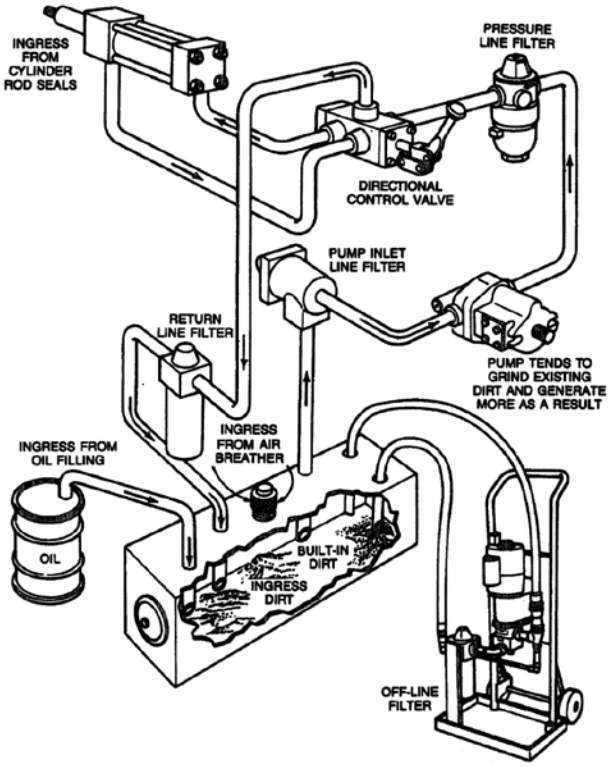

Fig. 10.65. Basic filtration of a hydraulic system (Courtesy of Vickers Inc.)

available. Figure 10.67 shows a list of tests that assure filter element quality.

The proper placement of filters in a hydraulic system is extensively debated among designers. Only two locations are really suitable for filters: the pressure line and the return line. Naturally, pressure line filters are more expensive than returning filters because of the higher pressure. Whether you choose the pressure line or return line or both, you should select a location that will see full pump flow all, or most, of the time (Figure 10.65). Otherwise, using a separate pump, you can create a "kidney loop" arrangement sized to turn over the entire reservoir in 30 minutes or less. Kidney-loop filtration is illustrated in Figure 10.65 as "off-line filtration," with the difference that the hoses should be connected to the tank by quick-fittings, not simply stuck through holes in the reservoir top.

Some designers recommend placing a strainer in the suction line of the pump, but others argue against placing anything that could cause a restriction in the suction line. The author does not recommend them, either, but if you decide to use suction strainers, they should be made of metal, be easy to clean, and have a mesh weave no tighter

Diminishing Returns Of Rasing Beta Ratios

Beta Ratio	Efficiency
2	50%
5	80
10	90
75	98.7
100	99.0
200	99.5

Fig. 10.66. Diminishing returns of rasing Beta ratios

than 100 mesh (149 micrometers). Finally, suction strainers should never be placed inside the tank out of sight.

Every filter or strainer should have some way of indicating that the unit is bypassing (dirty element). If you do not need the electrical type, opt for a vacuum-activated one over the mechanical type. Spinon filters, which are increasingly popular, use differential pressure gauges or upstream and downstream gauges that require the user to subtract the readings to determine whether the unit is bypassing. A sign nearby to remind everyone of the bypass valve pressure setting is a good idea. Non-bypass filters should be used ahead of critical components like servovalves, with an electrical alarm to indicate clogging.

To reiterate, the simple expedient of filtering all of the fluid that goes into a tank eliminates a lot of trouble. Avoid using the common breather strainer because mechanics tend to pour oil through it into the system; eventually, when the strainer becomes clogged, they puncture it or remove it to make the oil flow faster. The optimal system involves mounting a filter on the access opening with a snap connector for the fill pump hose. In a variation of this system, the filter is mounted on the return line with a tee and snap connector ahead of it. In this version, all flow, including fill line flow, goes through the filter before re-entering the tank, so a larger

Filter Tests That Assure Element Quality (a partial list)

1. ANSI B93.25 and
   ISO 2941 ..... Test for collapse/burst resistance
2. ANSI and
   ISO 2943 ..... Test for element material compatibility
3. ANSI and
   ISO 3723 ..... Test for element end loading
4. ISO 3724 ..... Flow fatigue resistance
5. ISO 2942 ..... Fabrication integrity
6. ISO 3968 ..... Flow-vs-Pressure Drop
7. ISO 3968 ..... Multipass filter test

Fig. 10.67. Filter test that assures element quality

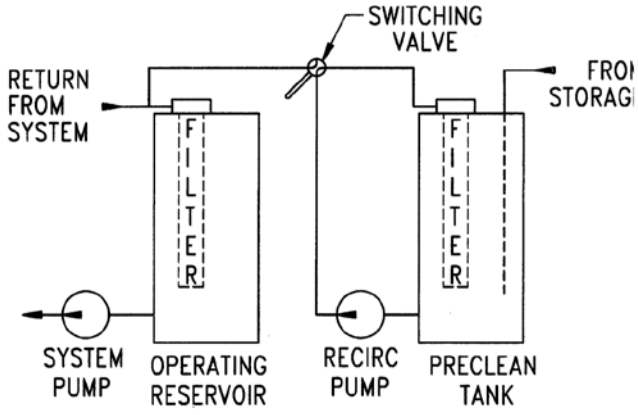

Fig. 10.68. Use of a Preclean Tank

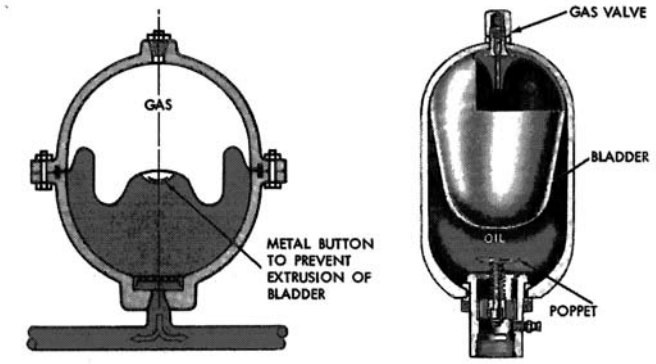

Fig. 10.69. Diaphragm Accumulator Uses Rubber Separator Between Gas and Liquid (Courtsey of Vickers Inc.)

filter is required (Figure 10.61). Remember that returning filters must be larger than pressure line filters because of the flow intensification that occurs with the retraction of differential cylinders.

Some designers recommend using a preclean tank (Figure 10.68) that necessitates putting the make-up oil into a separate tank, circulating it through filters and then, when needed, pumping it into the operating tank. Other designers believe that this accomplishes nothing more than the procedures described above and that it makes any project considerably more expensive. Filtering with a high-efficiency filter as the operating tank is filled, using a kidney-loop filter and using a return line filter should be adequate, and being able to tell when that filter is clogged is sufficient.

Accumulators

Accumulators are devices that store pressurized fluid in a hydraulic system for various reasons. Primarily, they are used to:

- Maintain system pressure while the pump unloads.
- Facilitate use of a smaller pump.
- Absorb pulsations and shockwaves.
- Store energy in emergencies.
- Keep system pressure constant.

Three designs are popular: the gas-filled bag, the piston with gas on one side, and the weighted. The two gas-filled designs rely on dry nitrogen because of its safety, inertness and low cost. If air were used, rapid compression in the presence of hot oil vapor could cause an explosion through dieseling.

Figure 10.69 shows a typical bottom-entry bag accumulator with an anti-extrusion valve that prevents the bag from migrating out into the pipe line. A tire valve molded into the bag permits gas charging from the top end. Accumulators must have isolation valves so rebuilds can be accomplished without system shutdown. Figure 10.70 shows a typical piston-type accumulator. Obviously, the seal is critical in this design because it separates the fluid from the gas. Although the weighted accumulator is very expensive (Figure 10.71), it is essential where constant system pressure must be maintained. Once the pump is on, the accumulator is forced to its peak position, where switches shut the pump off. The weight then sustains pressure on the system, even as internal or external leakage occurs. To compensate for this leakage, the accumulator gradually falls; when it hits a bottom switch, the pump is kicked back on to raise the accumulator up to the top switch, and the process repeats.

When the system is shut down, the accumulator may be dangerous because of pressure built up in the system that may be stored there. The accumulator should have a safety valve that closes when a pump is started and opens back to tank when power is shut off. Otherwise, mechanics should be reminded to open the dump line valve (Figure 10.72) before opening a hydraulic system with an accumulator.

Initial charge pressure for the gas-filled design should not exceed about 60% of normal system pressure. With

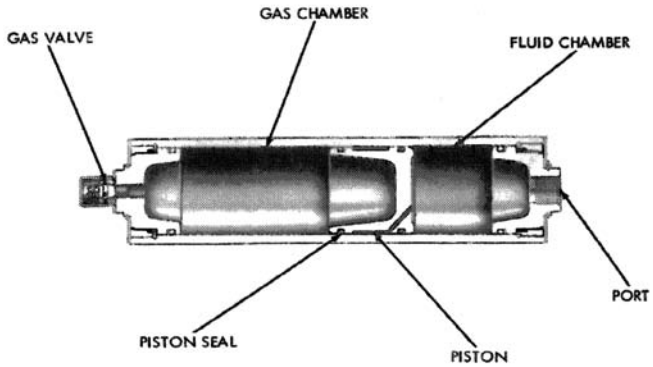

Fig. 10.70. Gas-Charged Piston Accumulator (Courtsey of Vickers Inc.)