

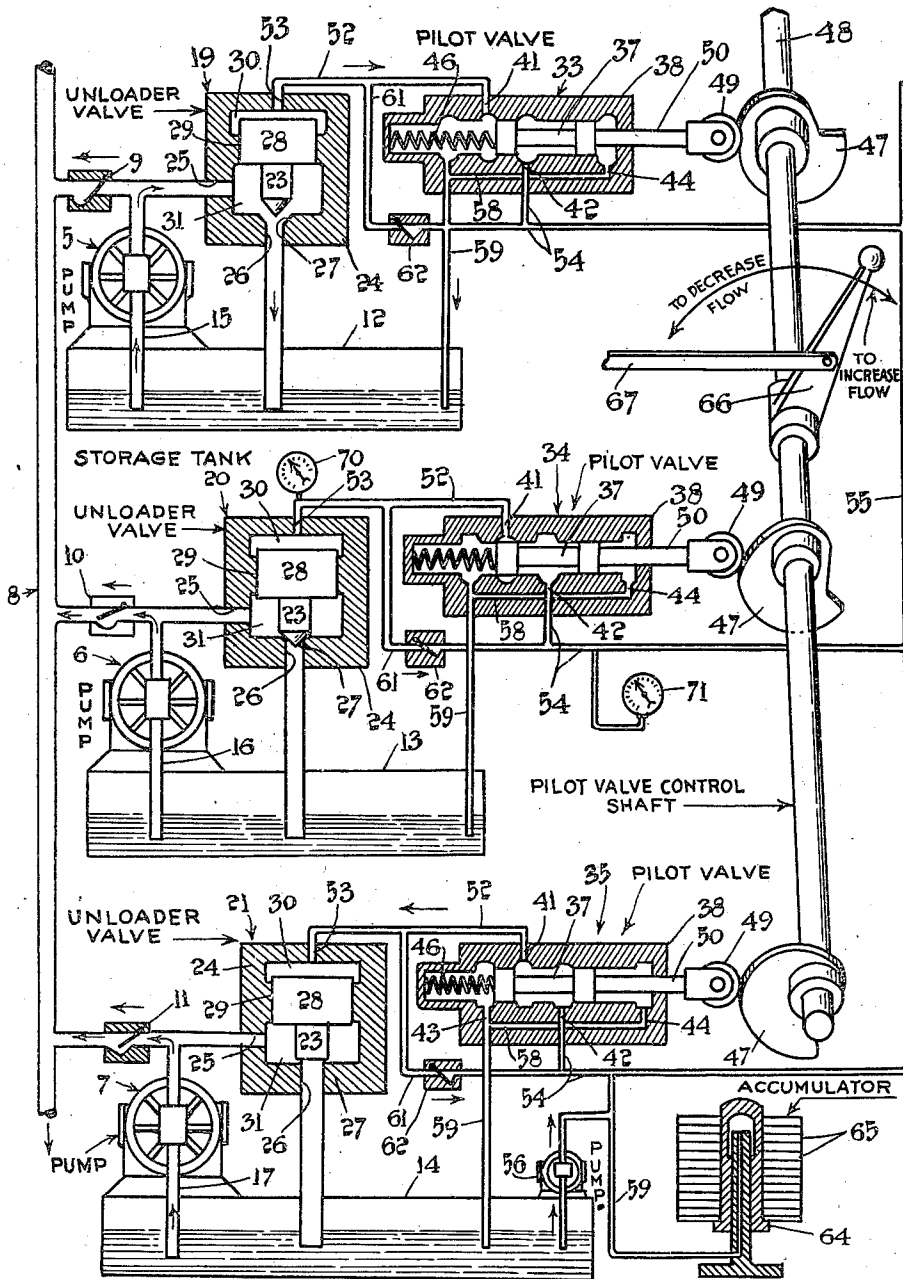
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CONTROL APPARATUS FOR HYDRAULIC MACHINES

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CONTROL APPARATUS FOR HYDRAULIC MACHINES

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This invention relates to control apparatus for controlling the speed and limiting the tonnage or maximum working pressure of hydraulic presses and other hydraulic machines.

The invention has, for one of its objects, to provide improved control apparatus in which stepped speed variation of a hydraulic machine is obtained by sequential operation of a series of pump unloader valves controlling the delivery of a plurality of pumps through which pressure fluid is supplied to the working cylinder or cylinders of said machine.

Another object is to provide, in connection with said improved speed controlling apparatus, means whereby the tonnage or working pressure of the hydraulic machine is prevented from rising above a predetermined maximum value.

Proceeding now to a more detailed description reference will be had to the accompanying drawing, in which the single figure is a diagrammatic illustration of what I now conceive to be the preferred embodiment of the invention.

Referring more particularly to the drawings, 5, 6 and 7 designate pumps having their pressure sides connected to a common discharge header 8 from which the pressure fluid delivered by the pumps is conducted to the working cylinder or cylinders of a hydraulic press or other hydraulic machine. Check valves 9, 10 and 11 are arranged to prevent reverse flow from the header 8 to the pumps 5, 6 and 7. The suction sides of pumps 5, 6 and 7 are shown connected to individual pressure-fluid storage tanks 12, 13 and 14 by their respective inlet connections 15, 16 and 17. If desired, these individual storage tanks may be replaced by a single storage tank serving all of said pumps.

The delivery of each pump is individually controlled by a separate pump unloader valve which is connected between the discharge side of the pump and its associated storage tank so that the pump discharge may be by-passed back to said storage tank through said unloader valve. These unloader valves are respectively indicated at 19, 20 and 21. They each comprise a valve element 23 operating in a valve casing 24 provided with an inlet port 25 connected to the discharge side of the associated pump and a discharge port 26 connected to the associated pressure-fluid storage tank. Valve element 23 closes against a seat 27 afforded by discharge port 26. This valve element is carried by a piston 28 which is a close sliding fit in the cylindrical guide portion 29 of the valve casing and divides the latter into upper and lower pressure chambers 30 and 31. It may

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be noted here that the pressure-receiving area afforded by the upper surface of piston 28 is much greater than that afforded by the lower annular surface of the piston surrounding the valve element 23.

The unloader valves 19, 20 and 21 are individually controlled by separate 3-way pilot valves respectively indicated at 33, 34 and 35.

Each pilot valve assembly comprises a spool valve 37 slidably mounted in a valve casing 38 provided with ports 41, 42, 43 and 44. Valve 37 is moved in one direction by a spring 46 and in the opposite direction by a cam 47 which is fixed to a cam shaft 8 and acts against a roller 49 carried by the valve stem 50.

The ports of each pilot valve are connected in the following manner: Port 41 is connected, through line 52, to a port 53 provided in the top casing wall of the associated pump unloader valve. Port 42 is connected, through line 54 and header 55, to an independent source of pressure fluid represented by pump 56. The ports 43 and 44 are located adjacent opposite ends of the valve casing 38 and are connected together by a fluid passage 58. These ports 43 and 44 are also connected to a common exhaust line 59 leading to the fluid pressure storage tank of the associated pump.

The hydraulic circuit of each pilot valve also includes a by-pass line 61 connected between the lines 52 and 54. A check valve 62, included in each by-pass line 61, permits flow of fluid from line 52 to line 54.

The header 55 and the pressure side of pump 56 are connected, through line 59, to a weight-loaded hydraulic accumulator 64 equipped with weights 65 which may be varied to adjust the pilot pressure by which the unloader valves are held closed against the normal working pressure established in the pressure chambers 31 of the unloader valves by the main pumps 5, 6 and 7.

The pilot valve operating cams 47 are fixed to control shaft 48 in different positions of relative angular displacement and the angular setting of these cams determines the sequence of operation of the pilot valves. The cams are shaped and arranged so that all the pumps 5, 6 and 7 are loaded at one limit of cam travel and are by-passed at the other limit of cam travel. The control shaft 48 is equipped with an operating lever 66 which may be operated either manually or automatically. In the case of automatic operation lever 66 is interconnected by suitable linkage 67 with valve restoring mechanism or other

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operating parts or control elements of the hydraulic machine.

In the present drawings the valve spool 37 of the uppermost pilot valve 33 is shown moved to the right by its operating spring 46 so that port 41 is uncovered. This permits the pressure fluid previously supplied to the upper pressure chamber 30 of unloader valve 19 to be exhausted to storage tank 12 via line 52, pilot valve ports 41 and 43 and exhaust line 49. Pressure fluid trapped between valve spool 37 and the right hand end of cylinder 38 is also exhausted by way of pilot valve port 44, passage 58 and exhaust line 59. With the pressure chamber 30 of the pilot valve 19 connected to exhaust as herein described the main pump pressure established in the lower pressure chamber 31 of unloader valve 19 is effective to raise the piston 28 and valve 23 to uncover discharge port 26 and thereby permit the discharge of pump 5 to be by-passed back to storage tank 12 through chamber 31 of unloader valve 19.

The valve spool 37 of pilot valve 34 is shown in a neutral position in which the left hand end of the valve spool is blocking the port 41. The pressure fluid thus trapped in the pressure chamber 30 of unloader valve 20 is effective to hold the valve element 23 of this unloader valve closed against the normal working pressure established in the pressure chamber 31 by the main pumps 5, 6 and 7. If the working pressure established in the pressure chamber 31 of unloader valve 20 by the main pumps 5, 6 and 7 should increase beyond normal limit while the valve spool 37 of pilot valve 34 is in the neutral position shown there would be an undesirable intensification of the pilot pressure in the pressure chamber 30 and line 52 of unloader valve 20. According to my invention this is taken care of by the provision of the by-pass line 61 and check valve 62. From this it will be apparent that at all times the main pump pressure acting against the valve operating piston of each unloader valve is limited to a value equal to some multiple of the opposing pilot pressure acting on said piston, dependent on the ratio of the lower annular pressure receiving area of the piston to the whole area of the upper surface of the piston. In this connection it will also be apparent that the pilot pressure should be maintained at a constant value that will limit the discharge of the main pumps 5, 6 and 7 to the required pressure. In the present instance this is accomplished by the provision of the weight-loaded hydraulic accumulator 64 but it will be understood that various other arrangements may be provided for adjusting the pilot pressure.

The main pump pressure acting on the lower annular pressure receiving areas of the valve operating pistons 28 of the several unloader valves is shown on a pressure gauge 70 while the pilot pressure applied to the upper pressure receiving areas of said pistons to hold the unloader valves closed is shown by a pressure gauge 71.

From the foregoing description and from a study of the drawings it will be apparent that the flow of fluid from the main pumps 5, 6 and 7 to the header 8 is decreased when the control lever 66 is swung to the left and is increased when said lever is swung to the right. In this connection it will be apparent that movement of lever 66 to the left from the position shown will turn the control cams 47 of the pilot valves 33, 34 and 35 in a direction to permit the valve spools 37 of these pilot valves to be moved to the right by the valve operating springs 46 a

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distance dependent on the extent to which the lever 66 is moved. In this connection it will be seen that even a relatively slight movement of the lever 66 to the left will result in the spool valve 37 of pilot valve 34 being moved to a position in which it at least partially uncovers the port 41 of said pilot valve to thereby permit exhaust of fluid from the pressure chamber 30 of unloader valve 20 with resulting opening of the valve 23 of this unloader valve to provide a by-pass connection for the pump 6. If the movement of the lever 66 to the left is continued a condition will be reached in which the pressure chambers 30 of all the unloader valves are connected to exhaust to permit the valve elements 23 of these unloader valves to be opened to unload all the main pumps 5, 6 and 7. When the lever 66 is moved to the right the spool valves 37 of the pilot valves 33, 34 and 35 will be shifted to the left in sequence against the resistance of the springs 46 to throttle or close off the by-passes afforded by said pilot valves and their pipe connections.

Having thus described what I now conceive to be the preferred embodiment of this invention it will be understood that various modifications may be resorted to within the scope and spirit of the invention as defined by the appended claims.

I claim:

1. Apparatus for controlling the operating speed of a hydraulic machine comprising a series of pumps, means for conducting pressure fluid from the pressure sides of all of said pumps to a working cylinder of the machine, a separate by-pass for each pump through which the pump discharge is diverted to decrease the flow of pressure fluid to said cylinder, a separate unloader valve controlling the by-pass of each pump and adapted to close against the pump pressure, a separate pilot valve for controlling the operation of each unloader valve, each pilot valve including a casing provided with a series of ports including a pressure fluid intake port connected to a pressure line in which a predetermined pressure is maintained independently of said pumps, a delivery port connected to the valve casing of the associated unloader valve by a pressure fluid transfer line and an exhaust port, a valve movable in the pilot valve casing to a pump loading position in which said valve establishes communication between said intake and delivery ports and blocks communication between said ports and the exhaust port or to a valve unloading position in which said valve establishes communication between the delivery port and the exhaust port and blocks communication between said ports and the intake port, each movable pilot valve element serving, in its pump loading position, to permit flow of pressure fluid to the valve casing of the associated unloader valve to thereby close said unloader valve against the pump pressure, said movable valve element of each pilot valve also serving, in its pump unloading position, to permit the valve closing fluid pressure previously supplied to the casing of the associated unloader valve to be exhausted from said casing to thereby permit opening of the unloader valve by the pump pressure acting thereagainst, a hydraulic pressure accumulator connected to the fluid pressure line serving the intake ports of said pilot valves and means for successively operating said pilot valves in predetermined sequence.

2. Apparatus as set forth in claim 1, including a separate check valve-controlled by-pass line

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connected to each of the transfer lines interconnecting the casings of the associated pilot and unloader valves to prevent undesirable intensification of the fluid pressure holding the unloading valves closed when the pilot valves are in their neutral position.

3. Apparatus for controlling the operating speed of a hydraulic machine comprising a series of pumps, means for conducting pressure fluid from the pressure sides of all of said pumps to a working cylinder of the machine, a separate by-pass connected to each pump and through which the pump discharge may be diverted to decrease the flow of pressure fluid to said cylinder, a pump unloader valve included in each by-pass and adapted to close against the pump pressure, a separate pilot valve for controlling the loading and unloading of each pump, each of said pilot valves being operable to a pump loading position establishing connections through which pressure fluid is supplied to the associated pump unloader valve to close said valve and being also operable to a pump unloading position establishing connections through which the closing pressure previously applied to the associated pump unloader valve is exhausted to permit the unloader valve to be opened by the pump pressure acting thereon and mechanism for operating said valves in a predetermined sequence comprising a shaft and a plurality of pilot valve actuating cams fixed to said shaft in different positions of angular adjustment.

4. Apparatus for controlling the operating speed of a hydraulic machine comprising a series of pumps, means for conducting pressure fluid from the pressure sides of all of said pumps to a working cylinder of the machine, a separate by-pass connected to each pump and through

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which the pump discharge may be diverted to decrease the flow of pressure fluid to said cylinder, a pump unloader valve included in each by-pass and adapted to close against the pump pressure, a separate pilot valve for controlling the loading and unloading of each pump, each of said pilot valves being operable to a pump loading position establishing connections through which pressure fluid is supplied to the associated pump unloader valve to close said valve and being also operable to a pump unloading position establishing connections through which the closing pressure previously applied to the associated pump unloader valve is exhausted to permit the unloader valve to be opened by the pump pressure acting thereon and mechanism for operating said valves in a predetermined sequence comprising a separate spring for operating each pilot valve in one direction, a separate cam for operating each pilot valve in the opposite direction against the resistance of said spring and means for simultaneously operating all of said cams, the setting of said cams being such as to operate the several pilot valves in predetermined sequence.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,408,942	Holdsworth	Mar. 7, 1922
1,607,531	Haight	Nov. 16, 1926
1,612,638	Metzgar	Dec. 28, 1926
1,649,297	Nelson	Nov. 15, 1927
2,165,938	Noble	July 11, 1939