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(54) **Variable displacement pump system.**

(57) A variable displacement pump system including a pressure and a load sensing compensator (18,19) for operating a pump adjusting mechanism (11-13) to vary the displacement by applying hydraulic fluid to a hydraulic positioning piston (13) and a spring biased piston (12). The load sensing compensator (19) senses the pressure drop of the working fluid flow across a system valve (15) and applies a modulated pressure to the hydraulic positioning piston (13). The spring biased piston (12) is connected (line 21) to a load sensing line (20).

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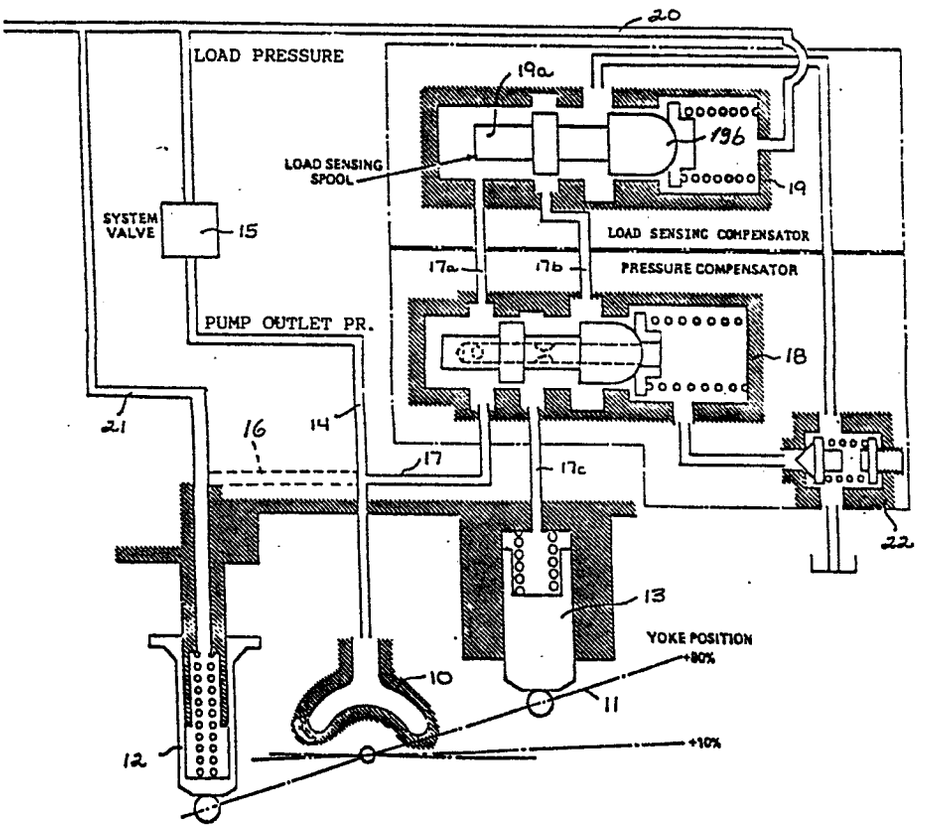

20
LOAD PRESSURE
19a
19b
LOAD SENSING SPOOL
19
SYSTEM VALVE
15
LOAD SENSING COMPENSATOR
17a
17b
PRESSURE COMPENSATOR
PUMP OUTLET PR.
18
21
16
14
17
17c
22
13
YOKE POSITION
+80%
10
11
+10%
12

This invention relates to variable displacement pump systems and particularly to hydraulic pump control systems thereof.

It is known (US-A-3,554,093) to provide a variable displacement pump with a pressure compensator for operating a hydraulic positioning piston to vary the displacement of the pump against the action of a spring biased piston. It is also known to provide a load sensing valve or compensator which functions to operate the hydraulic positioning piston to vary the displacement of the pump against the action of the spring biased piston. The load sensing compensator is active as the primary pump control except when the pressure of the pump is at the limit set by the pressure compensator at which time the pressure compensator overrides the load sensing compensator. In addition, it is known to apply the fluid pressure delivered to a system or directional valve to work in unison with the spring biased piston.

One of the problems with such a system is that under heavy loads and when the connecting lines are short, the system tends to become unstable causing hydraulic pulsations and resultant oscillating movement of the load or device being controlled.

Accordingly, an objective of the present invention is to provide a variable displacement pump system which is more stable.

In accordance with the invention, the load pressure as taken from a load sensing port or downstream from the system valve is connected to deliver this load pressure to the spring biased piston rather than using the output pressure of the pump to the spring biasing piston.

An embodiment of the invention is described

by reference to the drawing which shows a schematic of a hydraulic pump control system.

The variable displacement pump 10 may be of the variable axial piston type shown in US-A-3,554,093 which is incorporated herein by reference and comprises a yoke and a swash plate 11 that are movable to vary the stroke of axial pistons (not shown). A first smaller positioning piston 12 which is spring biased and is acted upon by a pressure yieldingly urges the yoke and the swash plate 11 to a maximum displacement position. A second larger positioning piston 13 acts on the yoke and the swash plate 11 in opposition to the first positioning piston 12. Working fluid flow from the pump 10 is directed through a feed line 14 to a directional valve system 15 ("system valve") and extended to a load such as a hydraulic actuator. In the known system (US-A-3,554,093) a control line 16 (shown in dashed lines) connects the pump outlet to the first positioning piston 12. Pump outlet pressure is connected through a further control line 17 to a compensator arrangement 18 / 19. The compensator arrangement comprises a pressure compensator 18 which may be of the pilot valve 22 controlled type to decrease the displacement as the pressure increases above a limit set by the spring force on pilot valve 22 (protection against over pressure).

The compensator arrangement also includes a load sensing compensator 19 which is connected at its first spool end 19a by the control line 17, 17a to pump outlet pressure, and at its second spool end 19b by a load sensing line 20 downstream of the system valve 15 to the pressure of fluid being delivered to the load. Thus the drop in pressure across the valve system 15 is sensed by compensator 19 which functions to modulate pump outlet pressure in lines 17, 17a and to deliver such modulated pressure via lines 17b, 17c to the second positioning piston 13. Modulation also depends on the spring preload of compensator 19. The second positioning piston 13 which is larger in cross section than the first

positioning piston determines the position of the yoke and swashplate 11 and therefore pump delivery rate. The displacement is varied in a manner to deliver exactly the load flow required by the actuator or actuators at the load pressure, which is, for example, 14 to 21 bar (200 to 300 p.s.i.) below the pump outlet pressure. When this difference of 14 to 21 bar is exeeded, the spring preload of the compensator 19 is surmounted and a modulated pressure produced which lowers the displacement of the pump so that the pressure difference is maintained.

It has been found that such a hydraulic system is unstable under high loads resulting in pulsation of the fluid and oscillating of the device being controlled, particularly when flows are small.

In accordance with the invention, the usual control line 16 is eliminated and a control line 21 is added which extends from the load sensing line 20 downstream of valve system 15 to the first positioning piston 12 which, therefore, is acted upon by load pressure.

It has been found that such a system overcomes the problem of stability of the prior art system.

It is believed that any change in the flow rate has a simultaneous influence on both positioning pistons 12 and 13, i. e. changes in the load pressure and in the modulated pressure will arrive practically simultaneously at the first positioning piston 12 and the second positioning piston 13, respectively, whereas it is believed that in the prior art system the influence on the first piston 12 (pump outlet pressure) is followed with a time lag by the influence on the second piston 13 (modulated pressure) so that the position of the swash plate is changed in one direction immediately followed by a change in the other direction which might be the reason for the pulsations observed.

Although the system has been described as used in connection with a variable displacement pump of the swash plate type, it will be understood by persons skilled in the art that it is also applicable to other types of

pumps having differing pump adjusting mechanism for varying the displacement such as eccentric adjustment variable vane pumps and pumps using a rotating group housed in a tiltable yoke assembly.

Claims

1. A variable displacement hydraulic pump control system comprising

a variable displacement pump (10) having an outlet and an inlet and including a pump adjusting mechanism (11 - 13) comprising a hydraulic positioning piston means (13) and spring biased piston means (12) yieldingly opposing said positioning piston means (13),

load sensing compensator means (19),

first passage means (17, 17a) connecting the outlet of the pump to one end (19a) of said load sensing compensator means (19) for sensing the pressure at the outlet of the pump (10),

second passage means (17b, 17c) extending between said load sensing compensator means (19) and said positioning piston means (13) for moving said pump adjusting mechanism (11 - 13) in response to activation of said load sensing compensator means (19),

a system valve (15),

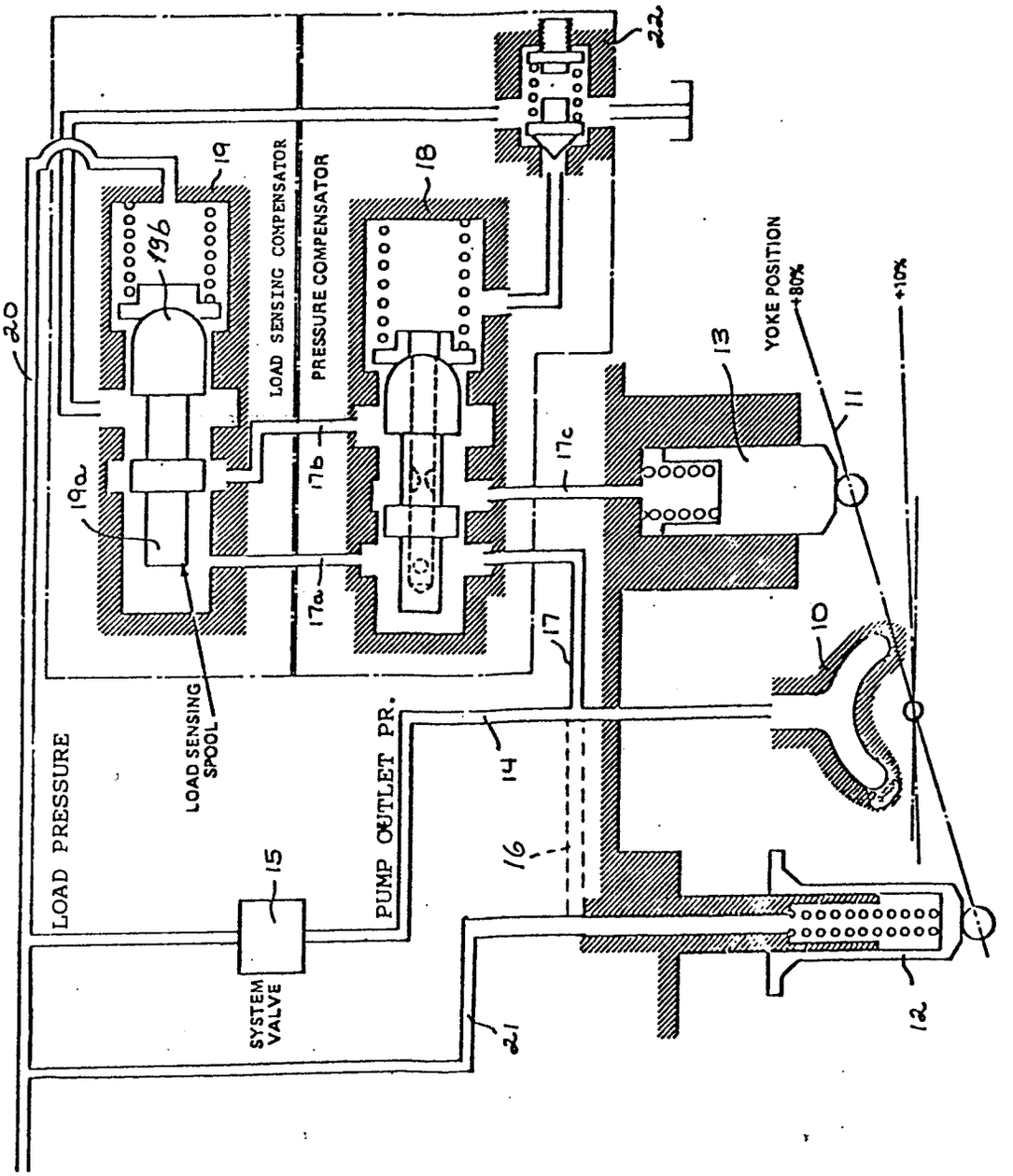
third passage means (14) between the outlet of said pump (10) and said system valve (15),

fourth passage means (20) extending between the other end (19b) of said load sensing compensator means (19) and said system valve (15), and

fifth passage means (21) between said fourth passage means (20) downstream of said system valve (15) and said spring biased piston means (12).

2. The variable displacement pump control system set forth in claim 1 including pressure compensated piston means (18) having one end connected to said first passage means (17),

said pressure compensated means (18) being connected in said second passage means (17b, 17c) and responsive to pressure in said second passage means to change the pressure to said positioning means (13) and thereby vary the displacement of the pump adjusting mechanism (11) when the pressure exceeds a predetermined amount.


22
19
19b
18
LOAD SENSING COMPENSATOR
PRESSURE COMPENSATOR
20
YOKE POSITION
+80%
+10%
13
11
19a
17b
17c
17a
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10
LOAD SENSING SPOOL
LOAD PRESSURE
PUMP OUTLET PR.
14
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SYSTEM VALVE
21
12