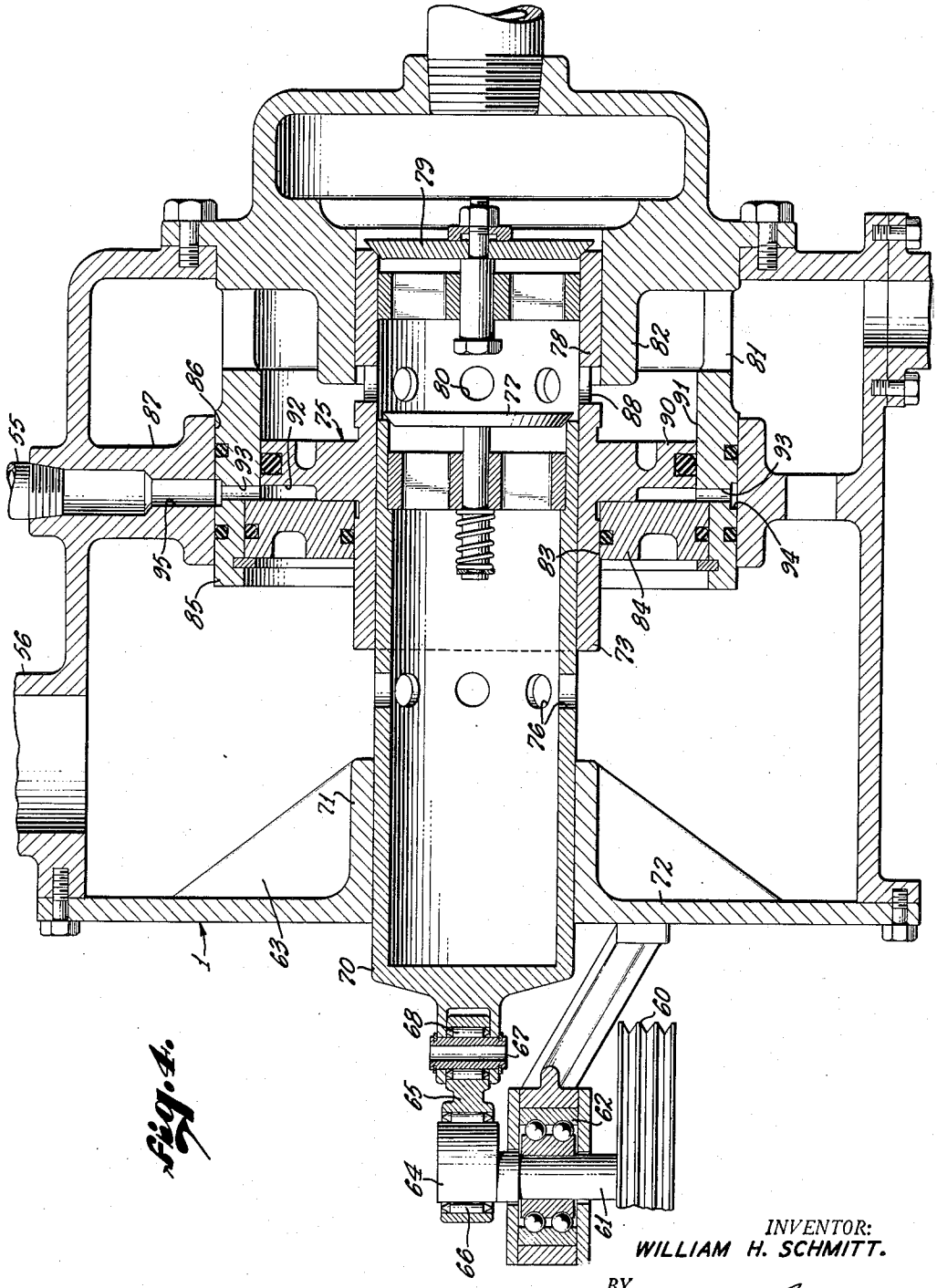


Fig. 4.

INVENTOR:
WILLIAM H. SCHMITT.

BY W. E. Beatty

ATTORNEY.

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PUMP

William H. Schmitt, Rialto, Calif., assignor to The Rialto Corporation, Rialto, Calif., a corporation of California

Application July 20, 1950, Serial No. 174,851

13 Claims. (Cl. 103—42)

The invention relates to a pump for oil or other liquid employed in hydraulic presses. In co-pending application, Serial Number 42,870, filed August 6, 1948, now abandoned, I have disclosed and claimed a pump of this type wherein a by-pass valve is employed to automatically remove the load from the pump when the pump pressure attains a desired value, while permitting the pump to continue to run when not developing pump pressure.

In the prior patent application, the control of the by-pass was dependent upon the operation of a by-pass valve controlled by opposing forces, one of which is air pressure. It has been discovered that such valve does not operate within close limits, due to friction and the compressibility of air.

An object of the present invention is to regulate the pump within closer limits than heretofore. This is accomplished by providing an improved type of valve control wherein the by-pass for the pump is controlled by opposing forces, both of which are liquid pressure, the force which operates the valve to shift the pump to non-pumping condition being derived from the liquid pressure developed by the pump, while means are provided to develop a liquid pressure independently of the pump to shift the by-pass valve to pumping position. This independent liquid pressure may be derived from the air pressure usually available in the plant.

A further object of the invention is to eliminate the hunting commonly found in other types of pressure regulator valves. This is accomplished by providing a valve control for either supplying or exhausting pressure to operate the by-pass for the pump, hunting being reduced or eliminated by providing for that control a double valve arrangement, one of which must seat in order to unseat the other valve.

A further object of the invention is to provide a valve control for operating the by-pass valve with a snap action. This snap action was obtained in the pump of the former patent application, but improved results are obtained in the present case as the snap action is more pronounced with the liquid control than with the air control formerly proposed.

In the former patent application, the crank and eccentric for the pump were at the interior of the pump casing which served as a sump.

A further object of the present invention is to increase the accessibility of the drive for the pump piston, the piston being in the form of a hollow cylinder having a check valve at its inner end and having ports communicating with the inside of the pump casing. This object is accomplished by providing an elongated piston supported by inner and outer walls of the pump casing, with the drive positioned outside of the pump casing.

While the features of the invention may be embodied in either a low pressure pump or a high pressure pump, they are illustrated as applied to the preferred form wherein both low and high pressure pumps are used, the low pressure pump delivering a large volume of liquid at low pressure to the work cylinders and the high pressure pump delivering a small volume of liquid thereto at high pressure.

For further details of the invention, reference may be made to the drawings wherein

Fig. 1 is a front view in elevation, partly in section of a high pressure pump and low pressure pump according to the present invention.

Fig. 2 is an enlarged vertical sectional view of the control valve for the high pressure pump.

Fig. 3 is an enlarged vertical sectional view of the low pressure pump, with parts broken away.

Fig. 4 is an enlarged vertical sectional view of the low pressure pump with parts broken away.

Referring to the drawings, in Fig. 1 there is provided a low pressure pump 1, and a high pressure pump 2. The pump 1 supplies liquid under pressure to an accumulator 3. Accumulator 3 and pump 2 supply liquid under pressure to an outlet 4 leading to a work cylinder or the like.

Spring loaded check valve 97 permits liquid to flow from accumulator 3 to the outlet 4, and prevents the discharge from the pump 2 from entering the accumulator 3. Accumulator 3 has a float valve 96 which seats if the liquid level 100 gets low, to prevent air supplied by pipe 98 from entering the connection 104 which leads to both pumps 1 and 2 and to the work cylinders, as well as to the connection 154 for the control valve 113 of the high pressure pump.

The shop air pressure of about 100 p. s. i. is connected to pipe 5 which has a branch 6 having a pressure regulator 7 and pressure gauge 8, also a branch 9 having pressure regulator 10 and pressure gauge 11. Assuming that the shop air pressure is about 100 p. s. i., for example, the regulator 7 may be adjusted to deliver 80 p. s. i., which can be checked by the gauge 8. This regulated air pressure is supplied to chamber 12, of control valve 13, at one side of a rubber diaphragm 14. As shown in Fig. 3, metal discs 15 and 16 are clamped to the opposite sides of diaphragm 14 by a bolt 17. The edge of the diaphragm 14 is clamped by bolts like 18 between the flanges 19 and 20 on the upper and lower sections 21, 22 of the valve casing. The section 22 has a shoulder 23 which serves as a stop for the disc 16, to limit its movement by the air pressure in chamber 12. The lower side of diaphragm 14 has a vent to atmosphere through casing section 22 as indicated at 24.

The casing section 22 has a comparatively large cylinder 25 adjacent the diaphragm 14, and spaced therefrom is a smaller cylinder 26, with an intermediate chamber 27. Slidably fitting in the casing section 22 is a hollow double piston 30 having a large piston 31 which slidably fits in the cylinder 25 and a smaller piston 32 which slidably fits in the cylinder 26.

Slidably mounted in a bore 33 at the lower end of the piston 32 is a double valve 34. Valve 34 has at its upper or inner end a conical valve head 35 which is larger than the bore 33 and adapted at times to seat on the inner end 36 of that bore. The valve 34 also has at its outer end a conical valve head 37 adapted at times to seat on the inner end 38 of a bore 39 through the seat member 40 in casing section 22.

Seat member 40 is removable through the bore 41 at the lower end of casing 22, being held in position between a shoulder 42 and a lock washer 43. The seat 40 has an O ring seal 44 and similar seals are provided for the cylinders 25 and 26 as indicated at 45 and 46 respectively.

The double piston 30 is hollow and has a central chamber 50, the outer end of which is removably closed by a plug 51. The double valve 34 may be mounted in position shown or removed, when the plug 51 is removed. The chamber 50 has a lateral port 52 communicating with chamber 27 and with pipe 53 which leads to the top of the accumulator 3 as shown in Fig. 1.

Between the lower end of double piston 30 and seat 40 is a chamber 54 which leads to a pipe 55 connected to pump 1 as shown in Figs. 1 and 4 and later described. The bore 41, or the outer end of control valve 13 is piped into the casing of pump 1 as indicated at 56.

The upper end of piston 30 is flat as indicated at 57, to be contacted by the disc 16 which actuates the piston 30 to the position shown, at certain times. The upper end of piston 30 has a recess 58 to receive the head 59 of bolt 17.

As shown in Fig. 4, the low pressure pump is driven by a suitable pulley 60 connected by a belt, to a motor not shown. Pulley 60 is fixed to a shaft 61 having a bearing 62 suitably supported on the outside of the pump casing 63. Shaft 61 has an eccentric 64 which drives the crank 65 through a roller bearing 66. Crank 65 is connected to the wrist pin 67 through a roller bearing

68. Wrist pin 67 is mounted on the outer end of an elongated hollow cylindrical piston 70 which has a bearing support 71 in the outer wall 72 of the pump casing and a bearing support in the sleeve 73 of a by-pass valve 75. Piston 70 has intermediate ports 76 which communicate with the interior of the pump casing 63. On the inner end of piston 70 is a spring loaded check valve 77. The outer end of by-pass valve 75 has a sleeve 78 on the outer end which seats a check valve 79. Valves 77 and 79 both seat in the same direction and prevent return flow. Between these valves, the sleeve 78 has by-pass ports 80 connected by annular groove 88 which at times by-pass the pump fluid through passages like 81 back into the pump casing 63, to prevent the pump from developing pressure, while at other times the ports 80 and groove 88 are closed by a cylinder 82 in which the sleeve 78 slidably fits.

Sleeve 73 slidably fits in a cylinder 83 in a ring 84 removably held in the inner end of a sleeve 85 which removably fits in the cylindrical bore 86 in a midrib 87. The sleeve 85 and cylinder 82 may be cast in one piece or separate pieces and suitably held together by bolts not shown.

The sleeves 73 and 78 have a piston 90 which slidably fits in the cylinder 91 in the outer end of sleeve 85. The inner side of piston 90 has an annular recess 92 which communicates with a number of radial passages 93 in the sleeve 85, the outer ends of such passages opening into an annular groove 94 which communicates with the passage 95 which opens into pipe 55.

The pump casing 63 is filled with hydraulic oil or other liquid, to a level above the piston 70. Preferably, the liquid is a light petroleum base oil free from acid.

The low pressure pump 1 delivers liquid under pressure through a check valve 96 to the accumulator 3. Return flow from the service outlet 4 and from pump 2 is prevented by check valve 97. The plant air pressure is supplied through a pipe 98 and check valve 99 to the top of accumulator 3, above the liquid level 100. Accumulator 3 has a conduit 101, the lower end 102 of which extends below the liquid level 100. Conduit 101 has a pipe connection 103 with the pipes 53 and 153.

Dealing first with the operation of the low pressure pump 1, the following dimensions and values are given by way of example, as various other values can be used.

It is assumed that the plant air pressure in pipe 5 is approximately 100 p. s. i. and that pressure regulator 7 is adjusted to supply 80 p. s. i. air to chamber 12 on top of diaphragm 14. Assuming that the area of diaphragm 14 is 2.5 sq. in., this air pressure creates a force of 200 pounds which urges piston 30 downwardly to the position shown in Fig. 3. The under side of diaphragm 14 is vented to atmosphere at 24 so that the full force above mentioned acts on diaphragm 14 and on the upper end 57 of piston 30. Chamber 27 is connected to pipe 53 which is connected through pipe 103 and conduit 101 to a point below liquid level 100. The air line 5 is connected through pipe 98 to the top of accumulator 3. If the plant air pressure equals 100 p. s. i., the pressure in chamber 27 at this time also equals 100 p. s. i. and acts on the effective area of piston 31. This effective area equals the difference between the bore of cylinder 25 and the bore cylinder 26 and is one sq. in. This leaves a net downward force of 100 p. s. i. which moves piston 30 initially to the position shown in Fig. 3.

The liquid from chamber 27 passes through port 52 into chamber 50, and as valve 35 is open, this liquid passes into chamber 54 and through pipe 55 and into recess 92 behind piston 90, forcing this piston outwardly so that sleeve 78 closes the ports 80, whereby the pump 1 is in pumping condition. That is to say, the pump pressure developed ahead of check valve 77 cannot find its way back into pump casing 63 through by-pass ports 80, and is pumped through check valve 79 to the outlet 104 of the pump which is connected to the bottom of accumulator 3.

The pump 1 remains in pumping condition until the liquid pressure in accumulator 3 is pumped up to approximately 200 p. s. i. The area of piston 32 at the lower end of the double piston 30 is approximately .3 sq. in. This area is also acted on by the liquid pressure in chamber 54, to assist in forcing the piston 30 upwardly to its alternate position, wherein valve 35 is closed and valve 37 is open, when 200 p. s. i. has been pumped up in accumulator 3. The piston 30 will then move upwardly, seating valve 35 and pulling valve 37 up from its seat. This allows liquid from annular recess 92 to escape by way of passages 93, 94, 95 and pipe 55, through chamber 54, bore 39, back into the pump casing 63 which is at atmospheric pressure. With no pressure behind the piston 90, the liquid pump pressure in outlet 104 acting on check valve 79 forces piston 90 to the position shown in Fig. 4, which opens ports 80 to by-pass the piston check valve 77 and prevent piston 70 from developing pump pressure even though this pump is still running.

It was above explained that the pressure acting on the lower end of piston 32 assists in raising the piston 30 to its alternate position. When in its alternate position, this assisting force is removed, as the lower end of piston 32 is then at atmospheric pressure. Also, there is a small additional downward force acting on the area of seat 36 when valve 35 is closed. Both of these forces are not sufficient to cause piston 30 to again move downwardly, due to the frictional drag of the ring seals 45 and 46. Thus the forces which operate the control valve 13 to shut off the low pressure pump are less than the forces acting to maintain the control valve 13 in that condition, whereby the control valve 13 is sensitive to a reduction of normal pressure in the accumulator 3 to again start up the low pressure pump 1 as required. By adjusting the regulated air pressure supplied to the top of diaphragm 14, that is by selecting a smaller or larger air pressure, the control valve 13 will then operate to maintain any desired value of normal pressure in accumulator 3.

The piston recess 92 of by-pass valve 75 is connected either to exhaust 41 or to the accumulator 3 by way of pipe 53, depending on the double valve 34. There is no hunting of the control valve 13 as double valve 34 closes or seats one of its valves 35 or 37 in order to unseat or open the other one, which means that when the piston 30 descends, the exhaust 41 is shut off before the pressure in pipe 53 is admitted to the piston area 92, and when piston 30 ascends, the pressure in pipe 53 is shut off from piston area 92 before opening the exhaust 41.

The by-pass valve 75 operates with a snap action, without an intermediate operating position, as can be seen by the fact that when the control valve 13 operates to raise double valve 34, the pressure on piston 90 drops to atmospheric, while the pressure pumped up in the chamber ahead of check valve 79 is of the order of 200 p. s. i., which moves the sleeve 78 very rapidly to the by-pass position shown in Fig. 4. If the pump 1 should be shut down with the by-pass valve 75 open as shown in Fig. 4, when the pump is next started up, or if the pressure in accumulator 3 should drop below 200 p. s. i. to operate control valve 13 to the position shown in Fig. 3, with the pressure in the accumulator applied to piston 90, the by-pass valve 75 will also operate with a snap action to close ports 80 and groove 88, as the area of piston 90 is two and one-half times greater than the area of sleeve 78.

The construction and operation of the high pressure pump 2 are substantially the same as previously described, except for dimensions. The outlet 110 of the high pressure pump is connected to the service outlet 4. In the high pressure pump 2, the area of the diaphragm 114 is 15 sq. in., the piston 130 like 30 being the same as before, which gives a ratio of 15 to 1. Also the high pressure control valve 113 is similar to valve 13 and has a ring seal 150 separating chamber 127 (like 27) from chamber 151 connected to accumulator 3 by pipe 153. Chamber 127 is exposed to the high pressure side of pump 2 by pipe connection 154.

With both pumps running at the start, both the by-pass ports 80 of the low pressure pump and the similar by-pass 180 of the high pressure pump will be closed and both pumps will deliver liquid under pressure through pipes 110 and 104 through branch pipe 4 to work cylinder. It was above assumed that the pump 1 would be changed to a non-pumping condition as above described when the pressure in accumulator 3 reaches 200 p. s. i. This pressure is reached quicker, with both pumps delivering liquid under pressure to the work cylinder, than would be the case if pump 2 were not employed. With pump 1 cutting out at 200 p. s. i., pump 2 continues to develop pressure until a high pressure such as 500 p. s. i. is reached. The pressure developed during this time by the pump 2 maintains control valve 13

in a position to keep by-pass ports **80** open. When 500 p. s. i. is reached, the piston **130** moves upwardly to relieve the pressure behind piston **190** (similar to piston **90**), into conduit **156** and into the casing of pump **2** which is at atmospheric pressure.

In this way, the plant air pressure is used to develop a liquid pressure which acts on piston **90** and **190** to close their respective by-pass ports **80** and **180** until such time as such liquid pressure is relieved and an opposing liquid pressure developed by the respective pump acts on its piston to open the ports **80** and **180**.

Various modifications may be made in the invention without departing from the spirit of the following claims.

I claim:

1. A pump comprising a casing having a reciprocating pump piston, said piston being hollow and having an inner end having an outwardly opening check valve, a by-pass valve having a port in front of said check valve, a seat for said by-pass port, a piston for operating said by-pass valve to one position wherein said by-pass port is open, or to another position wherein said by-pass port is closed by said seat, said casing comprising a well for liquid to be pumped by said pump piston, means for supplying liquid pressure developed by said pump piston for operating said valve piston to open said by-pass port, and means for supplying liquid pressure independently of said pump for actuating said valve piston to close said by-pass port.

2. A pump according to claim 1 wherein said by-pass valve comprises a cylinder in which said pump piston slidably fits.

3. A pump according to claim 1 comprising a source of air pressure for producing said liquid pressure.

4. A pump comprising a casing having a pump piston, said casing comprising a sump for supplying liquid to be pumped by said piston, a by-pass valve in said casing for said piston, said by-pass valve having a port for by-passing the pump space ahead of said piston into said casing, said by-pass valve having a piston, a control valve for supplying said liquid under pressure to the piston of said by-pass valve, and means responsive to the liquid pressure developed by said pump for operating said control valve.

5. A pump comprising a casing having an outer wall having a bearing, a hollow piston extending through said bearing, said casing having inside thereof a bearing, a by-pass valve having a sleeve portion slidably supported by said inside bearing, said casing having an opposite end wall, said by-pass valve having a second sleeve portion supported in said opposite wall, a check valve on the outer end of said second sleeve portion, a check valve on the corresponding end of said piston, a by-pass port in said second sleeve portion between said check valves, said piston slidably fitting in said first sleeve portion, and a reciprocating drive for said piston outside of said casing.

6. A pump according to claim 4 wherein said control valve comprises a valve device for admitting pressure developed by said pump to the piston of said by-pass valve and a second valve device for exhausting such pressure so admitted, each of said valve devices having a seat and each of said valve devices seating before the other valve device unseats.

7. A pressure regulator comprising a casing having a diaphragm, means for admitting fluid under pressure to one side of said diaphragm, means for regulating the fluid pressure admitted to said one side of said diaphragm, a piston at the other side of said diaphragm, said diaphragm and said piston having a driving connection therebetween, said piston being hollow and having a large piston area and a small piston area, an inlet for supplying liquid under pressure to said large piston area and into said piston, said small piston having a port therethrough and providing a seat, an exhaust outlet, a second seat communicating with said exhaust outlet, a work outlet for receiving or exhausting pressure communicating with both of said seats, a double valve having a valve head for each of said seats, said piston being slidable to seat the valve for said first seat and then lift said second valve from its seat at certain times, and to seat the valve of said second seat before opening said first valve at other times.

8. A pressure regulator according to claim 7 in combination with a pump having a pump piston, a by-pass valve for by-passing said pump piston, said by-pass valve having an operating piston communicating with said work outlet, said first mentioned inlet communicating with the pressure developed by said pump, means for supplying liquid to said pump piston to be pumped thereby.

9. A pump according to claim 1, both of said means for supplying liquid pressure comprising an accumulator in the outlet of said pump, a check valve preventing return flow from accumulator to said pump and an air supply for maintaining liquid in said accumulator under air pressure of a value less than the pressure developed by said pump.

10. A pressure regulator according to claim 7 in combination with a pump having a casing and a pump piston, a by-pass valve in said pump casing for by-passing said pump piston, said by-pass valve having an operating piston communicating with said work outlet, an accumulator supplied with liquid under pressure from said pump, air pressure means for maintaining liquid in said accumulator under air pressure, said first mentioned inlet communicating with said accumulator, and means for regulating the fluid pressure admitted to said one side of said diaphragm.

11. A pump comprising a casing having a liquid supply to be pumped, an accumulator receiving liquid discharge from said pump, a check valve preventing return flow from said accumulator to said pump, air pressure means for maintaining liquid in said accumulator under pressure independently of said pump, said pump having a by-pass valve having a piston, and means responsive to pressure in said accumulator for supplying liquid pressure from said accumulator to operate said piston of said by-pass valve.

12. A pump comprising a casing having a liquid supply to be pumped, an accumulator receiving liquid discharge from said pump, a check valve preventing return flow from said accumulator to said pump, air pressure means for maintaining liquid in said accumulator under pressure independently of said pump, said pump having a by-pass valve having a piston, means responsive to relatively low pressure in said accumulator for supplying liquid pressure from said accumulator to operate said piston of said by-pass valve, means responsive to higher pump pressure in said accumulator for discharging liquid from said by-pass valve piston to atmospheric pressure in said pump casing, said by-pass valve having a piston area exposed to pressure developed by said pump and operative when said by-pass valve piston pressure is thus relieved to operate said by-pass valve.

13. A pressure regulator comprising a pump having a casing, said pump having a piston and by-pass valve in said casing, an accumulator for receiving discharge from said pump, a check valve preventing return flow from said accumulator to said pump, means for supplying air pressure to the liquid in said accumulator, said by-pass valve having an operating piston and a piston area exposed to pressure ahead of said pump piston, a pressure regulator valve movable to one position to supply liquid pressure from said accumulator to said piston of said by-pass valve and close said by-pass valve when the pressure in said accumulator is at a relatively low value, said valve being movable to another position to discharge fluid pressure on said by-pass valve piston to atmospheric pressure in said pump casing whereupon said piston area of said by-pass valve is responsive to pressure ahead of said pump piston to operate said by-pass valve, fluid pressure means for operating said regulator valve to said one position, and means responsive to pressure in said accumulator for operating said regulator valve to said other position.

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