Parker Variable Flow Open-Center (VFO)

An Innovative Hydraulic System Focused on Circuit Simplification and Improved Reliability

Parker

ENGINEERING YOUR SUCCESS.

Variable Flow Open-Center Concept

Germano Franzoni, Ph.D.

Sr. Systems Engineer
Parker Hannifin Corporation
Global Mobile Systems

Hydraulic system layouts commonly used in mobile equipment are either based on open-center valve technology coupled with fixed displacement pumps or load-sensing (LS) valve technology coupled with variable, or sometimes fixed, displacement pumps.

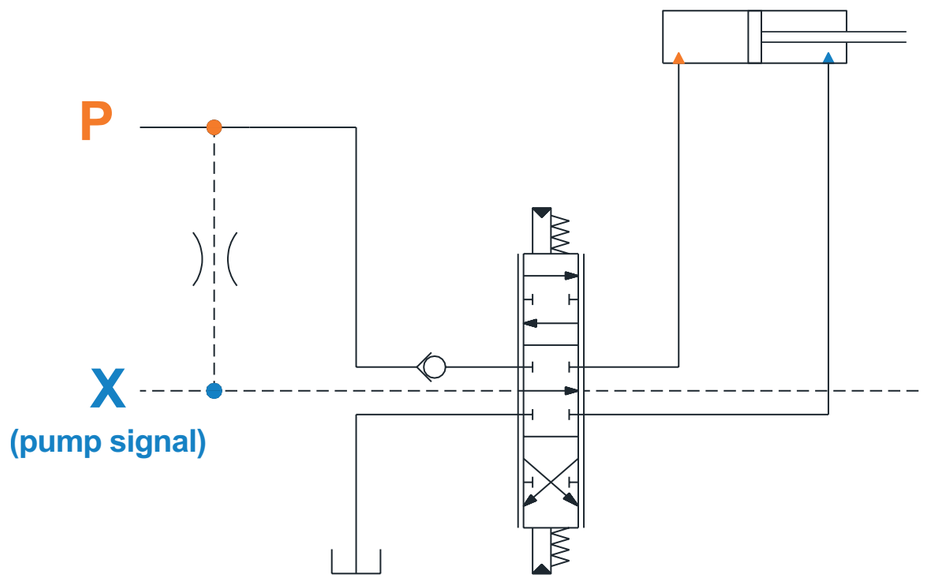
Each of the above-mentioned solutions has different merits: for example, the open-center system is simple, robust, cost-effective and provides a good operator feel (smooth operation and load-dependent flow are helpful especially in digging operations). On the other hand, the load-sensing technology has the benefit of energy efficiency (especially when coupled with variable pumps) and multifunction control.

What Is VFO?

Variable Flow Open-center is an innovative concept where a variable displacement pump is controlled by an open-center type valve. Therefore VFO combines several advantages of the existing technologies: simplicity, cost-effectiveness and smooth operation of the open-center valve together with the energy efficiency of piston pumps.

VFO in a Nutshell

- **Simplification:** no compensators and shuttle networks
- **Reliability:** less complexity means more dependability
- **Productivity:** energy balance of variable-pump technology
- **Applicability:** any valve control type, no need of electronics



Value to the customers— VFO addresses the following needs:

- **"I need to upgrade my system to piston pumps, but I am trying to keep the valve layout simple."**
- **"The current system uses LS valves, and this is too costly. I am looking to reduce system complexity."**
- **"I am building a machine in two versions: one with open-center valve and fixed displacement pump and another with variable piston pump and LS valve. Is there a way to keep the valve and plumbing the same for both systems?"**

How Does It Work?

The VFO system uses a standard load-sense or remote-pressure-compensated piston pump and an open-center valve with properly designed spools. The orifice connecting the power core and the open-center core of the valve allows a small amount of oil to be circulated through the open-center line. While the spool is shifted, the pump control is commanded to an increasing signal pressure, which in turn determines a higher pressure to the functions. See Figure 1 for an explanation.

When no function is commanded, the flow across the valve is tiny, and the system power draw is lower than a fixed-pump system, comparable to a variable-pump LS system. When a function is partially stroked, the pump matches the flow demand by the actuator added to the small open-center flow. When one or more functions are fully stroked, the pump is at full displacement and no flow is lost in the open-center galley. The metering during multifunction is handled by the spool design. Parker valve engineers have designed spools that adapt their position to the oil flow and achieve an extremely good level of compensation without the use of specific sectional compensators.

VFO can be applied to any valve control type: manual, hydraulic pilot or electro-hydraulic.

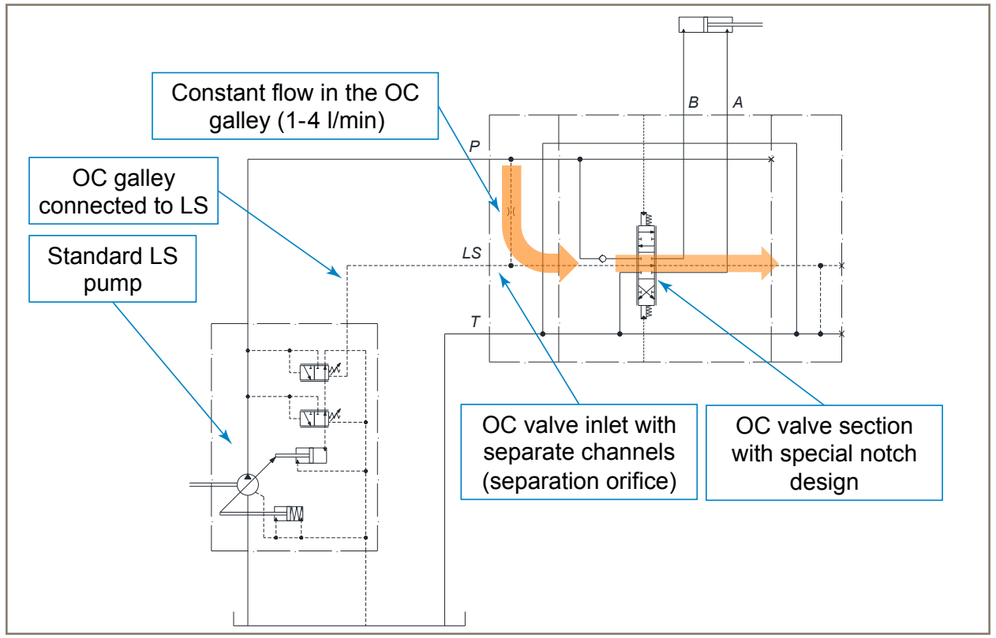


Figure 1. Principle of operation of the Variable Flow Open-center concept.

Examples of Application

Backhoe Loader

Figure 2 shows the schematic of a VFO backhoe loader application. The single piston pump (in this case in a remote pressure compensated configuration) is supplying two valve banks: one controlling the loader and the second the backhoe operation. The two valve banks control the same pump by simply connecting the two open-center galleys in series.

Comparison with standard open-center technology: In the case of a backhoe loader, from an energy standpoint, the VFO circuit provides up to 20% less energy consumption (which turns into a 20% productivity increase) with respect to a standard open-center fixed-pump circuit.

In terms of fuel saving, for a 100 hp (75 kW) machine, under the assumption of an average use of 2000 hrs/yr at various duty cycles (digging, loading, craning, grading, driving, idling, etc.), the fuel saved is about 4500 liters/yr, which is equivalent to approximately €4000 in the EU or $3,000 in the U.S.

Comparison with variable LS technology: Beside this, the VFO circuit has the advantage of very stable and "load-feel" operation, due to the design of the open-center spools. These features are very appreciated by operators, and they are very useful during operations that involve digging around gas or water pipes that cannot be damaged. On the other hand, load-sensing systems have similar energy balance as the VFO; however, they are characterized by a more "nervous" response, and the flow is independent of load pressure, not providing the load feedback to the operator, making some critical operations (like digging around pipes) more difficult.

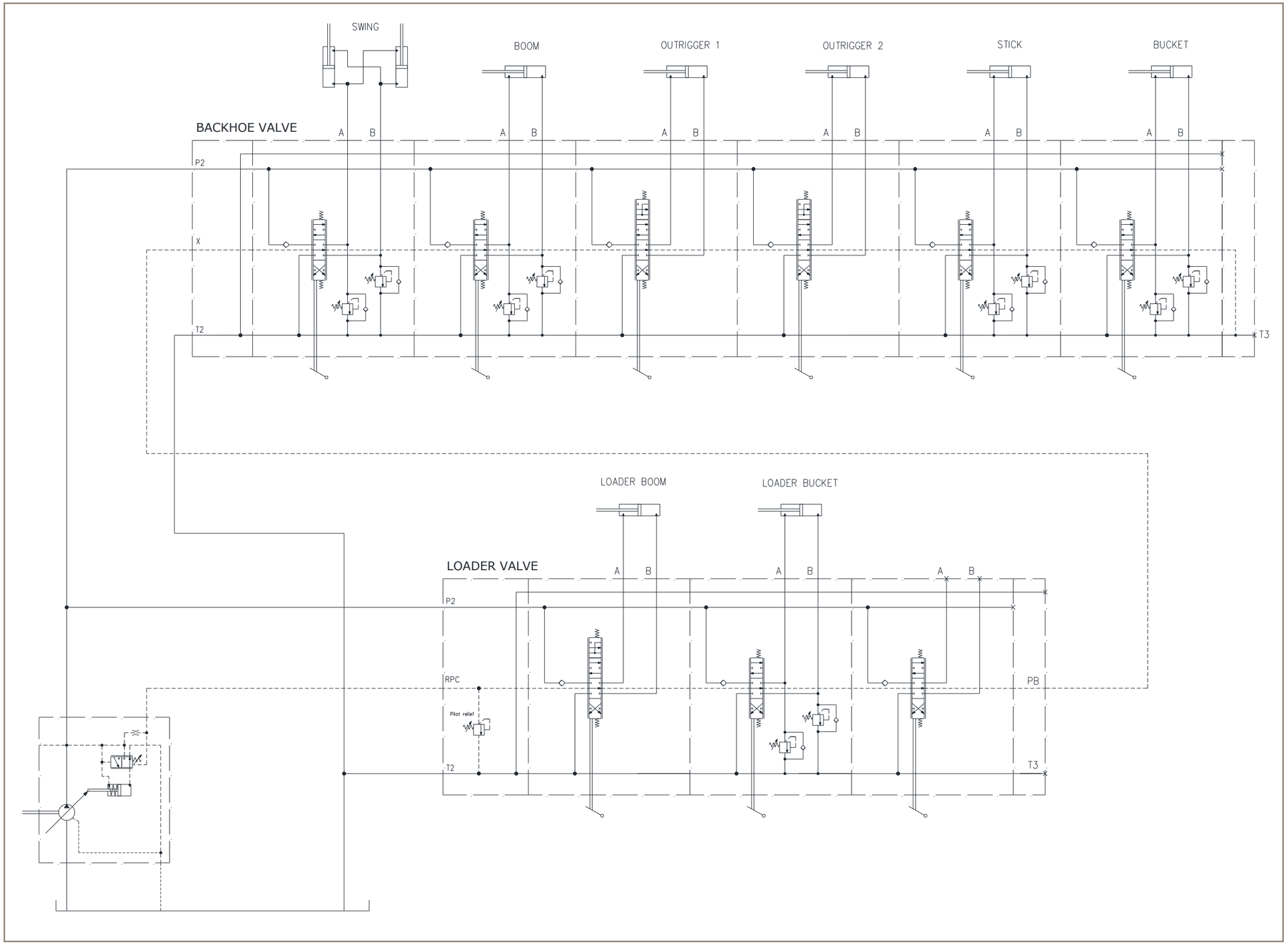


Figure 2. Application of VFO concept to a backhoe loader with two separate valve banks.

Examples of Application (continued)

Mini-Excavator

The schematic of Figure 3 shows how the VFO concept can be applied to a mini-excavator. For the sake of brevity, only the main functions of the arm have been included in the VFO valve bank. The valve controlling the excavating arm is very similar to the previous backhoe valve. The important thing here is that the VFO concept is combined with a standard LS valve for controlling the tracks. The flow-sharing valve is used here for guaranteeing the straight tracking feature.

VFO technology can be easily combined with any load-sensing (post- or pre-compensated) valve as well as CPU (constant pressure unloaded) valves.

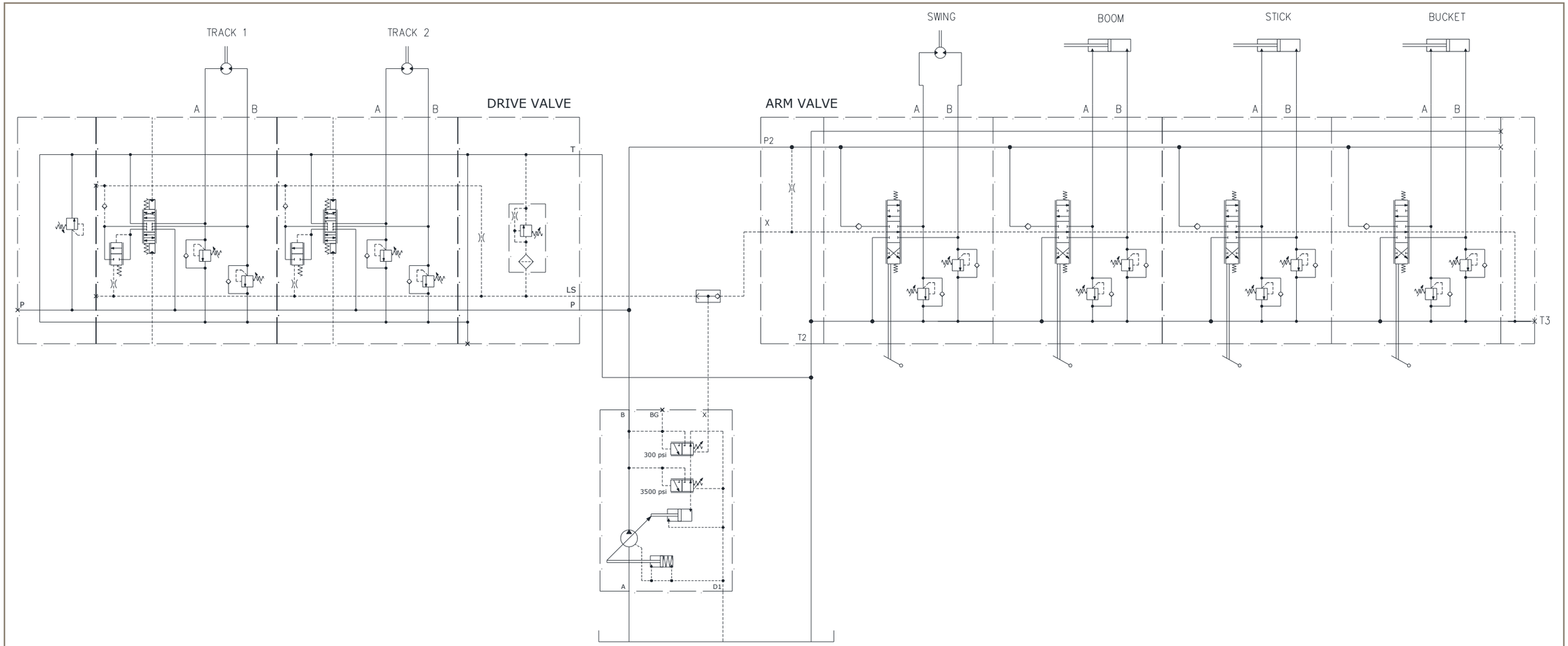


Figure 3. Application of VFO to a mini-excavator.
Combination of VFO and LS valve.

© 2015 Parker Hannifin Corporation

Parker Hannifin Corporation
Global Mobile Systems
850 Arthur Ave.
Elk Grove Village, IL 60007
phone 847 258 6200
fax 847 258 6299
www.parker.com