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(54) DEMAND COMPENSATED HYDRAULIC SYSTEM

(71) We, DEERE & COMPANY, a corporation organised and existing under the laws of the State of Delaware, United States of America, of Moline, Illinois 61265, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to a demand compensated hydraulic system in which the fluid output of a variable displacement pump can be made proportional to the instantaneous pressure demand of one or more fluid motors supplied by the pump.

In the past, the instantaneous demand has been sensed in accordance with the feed pressures at the motors, the feed pressures being fed back to a demand control valve by small pilot lines, as described in U.S. patent specifications 2,892,311 and 2,892,312. Economy dictates the use of small pilot lines but the substantial increase in fluid viscosity during cold weather causes severe problems by decreasing or eliminating the demand compensation response of the system. This is so because the pressure sensing has required a continuous bleed flow through the pilot lines and to a reservoir via a constricted orifice.

According to the present invention, there is provided a hydraulic system comprising a variable displacement pump with a displacement control device, a hydraulic motor, a pump line connected between the pump and the motor via a motor control valve for selectively opening and closing the pump output line, a control line connected between the pump and the displacement control device, a demand valve device interposed in the control line for selectively opening and closing the control line to allow and block the input of pressurized fluid to the displacement control device in response to pressurized fluid in a pilot line, the pilot line being connected between the pump output line in the vicinity of the motor and a pressure amplifier arranged to control the application of pressurized fluid from the pump output line in the

vicinity of the motor to the demand valve device. 50

The invention will be described in more detail, by way of example, with reference to the sole Figure which is a schematic diagram of a demand compensated system employed with a plurality of motors and embodying the present invention. 55

A variable displacement pump 10 has an intake line 12 connected to a reservoir 14 and a high pressure output line 16. The output line 16 is connected to a hydraulic system which includes first and second two-way hydraulic motors 18 and 20 which are connected in parallel to the output line 16 by first and second supply branches 22 and 24. First and second control valves 26 and 28 are interposed in the branches 22 and 24 for selectively causing pressurization of the motors 18 and 20 by the pump 10. Both control valves are shown in their neutral positions. 60

The output of the pump 10 is under the control of a pump displacement control device 32, comprising a chamber 34 in which a piston 36 moves in one direction under action of a biasing means in the form of a spring 38 to increase pump output and in the opposite direction to decrease pump output in response to pressurized fluid admitted to the chamber 34 through a demand compensating or demand control valve 40. 65

The demand control valve 40 comprises a piston 42 which separates a bore 44 into pressure and pilot chambers 46 and 48. The pressure chamber 46 is connected via a control line 50 to the output line 16, and by a port chamber 52 therein to the chamber 34 via a control line 54. The control line 54 further leads via a constricted orifice 56 to the reservoir 14. A relief valve 58 is connected across the lines 16 and 54 and dumps excessively pressurized fluid to the line 54 for ultimate exhaust to the reservoir 14, at the same time affording an instantaneous pressure rise in the chamber 34 for moving the pump out of stroke to decrease the pump output. The pilot chamber 48 of the demand valve 40 contains a spring 57 biasing the piston to- 70

wards the pressure chamber 46. The pilot chamber 48 is connected to the reservoir 14 through a restricted orifice 59 and to the output of a pressure amplifier 60.

5 The pressure amplifier 60 is further connected to a feedback or pilot line circuit 61 which in turn connects to first and second feedback or pilot line branches 62 and 63. The first feedback branch 62 contains a check valve 64 and is connected to the first supply branch 22 through a check valve assembly 65. The second feedback branch 63 is connected to the second supply branch 24 through a check valve assembly 66. The pressure amplifier 50 is further connected to the output line 16 by a high pressure line 68.

The pressure amplifier 60 includes a chamber 70 which is divided by a valving piston 72 into a pilot side chamber 74 connected to the pilot circuit 61 and a demand side chamber 76 connected to the demand valve 40. The valving piston 72 includes an annular groove 78 which is connected to the pilot side chamber 74 by a restricted orifice 80 and to the demand side chamber 76 by a fluid passage-way 82. The valving piston 72 is slidable in the chamber 70 to afford or block fluid communication between a port 84, in the wall of the chamber 70 to which the high pressure line 68 is connected, and the annular groove 78. A spring 90 biases the valving piston 72 towards the pilot side chamber 74.

A priority valve 92 of the nature described in the aforementioned U.S. Specification is interposed in the second supply branch 24 and is connected to the first pilot branch 62 in parallel with the check valve 64 and thence to the port chamber 52 of the demand valve 40. The priority valve 92 opens the second branch 24 when the port chamber 52 pressure is at a predetermined high value and closes the second branch 24 when the chamber pressure decreases to a predetermined low value.

In operation, assuming that both control valves 26 and 28 are in neutral, the pressure in the output line 16 and in the branches 22 and 24 on the feed side of the control valves 26 and 28 will be determined by the load applied by the spring 57 in the demand control valve 40. Consequently, the port chamber 52 will be open to connect the control line 50 and 54 for supplying fluid to the displacement control device 32. A small steady flow is supplied, the rate of which is dependent for one thing on the size of the orifice 56. Thus, the output of the pump is relatively low, being sufficient only to maintain the flow just described at a corresponding pressure which may be considered the stand-by pressure. At this time there will be no flow or pressure in the pilot circuit 61, since the control valves 26 and 28 are in neutral and any fluid trapped in the pilot circuit 61 can bleed to the reservoir 14 through the restricted orifice 80 and the passage 82 in the valving piston 72 of the

pressure amplifier 60 and thence through the restricted line 59.

If either the control valve 26 or 28 is moved out of its neutral position so as to establish fluid communication to the motor 18 or 20, a pressure will be created in the first or second branch 62 or 63 of the pilot circuit 61. As the pressure increases in the pilot circuit 61, the pressure on the pilot side chamber 74 of the pressure amplifier 60 will increase faster than it can be relieved through the orifice 80 and will overcome the loading of the spring 90 to cause the valving piston 72 to move to compress the demand side chamber 76. When the valving piston 72 moves sufficiently for the port 84 to come into communication with the annular groove 78, part of the pump flow will be diverted through the high pressure line 68 and the passage 82 into the demand side chamber 76 and thence into the chamber 36 of the demand control valve 40. The pressure rise below the demand piston 42 plus the load provided by the spring 57 will cause the piston 42 to close the port 52. Fluid trapped in the line 54 under the pressure of the spring 38 will bleed through the orifice 56 without being made up, resulting in the piston 36 moving to increase the output of the pump 10 and increase the pressure in the output line 16 to satisfy the system demand.

As soon as the motor 18 or 20 begins to move, the flow through the control valve 26 or 28 will lead to a pressure drop across its internal metering ports, causing the pressure in the pilot circuit 61 to drop below that of the pressure in the output line 16. The pressure in the pilot side chamber 74 decreases further due to bleed through the orifice 80, so causing the valving piston 72 to block fluid communication between the output line 16 and the demand valve 40. With a reduction of pressure in the pilot chamber 48, the demand valve piston 42 will uncover the port 52 to add further fluid to the chamber 34 and thus hold the pump output at that required by the fluid motor.

WHAT WE CLAIM IS:—

1. A hydraulic system comprising a variable displacement pump with a displacement control device, a hydraulic motor, a pump output line connected between the pump and the motor via a motor control valve for selectively opening and closing the pump output line, a control line connected between the pump and the displacement control device, a demand valve device interposed in the control line for selectively opening and closing the control line to allow and block the input of pressurized fluid to the displacement control device in response to pressurized fluid in a pilot line, the pilot line being connected between the pump output line in the vicinity of the motor and a pressure amplifier arranged to control the application of pres-

surized fluid from the pump output line in the vicinity of the motor to the demand valve device.

5 2. A hydraulic system according to claim 1, wherein the pressure amplifier includes a restricted flow passage connecting the pilot line to a reservoir.

10 3. A hydraulic control system according to claim 1, wherein the pressure amplifier has a port connected to the pump output line and a chamber defined by a piston slidable in a cylinder and spring biased in the sense to reduce the volume of the chamber, the pilot line communicating with the chamber and the piston being arranged to place the port in communication with the demand valve device when the pressure in the chamber urges the piston beyond a predetermined position against the spring bias.

20 4. A hydraulic control system according to claim 3, wherein the piston divides the

cylinder into the aforesaid chamber and a second chamber connected to the demand valve device and includes a second port connected to the second chamber, the second port coming into communication with the first mentioned port when the piston is urged beyond the predetermined position.

5. A hydraulic control system according to claim 4, wherein the pressure amplifier includes a restricted flow passage between the chamber to which the pilot line is connected and the second port.

6. A hydraulic system according to claim 1 and substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawing.

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