Oct. 25, 1960 A. MICHEL 2,957,419

CONTROL VALVES FOR TWO-STAGE PUMPS, ESPECIALLY IN HYDRAULIC PRESSES

Filed Sept. 11, 1957 2 Sheets-Sheet 1

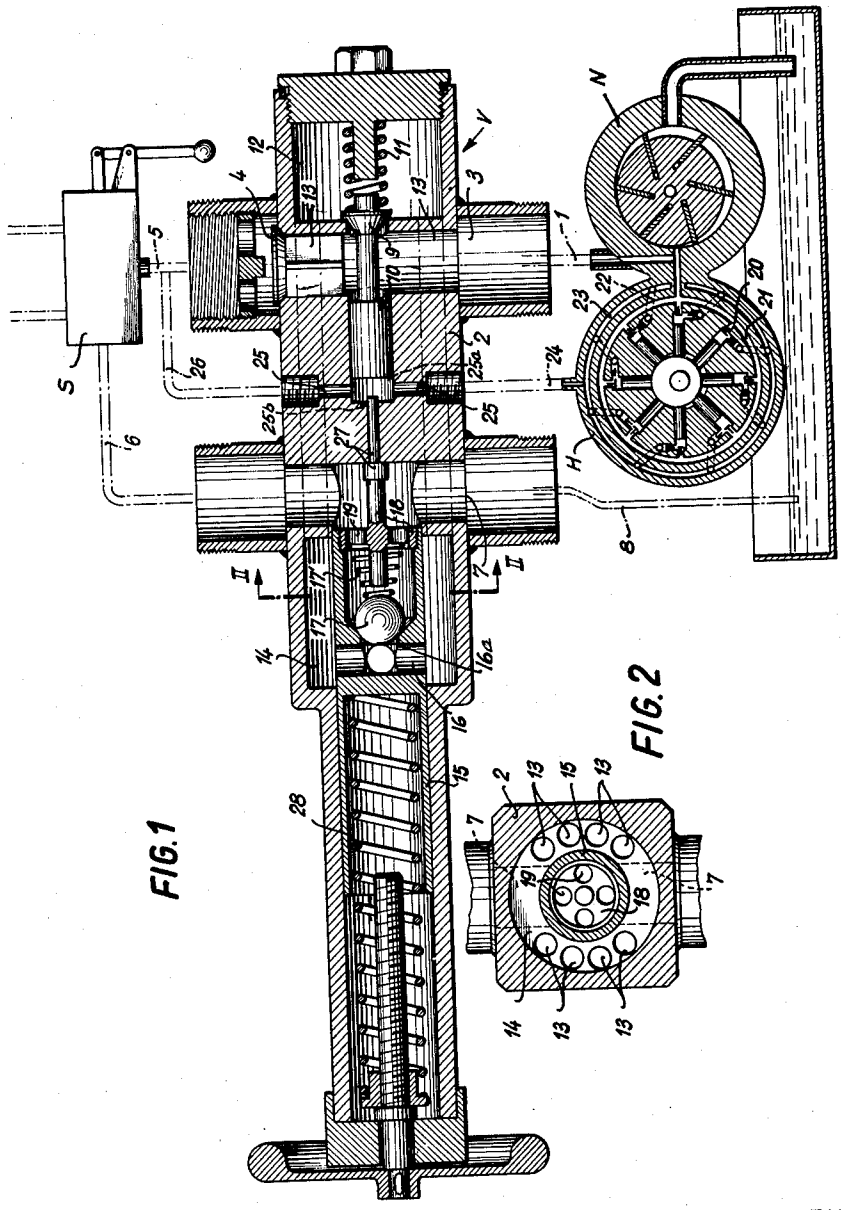


FIG. 1

FIG. 2

INVENTOR
Albert MICHEL

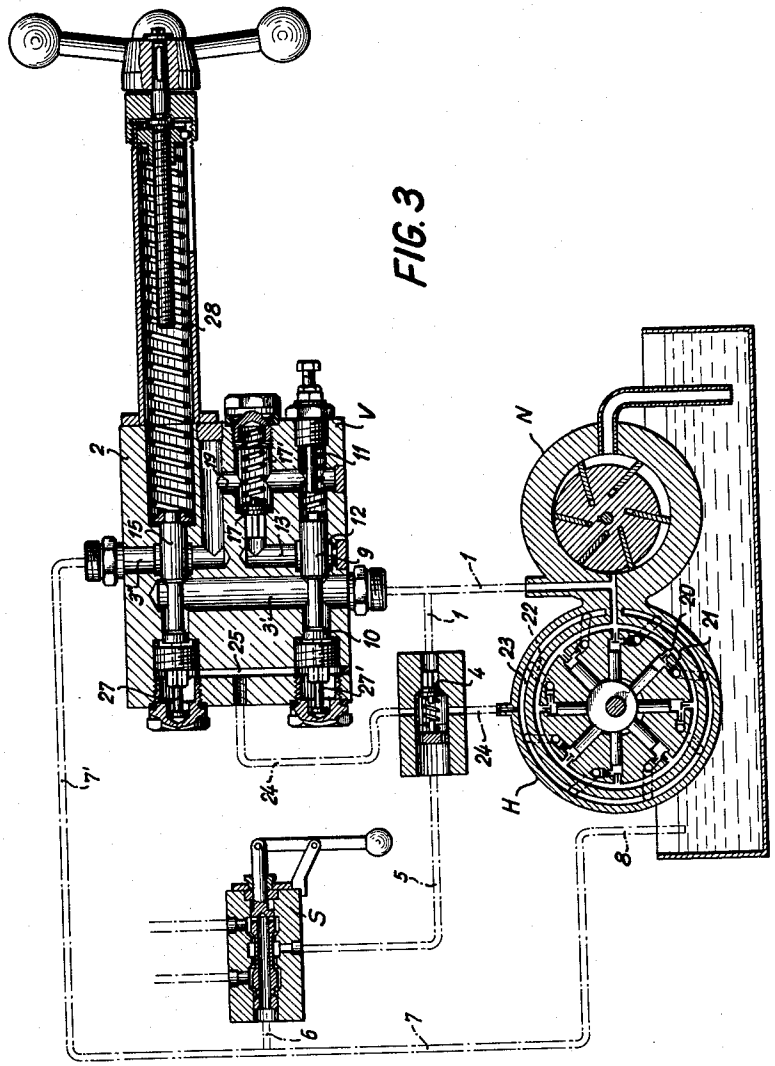
BY Robert K. Jacob
AGENT

Oct. 25, 1960 A. MICHEL 2,957,419

CONTROL VALVES FOR TWO-STAGE PUMPS, ESPECIALLY IN HYDRAULIC PRESSES

Filed Sept. 11, 1957 2 Sheets-Sheet 2

FIG. 3



INVENTOR
Albert MICHEL

BY Robert K. Jacob
AGENT

United States Patent Office 2,957,419 Patented Oct. 25, 1960

2,957,419

CONTROL VALVES FOR TWO-STAGE PUMPS, ESPECIALLY IN HYDRAULIC PRESSES

Albert Michel, Pirmasens, Pfalz, Germany, assignor to Schon & Cie. Gesellschaft mit beschrankter Haftung, Pirmasens, Pfalz, Germany, a German joint-stock company

Filed Sept. 11, 1957, Ser. No. 683,248

Claims priority, application Germany Sept. 11, 1956

8 Claims. (Cl. 103—11)

The invention relates to a two-stage pump unit particularly for hydraulic presses and comprises a low pressure pump and a high pressure pump. The unit is of the type in which the low pressure pump feeds on the one hand directly into the main pressure conduit until the beginning of the pressing procedure and then while the low pressure is maintained, is cut off from the said main conduit and feeds a valveless high pressure pump; the unit is also provided with a regulating means which, after the low pressure pump is disconnected from the main pressure conduit, provides for by-passing of any low pressure supply exceeding the amount necessary for filling the high pressure pump, and which on exceeding the optimum pressure in the main pressure conduit by-passes the whole of the low pressure supply. This last action is effected by means of a normally closed valve lying in the by-pass path for the supply from the low pressure pump, which valve, when the optimum pressure in the main conduit is exceeded, completely frees the cross section of such outlet.

It is one object of the invention to provide a control means by which, on the building up of a working pressure in the high pressure system, the low pressure is reduced merely to the necessary filling pressure for the high pressure pump and by which on exceeding a predetermined high pressure in the high pressure system, the low pressure is reduced below the requisite pressure to operate the high pressure pump.

It is another object of the invention to provide such control means in a form comprising a first valve in the low pressure circuit which is normally closed, means responsive to a predetermined pressure in the high pressure circuit to open said first valve, a second normally-closed valve in the path of fluid passing under low pressure through said first valve, set to open at a predetermined low pressure to reduce the low pressure to a minimum and a third normally-closed valve in the low pressure circuit set to open at a predetermined high pressure and thereby relieve said means which opens the first valve.

The invention will be described in more detail with reference to the embodiment illustrated in the accompanying drawings, wherein:

Fig. 1 is a cross-sectional elevation of the unit and of a regulating apparatus, the former being in vertical section and the latter in horizontal section;

Fig. 2 is a transverse section on line II—II of Fig. 1;

Fig. 3 is a similar view to Fig. 1, on a smaller scale, showing a modified embodiment of the invention.

Referring first to Figs. 1 and 2, the pump unit consists essentially of the low pressure pump N, the high pressure pump H and the pressure adjusting valve assembly V. The control valve S indicated in Fig. 1 is not a part of the pump unit proper but of the hydraulic press or like apparatus which is to be driven by the pump unit. It is included in the drawing for the sake of continuity.

The supply pipe 1 of the low pressure pump N is connected to a transverse bore 3 provided in the main valve body or casing 2 of the pressure-adjusting valve assembly V. In this bore is located a check valve 4 through which the oil is supplied into the connecting pipe 5 leading to the control valve S. A pipe indicated at 6, also connected to the control valve S is in communication with a second transverse bore 7 in the casing 2, and this bore leads into a pipe 8 going to the oil sump of the low pressure pump N.

A valve 9 having a shaft or stem penetrating the cross bore 3 and connected to a piston 10 is arranged in an axial bore of the casing 2. At the other side, the valve 9 is under the action of a spring 11 and is limited in its opening movement by the stops shown. The valve 9 opens into an oil chamber 12 which is in free communication with an oil chamber 14 via a plurality of parallel axial channels 13 in the casing 2.

In a cylindrical extension of the oil chamber 14 is a slide valve 15, the controlling end of which passes through the said oil chamber 14 and, in its respective positions, can open and close a gap leading to the transverse bore 7. The valve 15 has cross bores 16 and an axial passage 16*a* which is adapted to be cut off with a constant tension by means of a ball 17, under the action of a spring 17^1 supported against a screwed-in body 18 fixed in the otherwise open end of the body of the slide valve 15. The said screwed-in body 18 has overflow passages 19 and is provided with axial projections at its opposite sides as can be seen in Fig. 1.

The low pressure pump N, in known manner, is in valveless communication with the high pressure pump H. The connecting pipe leads through an annular conduit 21 to the inlet valves 20 associated with the respective pump cylinders. The cylinders deliver the oil through outlet valves and connecting pipes 22 into the annular conduit 23 which is connected via a high pressure pipe 24 to a third transverse bore 25 of the casing 2 of valve assembly V. To the other end of the transverse bore 25 is connected the high pressure pipe, as shown diagrammatically at 26, leading to the control valve S and also in suitable connection with the low pressure pipe 5.

The transverse bore 25 for the high pressure oil is also in communication with axial bores 25*a* and 25*b* in the casing 2 which extend right and left respectively toward the adjacent transverse bores 3 and 7, in one of which axial bores is the piston 10 and in the other a smaller piston 27. The piston 27, when displaced, can act on the adjacent axial projection of the said body 18 in the slide valve 15. The slide valve 15 is under the action of a spring 28, the stress of which can be adjusted by hand.

When there is no load the low pressure pump N draws the oil from the oil sump and passes it through the pipe 1 into the bore 3 of the valve body 2, via the check valve 4 and the pipe 5 into the central portion of control valve S, and further through the pipe 6, the bore 7, and the pipe 8 back into the oil sump.

The high pressure pump begins to work only when it is fed by the low pressure pump, that is, for example, at a pressure of about 2 atmospheres. The high pressure pump consists essentially of a known arrangement of an eccentric shaft which works on a number of star-shaped pistons which are moved in cylinders each having spring-loaded suction and pressure valves.

When the control valve S of the hydraulic press is in the start position and the press ram (not shown) has travelled over its idle path, the pressure from the low pressure pump to the high pressure pump and to the press cylinder begins to increase, until the valve 9 with its shaft 10 lifts, against the action of the spring 11, for example at 12 atmospheres.

Thereby a second path is opened to the oil which now passes through the chamber 12, the bores 13, the chamber 14, and the bores 16 of the slide valve 15, and lifts a ball 17 from its seat against the resistance of spring 17^1.

This oil flows back to the oil sump through bores **19** of the part **18**, the transverse bore **7** and the pipe **8**.

The spring **17¹** is so dimensioned that the ball is lifted at the necessary pressure (about 2 atmospheres). Instead of providing the ball **17** with spring **17¹**, it is possible to achieve the same purpose by making the passages **16**, **19** sufficiently small to achieve a corresponding throttling effect.

On termination of the no-load conditions on the press ram, the check valve **4** is pressed on its seat.

The high pressure pump becomes operative when the pressure of the low pressure pump has become sufficiently high (for example at 2 atmospheres) to lift the suction valves **20**. The oil coming from the low pressure pump to such valves through the annular channel **21** is pumped by the radial pistons through the exhaust valves and connection channels **22** into the annular channel **23**. This high pressure oil is then delivered through the pipe **24**, and the bore **25** to pipe **26** and meets the pipe **5** just before entry to the control valve S. If the high pressure oil has exceeded, for example, about 12 atmospheres it presses the valve **9** via its shaft **10** from its seat so that after the closing of the check valve **4** the low pressure is immediately reduced to about 2 atmospheres which is determined by the spring **17¹** or the throttle channels **16**, **19**.

After the closing of the check valve **4**, the high pressure pump works only on the driven press and the valve **9** is moved to its open position as far as its stop will permit.

On further increase in the pressure the small piston **27** reacts and presses the complete slide valve **15** back, against the power of the adjusted pressure spring **28** until, after obtaining the predetermined maximum pressure, a gap is formed between the end of the valve **15** and the right end wall of oil chamber **14** which, with a certain width of gap, ensures a direct and pressureless flow of the oil via the bore **7** and the pipe **8** into the oil sump.

As a result, the supply of oil to the high pressure pump is interrupted, but this supply starts again whenever, due to losses by leaking, a reduction in pressure occurs such as will narrow the said gap and the necessary filling pressure of about 2 atmospheres is again present. During the time of maximum pressure therefore, the width of the gap varies continually by oscillations which, as determined by the tightness or leakage of the whole installation, scarcely amount in practice to more than two tenths of one millimeter. On reversing the press, all valves return to the starting position.

Referring now to Fig. 3, a somewhat modified embodiment with structural simplifications and a smaller space requirement is shown, but this coincides in principle with the arrangement according to Fig. 1. In so far as the parts of Fig. 3 have the same significance as in Fig. 1, the same references have been used for these.

Compared with the construction of the control valve (pressure adjusting valve assembly V) according to Fig. 1 in which the oil flows through the main pipe **1**, **3**, **5**, in the construction according to Fig. 3 the corresponding flow is through the passages **1**, **3¹**, **13**, **19**, **3″**, and **7′**. The check valve **4** formerly in the pipes **1**, **5** is now omitted from the casing **2** and is arranged in a separate body which is in communication with the pipe **24** via a transverse bore which corresponding to the arrangement of Fig. 1 allows of the pipe **5** communicating with the pipe **24**.

The valve **4** in Fig. 3, with its axis in the horizontal position is under the action of a closing spring. The high pressure pipe **24** passes into a channel **25** on the casing **2**.

In the casing **2** of the pressure adjusting valve assembly V according to Fig. 3, the valves **9**, **15** and **17** are not co-axial as in Fig. 1, but are arranged on parallel axes alongside each other. The cross bore **3¹** of the casing **2** connected to the low pressure supply pump N is in communication (by ports not shown) with the oil chamber **12** and which opens into the channel **13** (in this case disposed cross-wise of the casing **2**) and as an outlet from that cas-

ing valve **17** is provided here as a mushroom valve member but which could be a ball as in Fig. 1, or a plate. Oil passing the valve **17** enters the port **19** into a channel **3″** which latter is controlled by the piston valve **15**. From this valve the oil runs out into a pipe **7¹** provided with the parts **7** and **8** leading into the oil sump, and a branch **6** leading to the control valve S.

The piston **10**, connected to the valve **9** or forming its shaft, may be influenced by a smaller piston **27¹** which controls one end of the channel **25**.

During no load conditions, the low-pressure pump N draws the oil from the sump and passes it through the pipe **1**, via the check valve **4**, and the pipe **5**, into the control valve S which is then in its middle position. The oil passes further through the pipes **6**, **7** and **8** back into the sump.

The high-pressure pump begins to work only when it is fed by the low-pressure pump, for example with a pressure of about 2 atmospheres.

When the control valve S of the hydraulic press is put into the start position and the press piston has travelled its idle path, the pressure from the low pressure pump begins to build up and eventually the piston valve **9** lifts, against the effect of the spring **11**, for example at 12 atmospheres.

Thereby a second path is opened for the oil which now passes via the chamber **12** and the bore **13**, raises the check valve **17** against the pressure of the spring **17¹** and flows back through the bores **19** and **3″**, **7¹**, **7** and **8** to the oil sump.

The spring **17¹** is so dimensioned that the oil flows at the necessary filling pressure for the high-pressure pump (about 2 atmospheres). Instead of the valve **17** with spring **17¹**, small passages with a corresponding throttling effect could be used, as in the embodiment of Fig. 1. On termination of the no load conditions of the press, the check valve **4** closes on to its seat.

The high pressure pump starts when the pressure of the low pressure pump is strong enough to open the spring-loaded suction valves **20**, for example at 2 atmospheres.

The high pressure oil is led through pipe **24** on the one hand to the control valve S and on the other hand to the bore **25** in the casing **2** and from this last bore it is able to act on the small pistons **27** and **27¹**. If the high pressure oil exceeds for example about 12 atmospheres, it presses the valve **9** from its seat, via its shaft piston **10**, and the small piston **27¹**, so that after the closing of the check valve **4** the low pressure is reduced immediately to about 2 atmospheres which is determined by the spring **17¹** (or throttle channels if used). After the closing of the check valve **4** the high pressure pump works only on the driven press. The valve **9** is moved to its open position as far as its stop will permit.

When the pressure increases, however, the small piston **27** also reacts and presses the complete slide valve **15**, against the force of the pressure spring **28** until, after reaching the adjusted maximum pressure, a gap is formed which with a certain width of gap ensures for the pressure oil a direct and pressureless flow via the bore **7¹** and pipe **8** into the oil sump.

Thereafter the high pressure pump works only if, due to leakage losses, a reduction in pressure results which so narrows the said gap that the necessary filling pressure of about 2 atmospheres is again reached. On reversing the press all valves return to the starting position.

What I claim is:

1. In a pump system adapted for use with a press or the like and having a low pressure stage operative at a predetermined normal pressure and a high pressure stage having a fluid supply connection with said low pressure stage and operative in response to a predetermined increase in pressure in the low pressure stage, control means including a main valve assembly defining a low

pressure fluid path, a low pressure fluid by-pass path and a high pressure fluid path and comprising a first normally closed valve disposed between and having fluid communication with said low pressure path and said by-pass path and having a pressure responsive control member extending to said high pressure path operative to open said first valve in response to a predetermined pressure in said high pressure path, a second normally closed valve in the said low pressure by-pass path including regulating means in fluid communication with said low pressure by-pass path responsive at a predetermined increase in low pressure to open and reduce said low pressure, and a third normally closed valve connected to said low pressure by-pass path and having a pressure responsive member extending to said high pressure path and operative in response to a predetermined high pressure to relieve the pressure on said first valve.

2. In a pump system adapted for use with a press or the like and having a low pressure stage operative at a predetermined normal pressure and a high pressure stage having a fluid supply connection with said low pressure stage and operative in response to a predetermined increase in pressure in the low pressure stage, control means including a main valve assembly defining a low pressure fluid path, a low pressure fluid by-pass path and a high pressure fluid path, said means compriing a first normally closed valve disposed between and having fluid communication with said low pressure path and said by-pass path and having a pressure responsive control piston extending to said high pressure path operative to open said first valve in response to a predetermined pressure in said high pressure path, a second normally closed valve in the said low pressure by-pass path including regulating means in fluid communication with said low pressure by-pass path responsive at a predetermined increase in low pressure to open and reduce said low pressure, and a third normally closed valve connected to said low pressure by-pass path and having a pressure responsive piston of smaller diameter than the diameter of said control piton extending to said high pressure path and operative in response to a predetermined high pressure to relieve the pressure on said first valve.

3. In a pump system adapted for use with a press or the like and having a low pressure stage operative at a predetermined normal pressure and a high pressure stage having a fluid supply connection with said low pressure stage and operative in response to a predetermined increase in pressure in the low pressure stage, control means including a main valve assembly defining a low pressure fluid path, a low pressure fluid by-pass path and a high pressure fluid path, said means comprising a first normally closed valve disposed between and having fluid communication with said low pressure path and said by-pass path and having a pressure responsive control piston extending to said high pressure path operative to open said first valve in response to a predetermined pressure in said high pressure path, a second normally closed valve in the said low pressure by-pass path including regulating means in fluid communication with said low pressure by-pass path responsive at a predetermined increase in low pressure to open and reduce said low pressure, and a third normally closed valve connected to said low pressure by-pass path and having a pressure responsive piston extending to said high pressure path and operative in response to a predetermined high pressure to relieve the pressure on said first valve, said valves being each provided with a separate spring, each spring biasing its associated valve toward closing position.

4. In a pump system adapted for use with a press or the like and having a low pressure stage operative at a predetermined normal pressure and a high pressure stage having a fluid supply connection with said low pressure stage and operative in response to a predetermined increase in pressure in the low pressure stage, control means including a main valve assembly defining a low pressure

fluid path, a low pressure fluid by-pass path and a high pressure fluid path, said means comprising a first normally closed valve disposed between and having fluid communication with said low pressure path and said by-pass path and having a pressure responsive control piston extending to said high pressure path operative to open said first valve in response to a predetermined pressure in said high pressure path, a second normally closed valve disposed in series with said first valve in the said low pressure by-pass path including regulating means in fluid communication with said low pressure by-pass path responsive at a predetermined increase in low pressure to open and reduce said low pressure, and a third normally closed valve connected in parallel with said second valve in said low pressure by-pass path and having a pressure responsive piston extending to said high pressure path and operative in response to a predetermined high pressure to relieve the pressure of said first valve.

5. In a pump system adapted for use with a press or the like and having a low pressure stage operative at a predetermined normal pressure and a high pressure stage having a fluid supply connection with said low pressure stage and operative in response to a predetermined increase in pressure in the low pressure stage, control means including a main valve assembly defining a low pressure fluid path, a low pressure fluid by-pass path and a high pressure fluid path, said means comprising a first normally closed valve disposed between and having fluid communication with said low pressure path and said by-pass path and having a pressure responsive control piston extending to said high pressure path operative to open said first valve in response to a predetermined pressure in said high pressure path, a second normally closed valve disposed in series with said first valve in the said low pressure by-pass path including regulating means in fluid communication with said low pressure by-pass path responsive at a predetermined increase in low pressure to open and reduce said low pressure, and a third normally closed valve connected in parallel with said second valve in said low pressure by-pass path and having a pressure responsive piston extending to said high pressure path and operative in response to a predetermined high pressure to relieve the pressure on said first valve, said valves being each provided with a separate spring, each spring biasing its associated valve toward closing position.

6. In a pump system adapted for use with a press or the like and having a low pressure stage operative at a predetermined normal pressure and a high pressure stage having a fluid supply connection with said low pressure stage and operative in response to a predetermined increase in pressure in the low pressure stage, control means including a main valve assembly defining a low pressure fluid path, a low pressure fluid by-pass path and a high pressure fluid path, said means comprising a first normally closed valve disposed between and having fluid communication with said low pressure path and said by-pass path and having a pressure responsive control piston extending to said high pressure path operative to open said first valve in response to a predetermined pressure in said high pressure path, a second normally closed valve disposed in series with said first valve in the said low pressure by-pass path including regulating means in fluid communication with said low pressure by-pass path responsive at a predetermined increase in low pressure to open and reduce said low pressure, and a third normally closed valve connected in parallel with said second valve in said low pressure by-pass path and having a pressure responsive piston extending to said high pressure path and operative in response to a predetermined high pressure to relieve the pressure on said first valve, said valves being each provided with a separate spring, each spring biasing its associated valve toward closing position, and said second valve being mounted in said third valve and being movable relative thereto in response to a predetermined low

pressure and being movable therewith in response to a predetermined high pressure.

7. In a pump system adapted for use with a press or the like and having a low pressure stage operative at a predetermined normal pressure and a high pressure stage having a fluid supply connection with said low pressure stage and operative in response to a predetermined increase in pressure in the low pressure stage, control means including a main valve assembly defining a low pressure fluid path, a low pressure fluid by-pass path and a high pressure fluid path and comprising an elongated housing having a transverse high pressure bore therethrough, a transverse low pressure fluid supply bore and a transverse fluid return bore, a first and a second low pressure chamber disposed in said by-pass path, at least one longitudinal conduit connecting said first and second low pressure chambers, a first normally closed valve disposed between and having fluid communication with said low pressure fluid supply conduit and said first low pressure chamber having a pressure responsive control member extending to said transverse high pressure bore operative to open said first valve in response to a predetermined pressure in said high pressure path, a second normally closed valve in the said second low pressure chamber including regulating means in fluid communication with said low pressure by-pass path responsive at a predetermined increase in low pressure to open and reduce said low pressure, and a third normally closed valve presenting a portion disposed in said second low pressure chamber having a pressure responsive member extending to said high pressure bore and operative in response to a predetermined high pressure to relieve the pressure on said first valve.

8. In a pump system adapted for use with a press or the like and having a low pressure stage operative at a predetermined normal pressure and a high pressure stage having a fluid supply connection with said low pressure stage and operative in response to a predetermined increase in pressure in the low pressure stage, control means

including a main valve assembly defining a low pressure fluid path, a low pressure fluid by-pass path and a high pressure fluid path and comprising an elongated housing having a transverse high pressure bore therethrough, a transverse low pressure fluid supply bore and a transverse fluid return bore, a first and second low pressure chamber disposed in said by-pass path, at least one longitudinal conduit connecting said first and second low pressure chambers, a first normally closed valve disposed between and having fluid communication with said low pressure fluid supply conduit and said first low pressure chamber having a pressure responsive control member extending to said transverse high pressure bore operative to open said first valve in response to a predetermined pressure in said high pressure path, a second normally closed valve in the said second low pressure chamber including regulating means in fluid communication with said low pressure by-pass path responsive at a predetermined increase in low pressure to open and reduce said low pressure, and a third normally closed valve presenting a portion disposed in said second low pressure chamber having a pressure responsive member extending to said high pressure bore and operative in response to a predetermined high pressure to relieve the pressure on said first valve, said second valve being mounted in said third valve and being movable relative thereto in response to a predetermined low pressure and being movable therewith in response to a predetermined high pressure.

References Cited in the file of this patent

UNITED STATES PATENTS

1,682,172	Ernst	Aug. 28, 1928
1,814,857	Rosle	July 14, 1931
2,214,390	Wahlmark	Sept. 10, 1940
2,366,388	Crosby	Jan. 2, 1945
2,407,923	Gall	Sept. 17, 1946
2,761,387	Gaubatz	Sept. 4, 1956