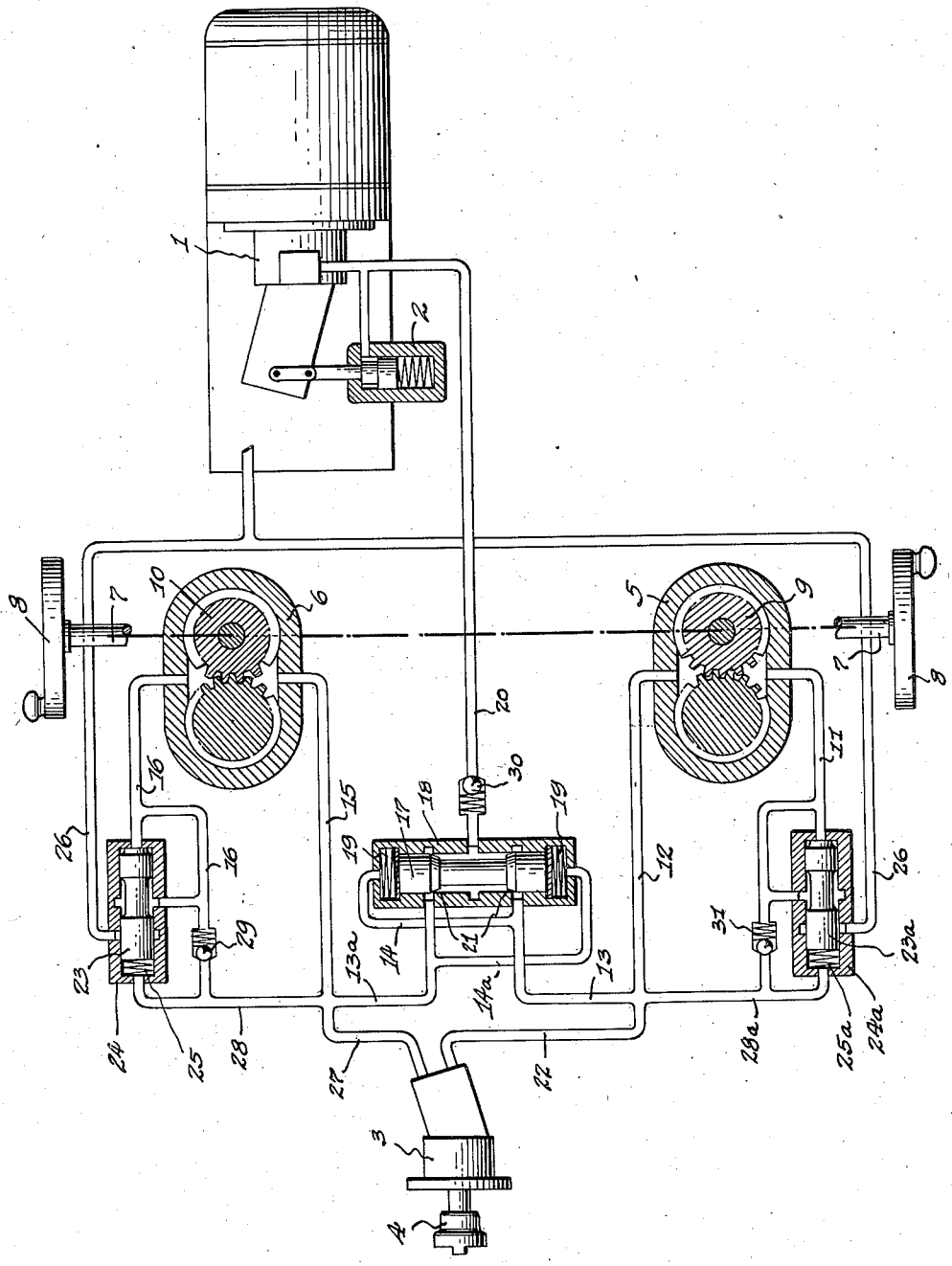
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METERED PUMP DISPLACEMENT CONTROL

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METERED PUMP DISPLACEMENT CONTROL

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This invention relates to a hydraulic control device for a hydraulic motor, and has particularly to do with means for controlling the direction and speed of a hydraulic motor.

The object of this invention is to provide a means to be located in a hydraulic system having a pressure source and a reversible motor, said means being capable of being manually actuated to control the power output of the motor. The device might be designated as producing a follow-up movement and is adapted to effect a smooth flow of available power at the hydraulic motor output shaft in direct proportion to rotation applied by handwheels. A feature of the invention is its ability to counteract any tendency of the power driven means to "kick-ahead" or "kick-back" and this makes the invention especially useful in controlling the actuation and movement of large masses. A further feature of the invention is its reversibility which permits its use with a reversible hydraulic motor and makes it an ideal control device.

Briefly, these objects are accomplished by placing two hand-driven constant displacement pumps in a hydraulic circuit in such a manner that the output of one of the pumps will shift a directional control valve thereby admitting pressure from the pressure source to the motor; the other pump will be placed in series with the exhaust of the motor and will serve to meter the exhaust flow thereby controlling the speed of the motor in direct proportion to the speed of the hand driven pumps.

In the drawing the hand driven pumps and control valves of the invention are shown in cross section in a hydraulic system in which the pressure source and motor and connecting conduits have been diagrammatically displayed.

It is believed that the invention can best be disclosed by describing the operation thereof along with the recital of the elements in the circuit. In the main, the system consists of a variable displacement pump 1 having a pressure compensator 2, a reversible hydraulic motor 3 having a power shaft 4, and constant displacement gear pumps 5 and 6, each having one gear keyed to a common shaft 7 adapted to be rotated by handwheels 8.

Assuming that driven gears 9 and 10 in the gear pumps 5 and 6, respectively, are turned in a counterclockwise direction by movement of the handwheels 8 and shaft 7, the pump 5 will exhaust line 11 and will force fluid into lines 12, 13 and 14. Pump 6 will exhaust a line 15 and will force fluid into a line 16. As a result the pressure in the line 14 will actuate a shuttle valve 17 which is normally centered in a housing 18 by springs 19. The housing 18 is connected to the pressure source 1 by a line 20. The spring centered shuttle valve 17 normally admits pressure from line 20, through restricted openings 21, to lines 13 and 13a. When the gear pumps 5 and 6 are actuated as above described the pressure in the line 14 will shift the shuttle valve 17 downwardly as viewed in the drawing, thereby opening the line 13 to the pressure line 20 and cutting off the line 13a entirely. Pressure in the line 13 is directed to the hydraulic motor 3 through a line 22.

The manually generated pressure from the pump 6 in the line 16 acts directly on the head of a valve 23 which is slidably contained in a housing 24. The pressure in the line 16 will shift the valve 23 by overcoming a spring 25 and will thereby open the line 16 to a tank line 26.

Fluid which enters the motor 3 under pressure through line 22 is exhausted through a line 27 and passes through the line 15 to the pump 6. The line 27 is also connected to a valve housing 24 through line 28 and admits pressure to the spring end of a valve 23. The exhaust flow from the motor 3 will be metered through the pump 6 at a rate directly proportional to the speed at which the handwheels are being turned, and the speed of the motor 3 will thereby be directly controlled by the handwheels 8. A check valve 29 is interposed between the line 28 and the line 16 but there can be no flow through this check valve at this time since pressure in line 16 keeps it closed. Any tendency to increase the pressure in the lines 15 or 28 above that of the pressure in the line 16 will permit the spring 25 to close the valve 23 thereby cutting off the flow through line 16. Thus the pump 6 cannot be driven as a motor by pressure from line 15. Liquid will be passed through the pump 6 from line 15 to line 16 at a rate proportional to the rate at which the handwheels are being turned by the operator and consequently the speed of motor 3 may be directly controlled. This metering action of the pump 6 in cooperation with the valve 23 will counteract any tendency of the power shaft 4 to "kick-ahead," as for example, from the forward inertia of the driven member. Any "kick-back" forces on the power shaft 4 will be opposed by a check valve 30 in the pressure line 20. A check valve 31 acts to bypass the flow from the pump 5 in line 12 to the line 11. At this time lines 13, 14, 22, 12, 28a and 11, through check valve 31, are subjected to pressure from line 20 through

valves 30 and 18. Fluid is displaced by pump 5 from line 11 to line 12 through line 28a and valve 31 back into line 11 allowing pump 5 to be rotated idly with only enough effort to overcome valve 31. Since pressure is higher on the spring end of valve 23a, line 11 will be cut off from line 26.

When handwheels 8 and motor 6 are stopped, liquid from motor 3 will build up pressure in lines 27, 15, 28 and 16. Due to the drop across valve 29, pressure in lines 15 and 28 is greater than pressure in line 16 and the valve 23 will be moved to close off line 16 from line 26. If there is no torque load on shaft 4, the motor 3 will continue to rotate until pressure in lines 27, 15, 28, 13a and 14a is equal to pressure in lines 22, 13, 14, 28a and 12. Pressure will then be equalized on each end of valve spool 17 so that it may be centered by springs 19. If torque is still required at power shaft 4 when the handwheels are stopped, the motor 3 can not turn to equalize pressure in lines 14 and 14a, so that pressure will still be available at line 22 to hold the load. Upon removal of the load the equalization of pressure on valve 17 will take place as above described.

Rotation of the handwheels 8 in the opposite direction resulting in a clockwise rotation for the driven gears 9 and 10 will cause an exact reversal of the flow through the system. The shuttle valve 17 will be shifted upwardly by manually generated pressure flowing through lines 15, 13a, and 14a. Pressure from line 20 then flows to the motor 3 through lines 13a and 27 and the exhaust from the motor flows through lines 22 and 12 and is metered through the pump 5 and exhausted through a valve 24a as previously explained with reference to the pump 6 and valve 24.

It will thus be seen that a manually controlled system is provided which directly controls the speed of a pressure operated hydraulic motor due to the fact that the exhaust of the motor is metered through the constant displacement pumps which are turned at the speed desired. Reversal of the direction of rotation of the power output shaft can be had by simply reversing the manually operated handwheels 8.

With the use of the pressure compensator 2 on the movable head of the variable piston displacement pump 1, the pump 1 may be continuously operated. The volume output of the pump will depend on the pressure in the outlet line 20 which is controlled by the rate of flow through the pumps 5 and 6.

We claim:

1. A hydraulic follow-up device for controlling the speed and direction of a pressure operated motor comprising a pressure source and tank, a pressure operated directional control valve adapted to direct liquid under pressure to said motor, and two manually operated control pumps, one of which directs pressure to shift said directional control valve and the other being located in series with the exhaust of said motor and the tank whereby the exhaust flow of the motor is metered through said last named pump at a rate depending on the speed at which the manually operated pumps are actuated.

2. A hydraulic follow-up device for controlling the speed and direction of a pressure operated motor comprising a pressure source and tank, a pressure operated directional control valve adapted to direct liquid under pressure to said motor, and two manually operated control pumps, one of which directs pressure to shift said directional control valve and the other being located in series with the exhaust of said motor and the tank whereby the exhaust flow of the motor is metered through said last named pump at a rate depending on the speed at which the manually operated pumps are actuated, and valve means hydraulically connected to each of said pumps and to said motor whereby the exhaust flow through said last named pump is positively controlled.

3. A hydraulic follow-up device comprising a pressure operated motor having inlet and outlet conduits, a pressure source and liquid supply tank, a pressure operated directional control valve adapted to direct liquid under pressure from the pressure source to the inlet conduit of said motor, two manually operated control pumps, one of which directs pressure to shift said directional control valve and the other being located in series with the outlet conduit of said motor and the tank whereby the exhaust flow of the motor is metered through said pump at a rate depending on the speed at which the manually operated pumps are actuated, and a pressure responsive exhaust cut-off valve adapted to be opened at the manually generated pressure of said last named pump and adapted to close when pressure behind said last named pump increases above that ahead of said pump.

4. A hydraulic follow-up device for controlling the speed and direction of a reversible pressure operated motor provided with interchangeable pressure-exhaust ports, comprising a pressure source and tank, a pressure operated directional control valve adapted to direct liquid under pressure to either side of said motor, and two manually operated reversible control pumps synchronized in direction and speed of movement, each pump adapted to direct manually generated pressure to shift said directional control valve and each adapted to be placed in series with the exhaust of said reversible motor and the tank whereby the exhaust flow of the motor is metered through said pump at a rate depending on the speed at which the manually operated pumps are actuated, each of said pumps being adapted to perform one or the other of said functions depending on the direction in which said pumps are actuated.

5. A hydraulic follow-up device comprising a reversible pressure operated motor provided with ports to be used interchangeably as pressure and exhaust ports, a pressure source and tank, a pressure operated shuttle valve, hydraulic connections between said valve and the pressure source and between the valve and each of the ports of said motor, whereby a shifting of said valve directs pressure from said pressure source to one of said ports depending on the direction in which the valve is shifted, two reversible pumps both manually actuated and provided with ports to be used interchangeably as pressure and exhaust ports, hydraulic connections between said pump ports and said motor ports and between said pump ports and said shuttle valve whereby simultaneous actuation of said pumps in either direction will shift said shuttle valve, admit liquid under pressure from the pressure source to one of the ports of said motor, and direct exhaust liquid from the other of said motor ports to one of said pumps whereby the exhaust of the motor is metered through said pump to the tank at a rate proportional to the rate at which said pumps are actuated.

6. A hydraulic follow-up device comprising a reversible pressure operated motor provided with ports to be used interchangeably as pressure and exhaust ports, a pressure source and tank, a pressure operated shuttle valve, hydraulic connections between said valve and the pressure source and between the valve and each of the ports of said motor, whereby a shifting of said valve directs pressure from said pressure scurce to one of said ports depending on the direction in which the valve is shifted, two reversible pumps both manually actuated and provided with ports to be used interchangeably as pressure and exhaust ports, hydraulic connections between said pump ports and said motor ports and between said pump ports and said shuttle valve whereby simultaneous actuation of said pumps in either direction will shift said shuttle valve, admit liquid under pressure from the pressure source to one of the ports of said motor and direct exhaust liquid from the other of said motor ports to one of said pumps whereby the exhaust of the motor is metered through said pump to the tank at a rate proportional to the rate at which said pumps are actuated, and valve means hydraulically connected to each of said pumps and to said motor ports whereby the exhaust flow through either of said pumps is positively controlled.

7. A hydraulic speed control and follow-up device comprising a reversible pressure operated motor provided with ports to be used interchangeably as pressure and exhaust ports, a pressure source and tank, a pressure operated shuttle valve for directing pressure to said motor ports, reversible pumps connected to operate simultaneously, and provided with symmetrically opposite ports for acting alternatively as pressure and exhaust ports, hydraulic connections between said pump ports and said motor ports and between said pump ports and said shuttle valve whereby simultaneous manual actuation of said pumps in either direction will generate pressure in one of said pumps to shift said shuttle valve and admit liquid from the pressure source to one of the ports of said motor, and direct exhaust liquid from the other of said motor ports to the other of said pumps whereby the exhaust flow and the speed of the motor is controlled by the movement of said last named pump, and valve means hydraulically connected to each of said pumps and to said motor ports whereby the exhaust flow through either of said pumps is positively controlled.

8. A hydraulic speed control and follow-up device comprising a reversible pressure operated motor provided with ports to be used interchangeably as pressure and exhaust ports, a pressure source and tank, a pressure operated shuttle valve for directing pressure to said motor ports, reversible pumps connected to operate simultaneously, and provided with symmetrically opposite ports for acting alternatively as pressure and exhaust ports, hydraulic connections between said pump ports and said motor ports, and between said pump ports and said shuttle valve whereby simultaneous manual actuation of said pumps in either direction will generate pressure in one of said pumps to shift said shuttle valve and admit liquid from the pressure source to one of the ports of said motor, and direct exhaust liquid from the other of said motor ports to the other of said pumps whereby the exhaust flow and the speed of the motor is controlled by the movement of said last named pump, valve means hydraulically connected to each of said pumps and to said motor ports whereby the exhaust flow through either of said pumps is positively controlled, and a check valve between said shuttle valve and said pressure source.

9. A hydraulic speed control and follow-up device comprising a reversible pressure operated motor provided with ports to be used interchangeably as pressure and exhaust ports, a pressure source and tank, a pressure operated shuttle valve for directing pressure to said motor ports, reversible pumps connected to operate simultaneously, and provided with symmetrically opposite ports for acting alternatively as pressure and exhaust ports, hydraulic connections between said pump ports and said motor ports, and between said pump ports and said shuttle valve whereby simultaneous manual actuation of said pumps in either direction will generate pressure in one of said pumps to shift said shuttle valve and admit liquid from the pressure source to one of the ports of said motor, and direct exhaust liquid from the other of said motor ports to the other of said pumps whereby the exhaust flow and the speed of the motor is controlled by the movement of said last named pump, and a pressure responsive exhaust control valve adapted to be opened by the manually generated pressure of said last named pump and adapted to close when the exhaust flow of said motor develops pressure above that of the said pump.

10. Hydraulic positive displacement pump means adapted to be manually operated, a pressure source, a pressure operated motor having inlet and outlet ports, hydraulic connections between said pump means, pressure source, and motor whereby an inlet of said pump means is in series with the outlet of said motor and whereby the exhaust flow and speed of said motor is controlled by the speed of said manually operated pump means, and an exhaust flow control valve, hydraulically connected to the outlets of said pump means and said motor, said valve being adapted to be opened by manually generated pressure from said pump means and to close when the motor exhaust pressure rises above the outlet pressure of said pump means.

11. A hydraulic follow-up device for controlling the speed and direction of a pressure operated motor comprising a pressure source, control means for directing fluid under pressure from said source directly to said motor, and pump means to be manually operated for actuating said control means to cause fluid under pressure to be directed to said motor and for simultaneously metering exhaust flow from said motor whereby the speed of said motor is proportional to the movement of said manually operable means.

12. A hydraulic follow-up device for controlling the speed and direction of a pressure operated motor comprising a pressure source, control means for directing fluid under pressure from said source directly to said motor, a first manually operable pump means for actuating said control means to cause fluid under pressure to be directed to said motor, and a second manually operable pump means for simultaneously metering exhaust flow from said motor, said first and second means each being reversible whereby said second means actuates said control means and said first means meters exhaust flow from said motor to effect reversal of said motor.

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