FLUID POWER
Design Data Sheet

Revised Sheet 62 - Womack Design Data File

PRESSURE COMPENSATED HYDRAULIC PUMPS

A pressure compensator is a device built into some pumps for the purpose of automatically reducing (or stopping) pump flow if system pressure sensed on the pump outlet port, should rise above a pre-set desired maximum pressure (sometimes called the "firing" pressure). The compensator prevents the pump from being overloaded if an overload is placed on the hydraulic system.

A compensator is built into the pump at the factory and usually cannot be added in the field. Any pump built with variable displacement can be controlled with a compensator. These include several types of axial piston pumps and unbalanced (single lobe) vane pumps. Radial piston pumps can sometimes be built with variable displacement but do not lend themselves readily to this action. Most other positive displacement pumps including internal and external gear, balanced (double lobe) vane, gerotor, and screw types cannot be built with variable displacement.

Figure 1 is a schematic of a check valve axial piston pump, variable displacement, controlled with a pressure compensator. The pistons, usually 5, 7, or 9 in number, are stroking inside a piston block which is keyed to and is rotating with the shaft. The left ends of the pistons are attached through swivel joints, to piston shoes which bear against and slide around on the swash plate as the piston block rotates. The swash plate itself does not rotate; it is mounted on a pair of trunnions so it can swivel from neutral (vertical) position to a maximum tilt angle. The angle which the swash plate makes to the vertical causes the pistons to stroke, the length of stroke being proportional to the angle. Normally, at low system pressures, the swash plate remains at its maximum angle, held there by spring force, hydraulic pressure, or by the dynamics of pump construction, and pump flow remains at maximum. The compensator acts by hydraulic pressure obtained internally from the pump outlet port. When pump

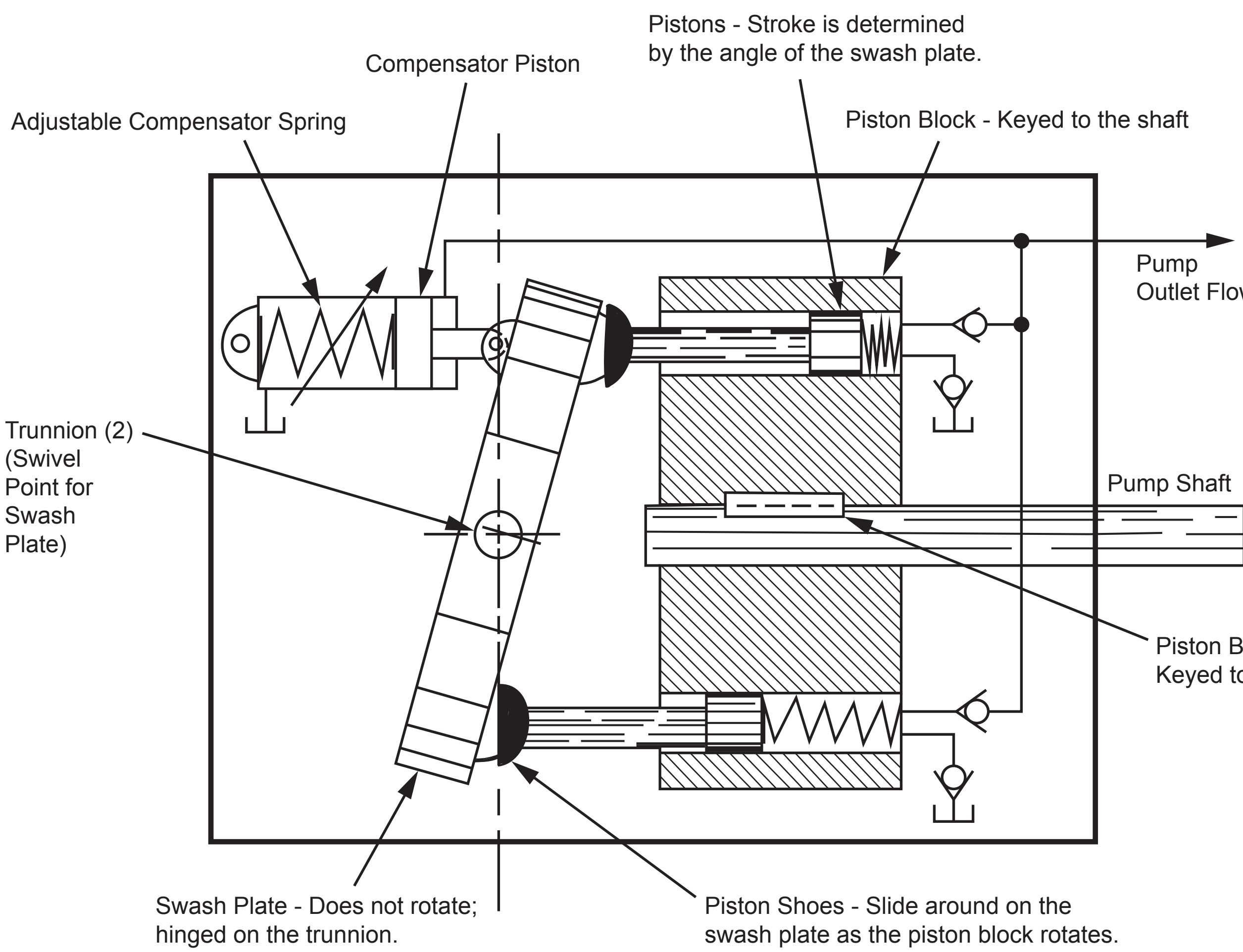

Figure 1. *Schematic of a variable displacement, check valve piston pump, with built-in pressure compensator.*

pressure rises high enough to over-come the adjustable spring behind the compensator piston, the “firing” pressure has been reached, and the compensator piston starts to pull the swash plate back toward neutral, reducing pump displacement and output flow. The spring in the compensator can be adjusted for the desired maximum or “firing” pressure.

Under working conditions, on a moderate system overload, the compensator piston reduces the swash plate angle just enough to prevent the system pressure from exceeding the “firing” pressure adjusted on the compensator. On severe overloads the compensator may swing the swash plate back to neutral (vertical) to reduce pump flow to zero.

Maximum Displacement Stops. Some pumps are available with internal stops to limit the tilt angle of the swash plate. These stops limit the maximum flow and limit the HP consumption of the pump. They may be fixed stops, factory installed and inaccessible from the outside, or they may be externally adjustable with a wrench.

Manual Control Lever. Some pressure compensated pumps, especially hydrostatic transmission pumps, are provided with an external control lever to enable the operator to vary the swash plate angle (and flow) from zero to maximum. On these pumps the pressure compensator is arranged to override the manual lever and to automatically reduce the swash plate angle if a system overload should occur even though the operator control lever is still shifted to maximum displacement position.

Where Pressure Compensated Pumps Are Used

Basically the pressure compensator is designed to unload the pump when system pressure reaches the maximum design pressure. When the pump is unloaded in this way, there is little HP consumed and little heat generated even though pressure remains at the maximum level, because there is no flow from the pump.

Variable displacement pumps are usually more expensive than fixed displacement types, but are especially useful in systems where several branch circuits are to be supplied from one pump, and where full pressure may be required simultaneously in more than one branch, and where the pump must be unloaded when none of the branches is ill operation. If individual 4-way valves are used in each branch, each valve must have a closed center spool. The inlet ports on all 4-way valves must be connected in parallel across the pump line. However, if all branch circuits are operated from a bank valve of the parallel type, a pressure compensated variable displacement pump may not be necessary; a fixed displacement pump, gear, vane, or piston, may serve equally well because the bank valve will unload the pump when all valve handles are placed in neutral, but when two or more handles are simultaneously shifted, their branch circuits will automatically be placed in a parallel connection.

As in all hydraulic systems, more pump oil will flow to the branch with the lightest load. Bank valve handles can be modulated to equalize the flow to each branch. When individual 4-way valves are used in each branch, flow control valves may be installed in the branch circuits and adjusted to give the flow desired in each branch.

Figure 2 shows a multiple branch circuit in which a variable displacement pump is used to advantage. Individual 4-way valves, solenoid operated, are used for each branch, and they have closed center porting. Please refer to **Design Data Sheet 54** for possible drift problems on a pressure manifold system. A pressure relief valve is usually required even with a pressure compensated pump due to the time interval required for the swash plate to reduce its tilt angle when a sudden overload occurs. The relief valve will help absorb part of the pressure spike generated during this brief interval. It should be adjusted to crack at about 500 PSI higher than the pressure adjustment of the compensator piston spring to prevent oil discharge across it during normal operation.

All hydrostatic transmission systems use a variable displacement pump with pressure compensator, and often combine the compensator with other controls such as the horsepower input limiter, load sensing, flow sensing, or constant flow control.

Published by:
WOMACK EDUCATIONAL PUBLICATIONS
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13835 Senlac Dr.
Farmers Branch, TX 75234
Tel: 800-859-9801
Fax: 214-630-5314
www.womack-educational.com

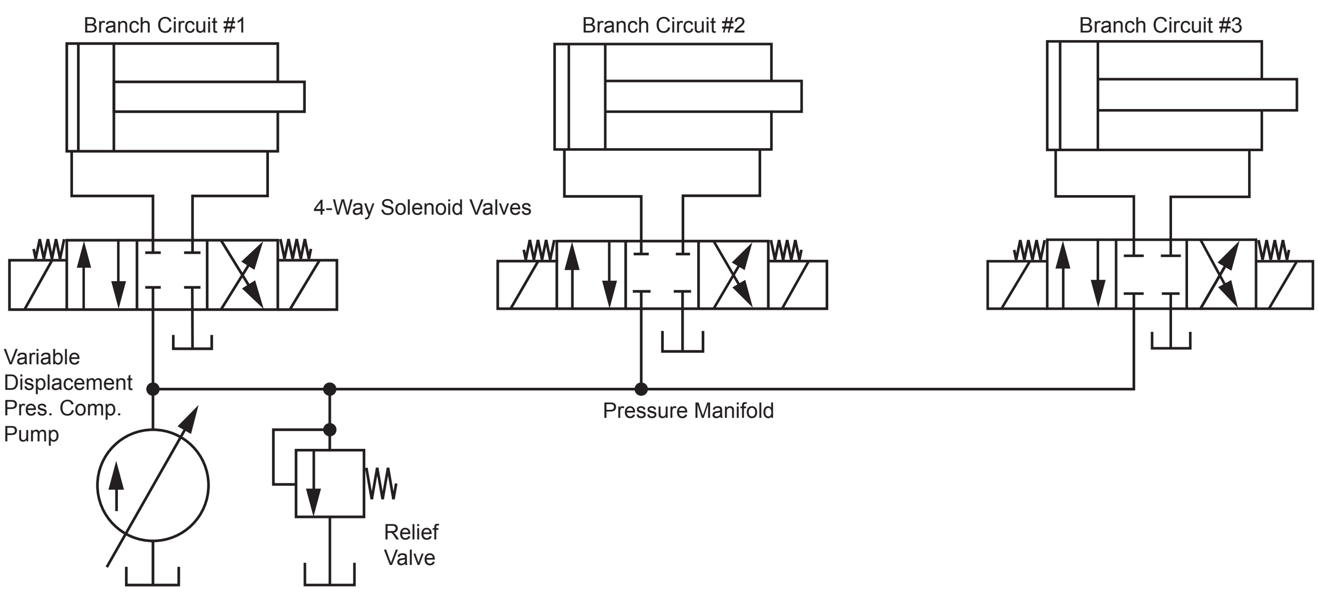

Figure 2. *Pressure compensated, variable displacement pumps are useful in systems where several branch circuits must be operated in parallel from one pump.*