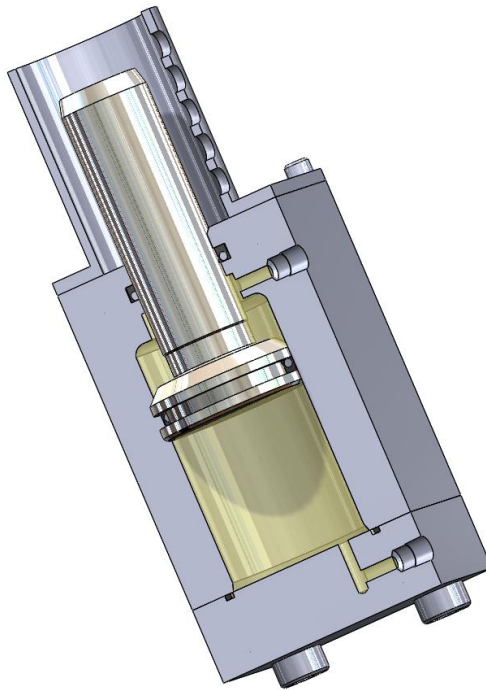


Chapter D18

Pressure staging



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Individual chapters of the Kalsi Seals Handbook are periodically updated. To determine if a newer revision of this chapter exists, please visit www.kalsi.com/seal-handbook.htm.

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1. Introduction

Pressure staging is the technical term for dividing fluid pressure among more than one rotary shaft seal, in order to handle high differential pressure. Figure 1 illustrates the basic concept. In Figure 1, the lubricant to the right of the first stage seal is at pressure P , while the lubricant on the left of the first stage seal is at $P/2$. In this arrangement, the first and second stage seals each have to retain a pressure differential equal to $P/2$. Any desired number of pressure stages may be used.

Figure 2 is a simplified schematic showing how differential area pistons can be used to produce the first and second stage lubricant pressures. Although the pistons are shown as part of a manifold assembly, the pistons could also be located in individual housings. Other arrangements, such as creating back pressure with a computer controlled pinch valve, can also be used to provide the lubricant pressures. For general information on various lubricant supply systems, see Chapter D11.

The use of pressure staging in oilfield washpipe assemblies is covered by U.S. Patent 6,007,105. The use of pressure staging in conjunction with laterally translatable seal carriers (Figure 3) is covered by U.S. Patent 6,227,547; contact Kalsi Engineering, Inc. for licensing details. Figure 4 shows how to provide pressure staging in a side port swivel, and Figure 5 shows how to provide pressure staging in an oilfield downhole drilling tool.

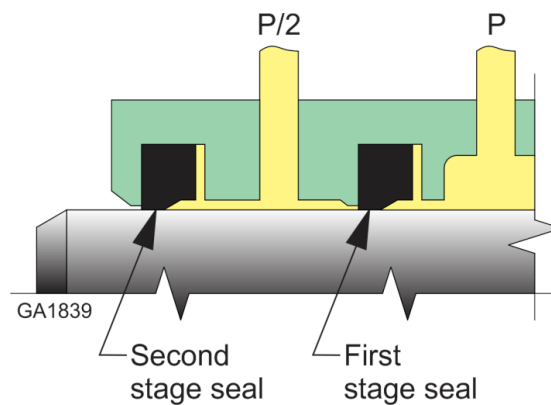


Figure 1
Pressure staging

Pressure staging is the sharing of differential pressure across more than one rotary shaft seal. In this pressure staging example, each seal is exposed to a differential pressure equal to one half of the pressure P .

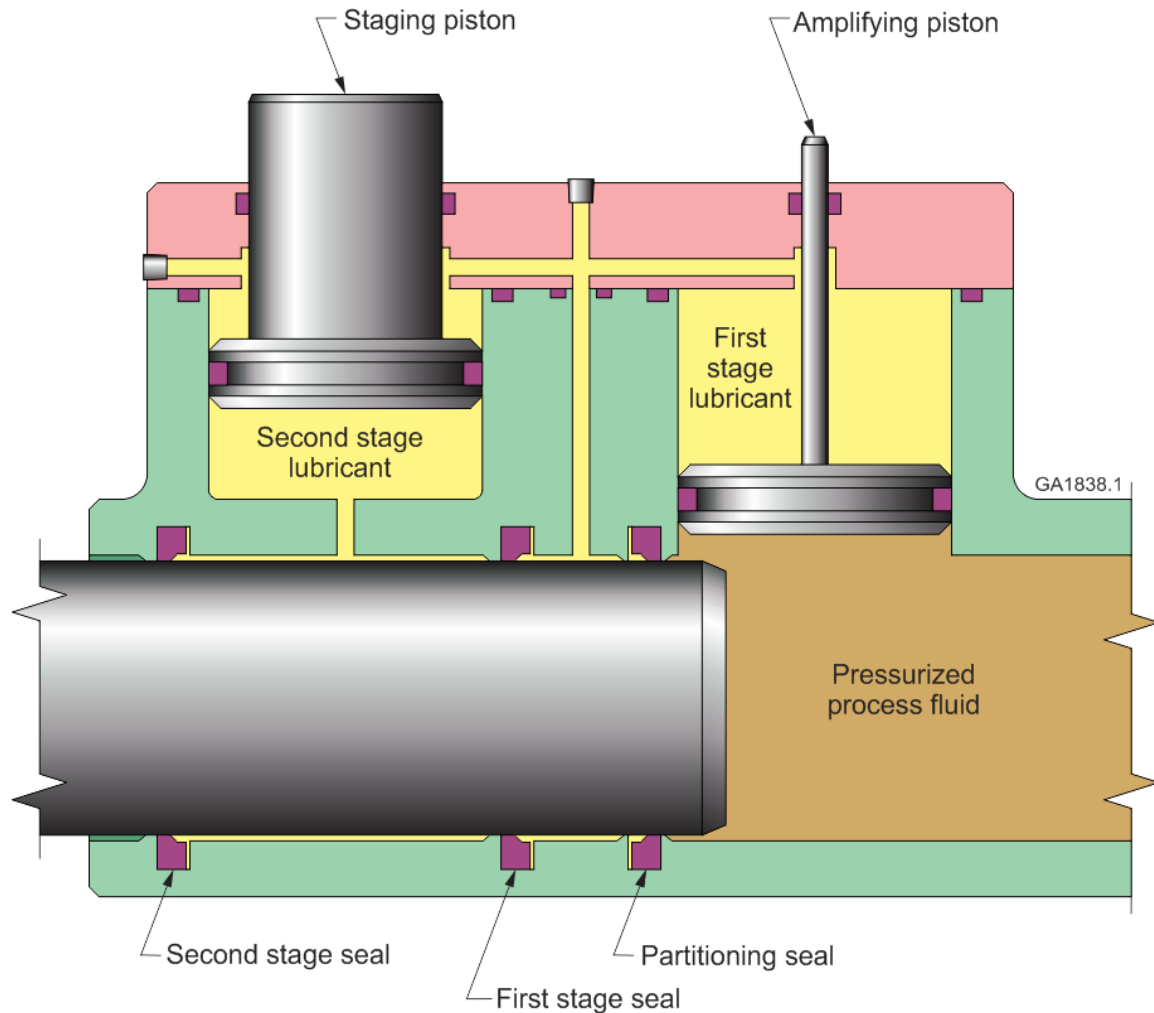


Figure 2

Schematic showing the use of pistons to produce staging pressure

In this simplified schematic, the first stage lubricant pressure is amplified above the process fluid pressure by the amplifying piston, in order to provide differential pressure across the partitioning seal. The staging piston reduces the second stage lubricant pressure to about one half of the first stage pressure. The first and second stage rotary seals each retain a differential pressure that is about one half of the pressure of the first stage lubricant. This schematic does not show the bearings that would be required to support the rotary shaft. Ideally, the amplifying piston would be spring loaded to provide differential pressure across the partitioning seal even in the absence of process fluid pressure.

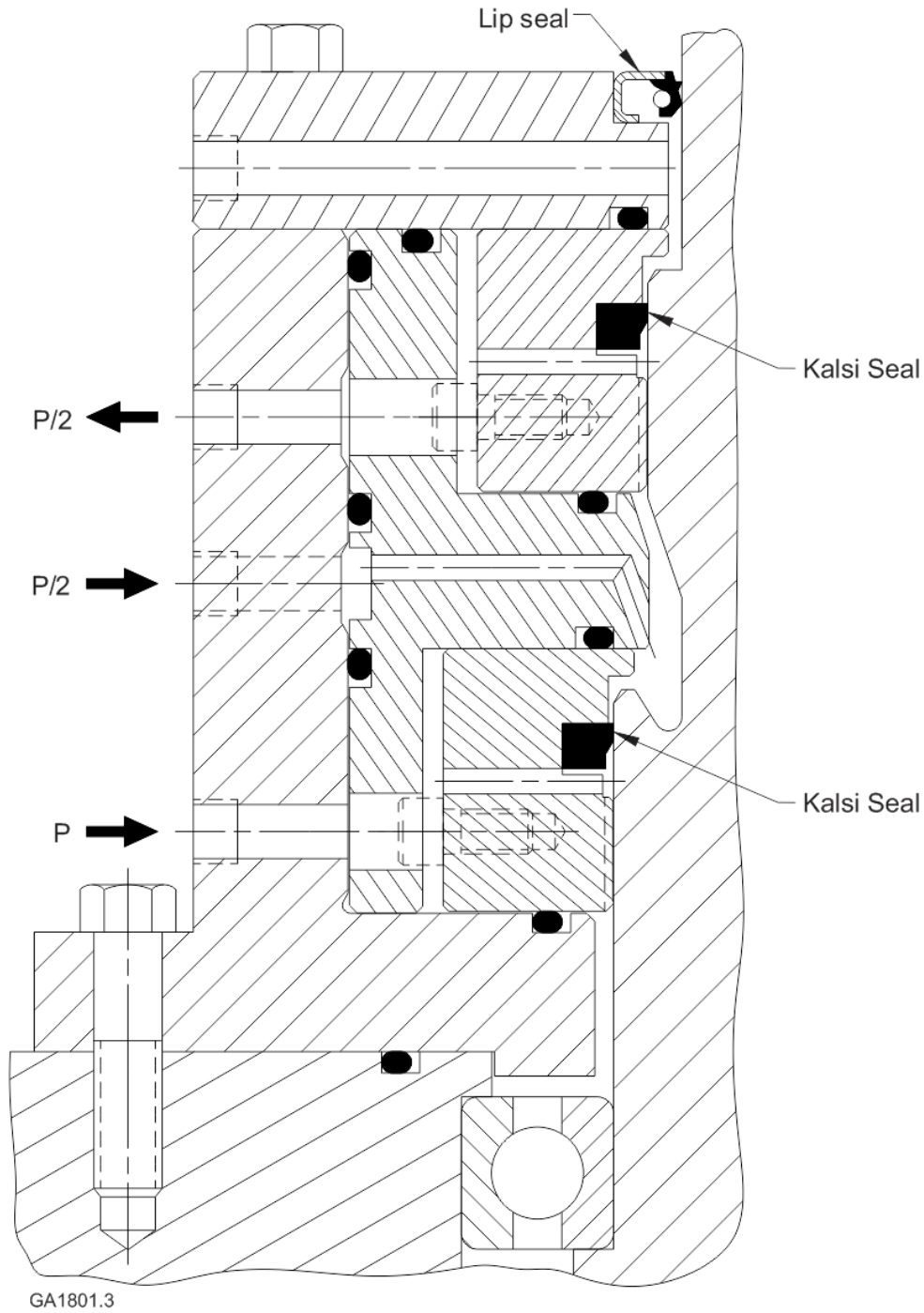


Figure 3

High pressure, staged, laterally translating seal carriers

This laterally translating seal carrier arrangement was originally developed for oilfield rotary control device (RCD) high pressure sealing, but is also useful in other types of machines. It divides the lubricant pressure P across two seals using pressure staging. If desired, lubricant circulation can be employed to provide seal and bearing cooling. (U.S Patent 6,227,547; contact Kalsi Engineering, Inc. for licensing details.)

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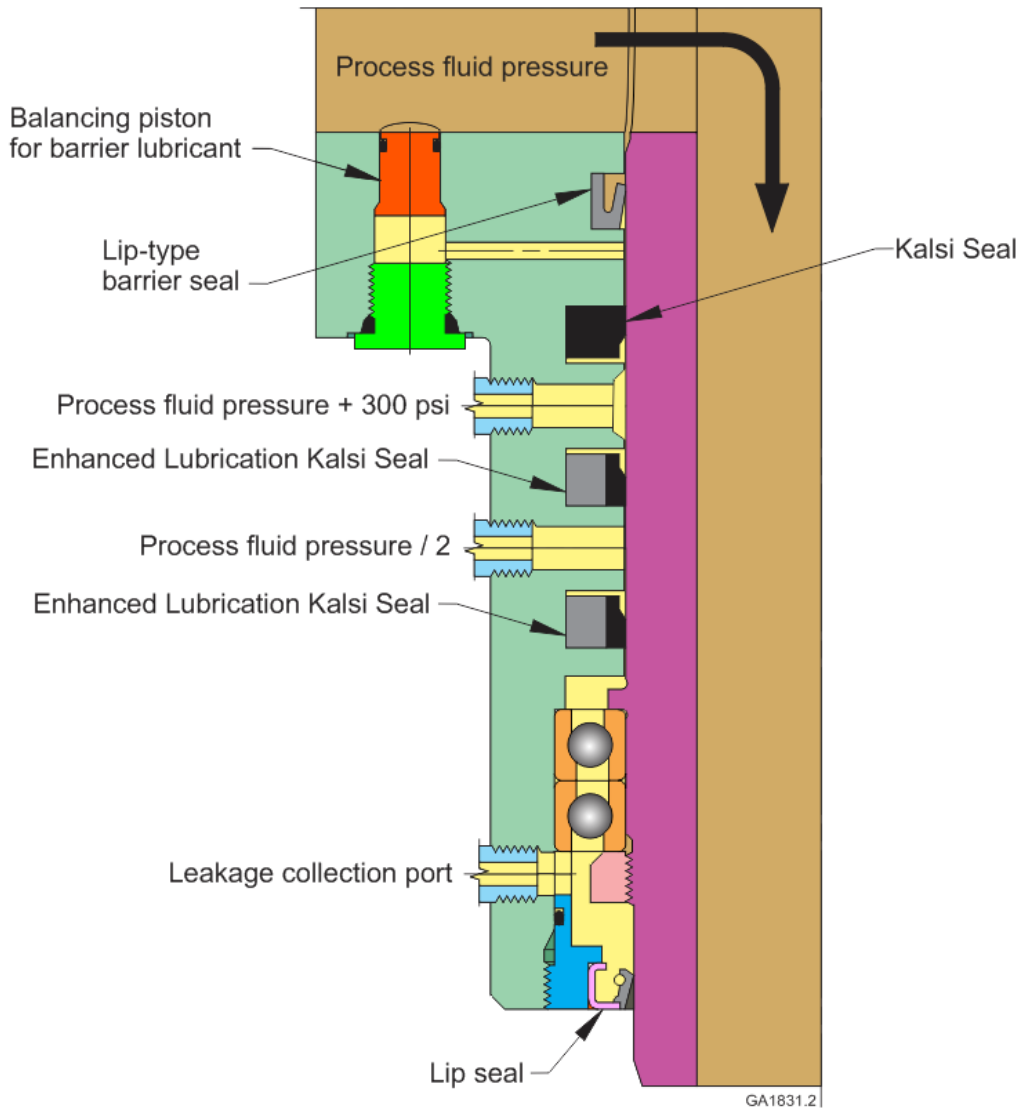


Figure 4
Pressure staging in a side port swivel (schematic)

This schematic shows the use of pressure staging in a side port swivel (only ¼ of the swivel is illustrated). In addition to pressure staging, the swivel incorporates lip-type barrier seals for added resistance to lubricant pressure lag and any chemical effects of the process fluid. The piston balances the barrier lubricant to the process fluid pressure. If the piston bottoms out in the position shown, the hydrodynamic pumping related leakage of the Kalsi Seal will vent past the dynamic lip of the barrier seal, lubricating the lip.

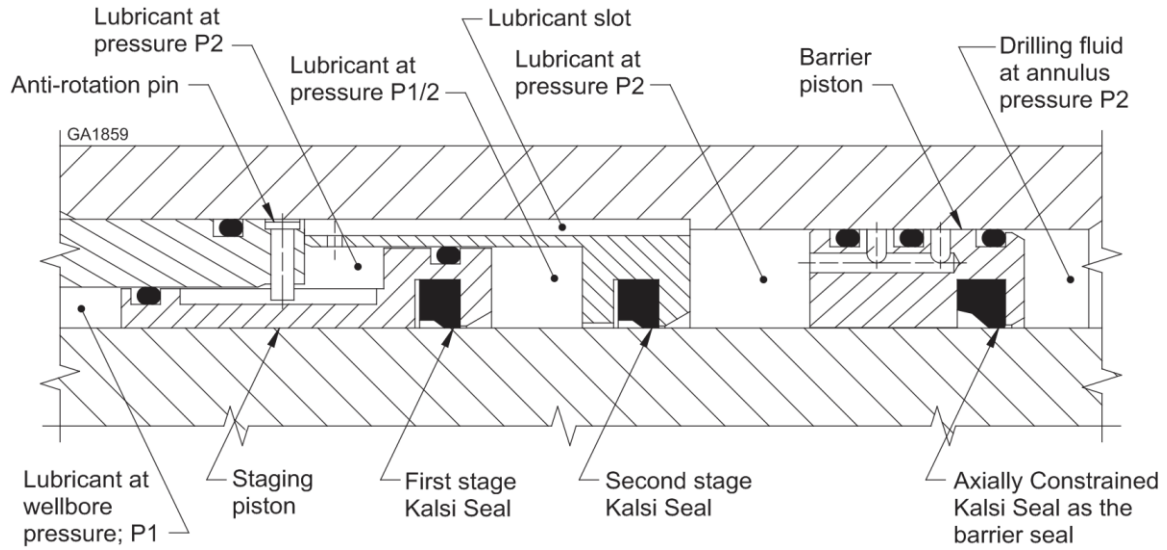


Figure 5

Pressure staging in an oilwell downhole tool

This schematic shows the use of pressure staging in an oilfield downhole tool. The pressure difference between the wellbore and the well annulus is shared by the first and second stage Kalsi Seals. The barrier seal provides a clean lubricated environment for the second stage Kalsi Seal, and provides clean lubricant to the staging piston. This schematic does not take radial bearing guidance of the shaft into account, and merely shows the basic piston arrangement that we suggest for downhole pressure staging.