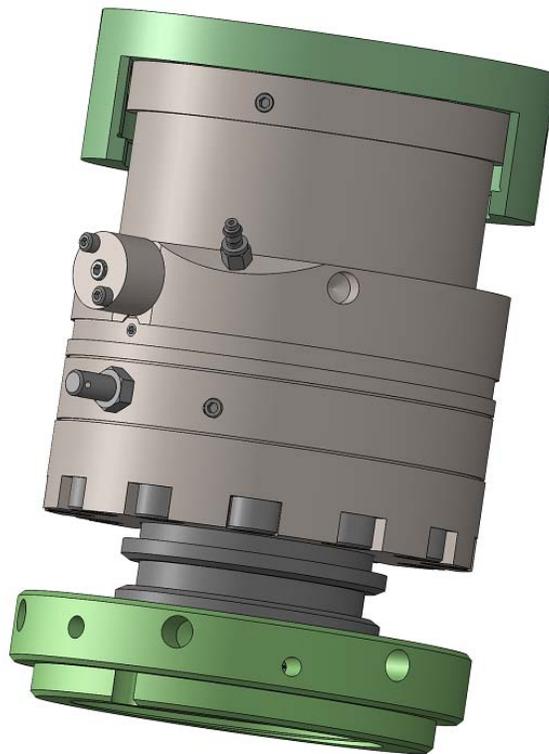


## Chapter E4

### High pressure washpipe assembly with integral reservoir



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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 <https://www.kalsi.com/seal-handbook/>.

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## 1. Introduction

Washpipe assemblies for oilfield drilling swivels and top drives conduct high pressure, abrasive-laden drilling fluid from the stationary gooseneck to the rotating spindle. This chapter describes a mechanical arrangement for using Kalsi Seals® in a high pressure washpipe assembly. The assembly uses a fixed washpipe, a floating backup ring, and a floating seal carrier, as described below, and is covered by issued and pending patents.

The design is robust, and easy to assemble and disassemble. Unlike previous Kalsi Washpipe assemblies, this assembly does not require an external lubricant pressurization system.

## 2. Background on Kalsi Washpipe assemblies

The first high pressure Kalsi washpipe assembly was field tested in November 1998 and provided significant improvement compared to conventional washpipe packing assemblies.<sup>1</sup> An improved Kalsi washpipe assembly was field tested in early 2000 that provided even longer life. Both assemblies used an external piston type pressurized lubricant system with three pressure stages, to minimize the amount of pressure acting across each pressure retaining seal.

Advancements in sealing technology eliminate the need for pressure staging, which allows an integral lubricant reservoir to be used with the current high pressure washpipe assembly. As with the previous assemblies, the current assembly uses a partitioning seal to separate the seal lubricant from the drilling fluid. The seal lubricant is pressure balanced to the drilling fluid pressure, and is retained by a high pressure seal(s)<sup>2</sup>.

## 3. Overview of the swivel figures

Figures 1 through 3 are section views of a high pressure washpipe assembly taken at different angles to show various internal details. Figure 1 is a section view taken through the internal porting. Figure 2 is a section view taken through the bulkhead bolts. Figure 3 is a section view taken through the barrier fluid piston.

The assembly was engineered by Kalsi Engineering, and is designed for 7,500 psi operation at 200 RPM. The washpipe has a 3 inch bore and a 4.5 inch diameter. The lubricant reservoir is sized to allow for at least 24 hours between refills. The basic design can be adapted to other sizes and types of swivels.

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<sup>1</sup> IADC SPE 59107.

<sup>2</sup> The field tested assemblies used pressure staging and three high pressure seals to retain the pressurized seal lubricant.

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Figure 4 shows the washpipe assembly installed in a typical gooseneck support housing. The first step in installing the assembly is to loosely thread the upper thread collar to the gooseneck with the slot opening facing out. The assembly is installed into the slot. The thread collars are then tightened to the gooseneck and spindle with the tightening tool shown in Figure 5. Other connection arrangements are possible.

#### 4. How the washpipe assembly operates

##### ***General arrangement of the washpipe assembly***

The lower end of the washpipe is rotationally driven by, and retained to, the rotating spindle (not shown). The lower thread collar provides initial friction between the spindle and washpipe to prevent relative rotation. The O-ring sealing diameter that seals the washpipe to the spindle is smaller than the rotary sealing diameter. Drilling fluid pressure acting over this area imbalance creates a hydraulic force that loads the washpipe against the spindle, resulting in additional friction between the washpipe and spindle. This force also orients and locks the washpipe to the spindle. The washpipe has a piloted fit with the spindle to minimize washpipe runout.

The pressure housing consists of the bulkhead housing, retainer housing, seal cap, and lubricant reservoir that are bolted together as shown in Figure 2. The housing contains a floating seal carrier and a high pressure floating backup ring that are free to move laterally to accommodate washpipe misalignment and runout.

##### ***Integral lubricant reservoir***

An annular sliding piston is used to balance the pressure of the seal lubricant to the pressure of the drilling fluid being conducted by the swivel. A cross-drilled hole communicates the pressurized lubricant to a sealed region between the pair of rotary seals. The high pressure seal is isolated from the drilling fluid, and only has to retain the high pressure of the clean seal lubricant. The partitioning seal and barrier seal are isolated from high differential pressure, and only have to exclude the abrasive content of the drilling fluid. The piston axial motion also accommodates lubricant volume changes due to thermal expansion and lubricant loss associated with hydrodynamic seals.

The reservoir capacity, which is approximately 0.60 liters, is defined by the area and stroke of the piston. This capacity is designed to accommodate the slow loss of lubricant that results from the hydrodynamic pumping action of the rotary seals. This pumping action decreases at higher pressures and temperatures. Although the recommended refill schedule is every one to two days, the reservoir is designed to last four days with the higher pumping rate associated with lower temperatures and drilling fluid pressures.

The reservoir is designed to be refilled at low pressure. A lip seal mounted in the annular piston accommodates lubricant thermal expansion by venting excess lubricant volume. The reservoir can be filled using an oil gun. It is useful to attach a pressure gauge to the oil gun. The gauge pressure will increase to about 100 psi when the reservoir is filled.<sup>3</sup>

### ***The high pressure seal***

The pressure retaining seal incorporates a highly extrusion resistant plastic liner and an innovative hydrodynamic geometry that is aggressive enough to lubricate the dynamic sealing interface, despite the stiff nature of the plastic liner. This interfacial lubrication greatly increases the pressure X velocity (PV) capacity of the seal, compared to seals constructed entirely of elastomer. To learn more about plastic lined Kalsi Seals™, see Chapter C16 of our rotary seal handbook.

### ***Floating backup ring for the high pressure seal***

In addition to the plastic lined Kalsi Seal™, the high pressure performance of the washpipe assembly relies on our patented floating backup ring. The ring, which is axially force balanced and radially pressure balanced, is guided radially by a journal bearing-type fit with the washpipe. This fit and the radial pressure balance allow the smallest possible extrusion gap to be used, thereby achieving maximum seal extrusion resistance. The axial force balance allows the backup ring to move laterally to accommodate runout and misalignment of the washpipe. This prevents heavily loaded metal-to-metal contact at the extrusion gap and the seal-damaging heat that such contact would produce. This also isolates the seal from runout-induced radial compression changes.

To learn more about floating backup rings, and how they work, see Chapter D17 of our rotary seal handbook.

### ***The partitioning seal***

The partitioning seal is a 673-series axially constrained Kalsi Seal™. This type of seal was developed to overcome the challenges associated with excluding abrasives in the absence of differential pressure, and in the presence of low levels of potentially reversing differential pressure. This seal is also compatible with relatively low viscosity seal lubricants. To learn more about 673-series axially constrained seals, see Chapter C4 of the Kalsi Seals Handbook.

### ***The barrier seal and barrier fluid piston***

The barrier seal is a spring-loaded lip seal. The advantage of an outboard barrier seal is that it allows the partitioning seal to operate in a clean environment until the barrier seal

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<sup>3</sup> The reservoir can be refilled remotely by connecting the refill fitting to a dedicated hydraulic line.

fails. We have tested this type of barrier seal for hundreds of hours at a time against abrasive drilling fluid with intentional shaft runout at twice the surface speed of a washpipe. The tested seals were in very good condition at the end of the tests.

Whenever pairs of rotary shaft seals are employed in high ambient pressure conditions, the lubricant between the two seals must be balanced to the ambient pressure. If no balancing is provided, the lubricant pressure between the seals will be atmospheric. This causes both seals to be exposed to a high differential pressure that is equal to the ambient pressure. The barrier fluid piston, shown in Figure 3, balances the barrier fluid pressure to the high ambient drilling fluid pressure.

***Floating seal carrier for the partitioning and barrier seals***

The laterally translating partitioning seal carrier improves the performance of the low-pressure rotary seal by moving laterally in response to shaft offset and runout.

On the lubricant side of the rotary seal, the carrier has a closely fitting journal bearing type fit with the washpipe that locates the carrier laterally, and causes the carrier to follow the runout of the washpipe. On the drilling fluid side of the rotary seal, the carrier defines a carrier-to-washpipe extrusion gap clearance that is larger than the journal bearing clearance. The journal bearing fit on the lubricant side of the seal helps to maintain the extrusion gap clearance at a relatively constant value. This facilitates exclusion of the drilling fluid and reduces abrasive wear of the washpipe.

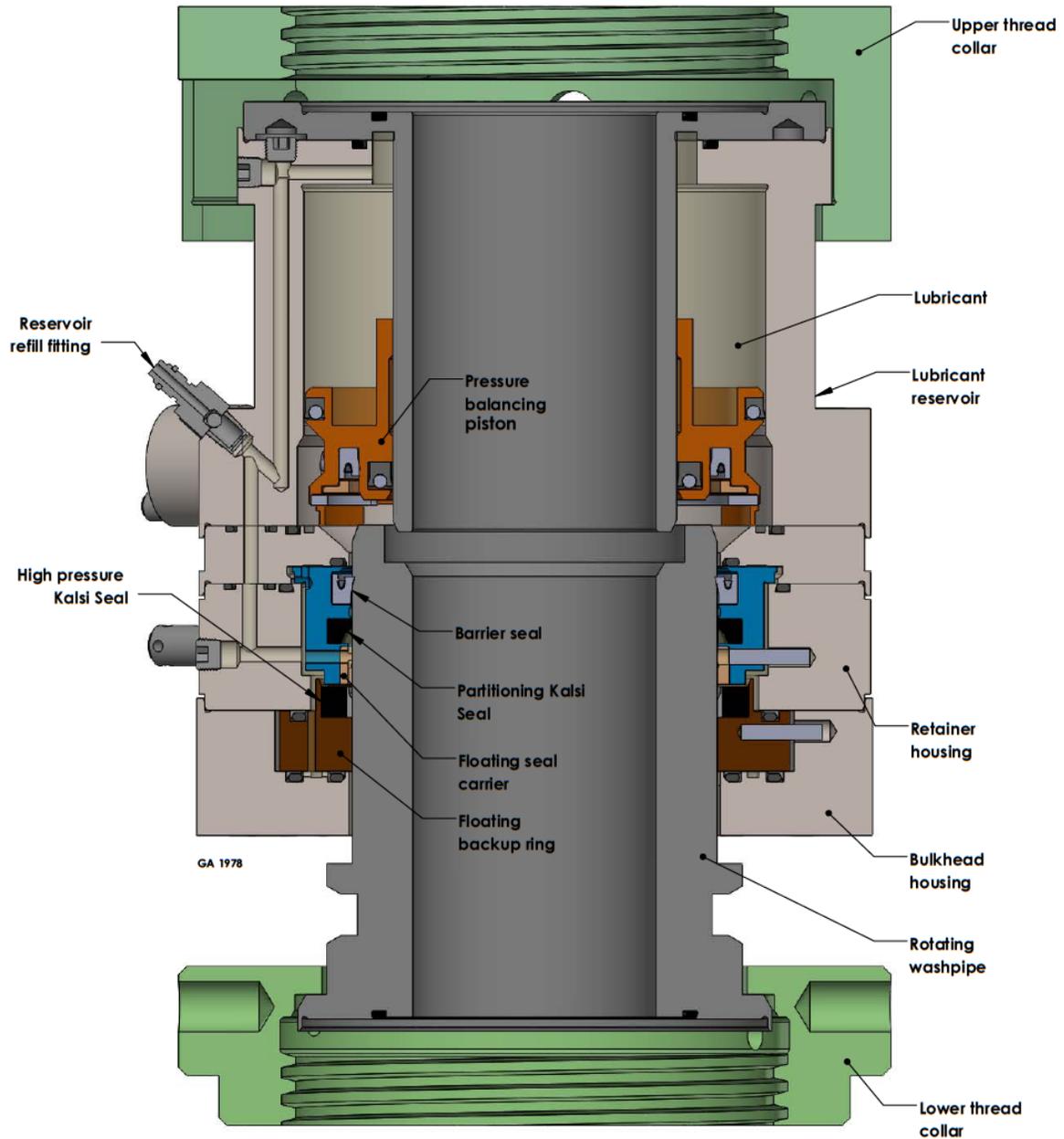
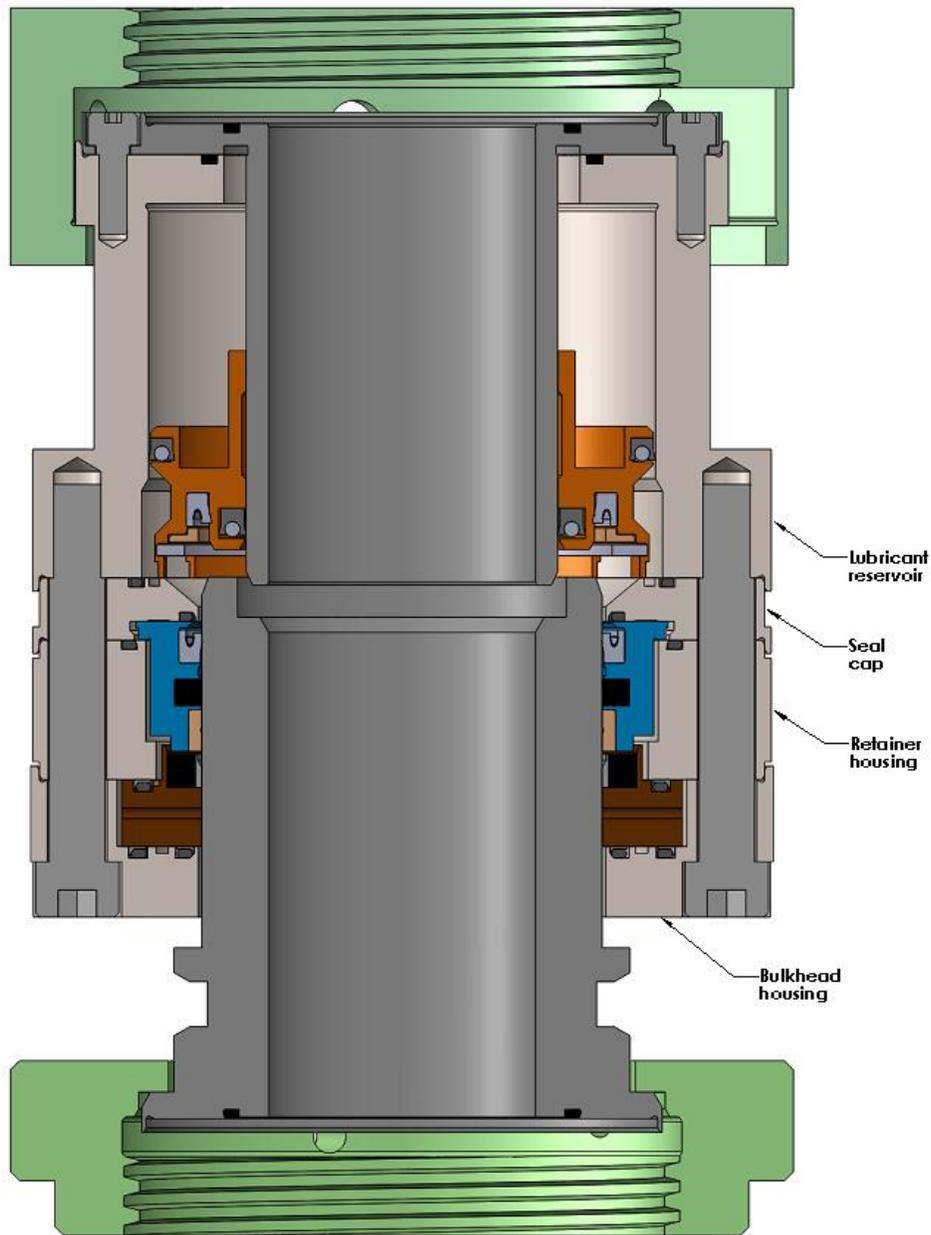


Figure 1

**Washpipe assembly with floating seal carrier and backup ring**

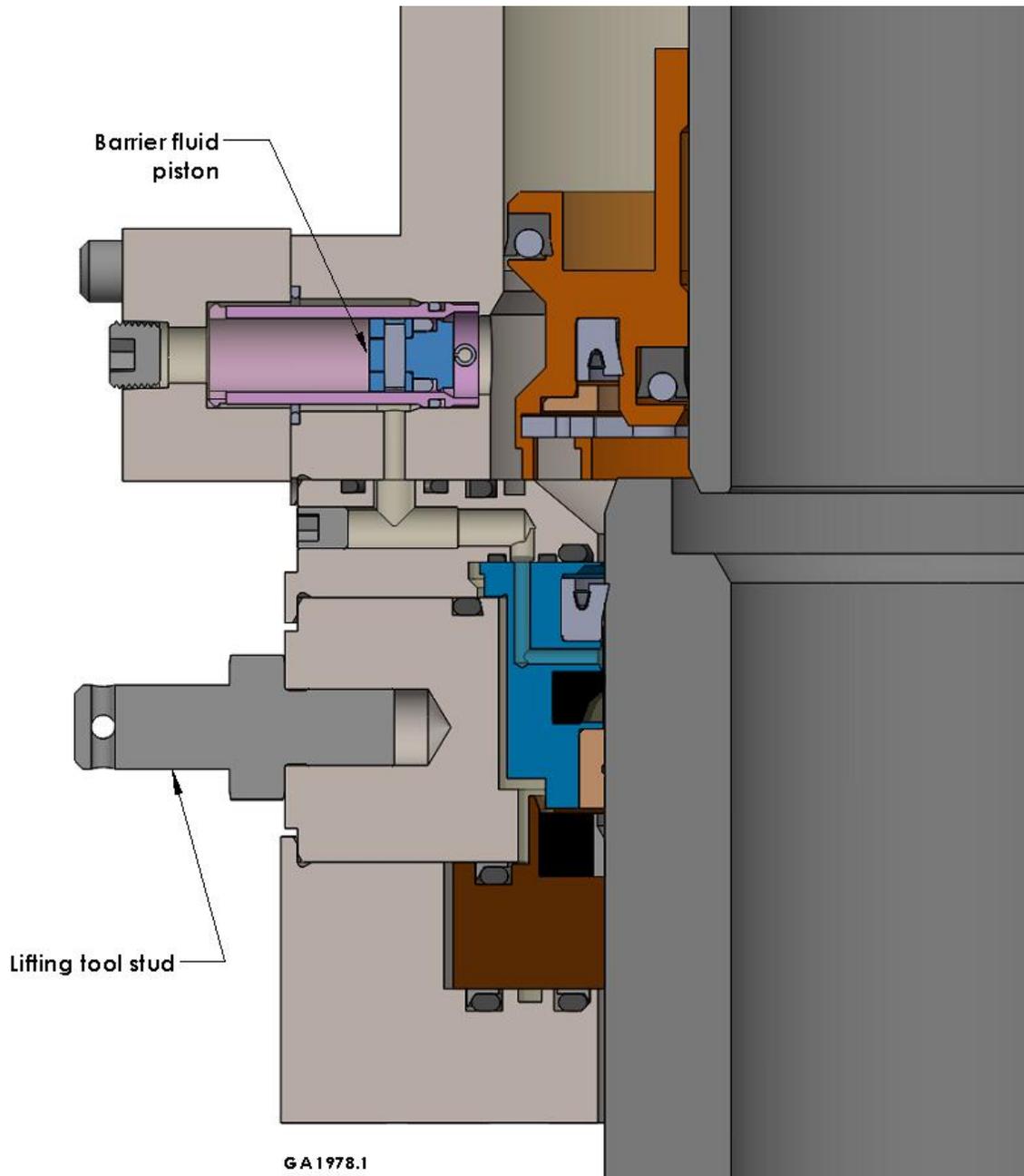
In this drilling swivel washpipe assembly, the rotary seals are installed in floating carriers that align with and follow lateral motion of the washpipe. The floating metal backup ring minimizes the size of the high pressure extrusion gap to improve high pressure seal performance. The illustrated assembly has a three inch bore and is engineered for 7,500 psi service.



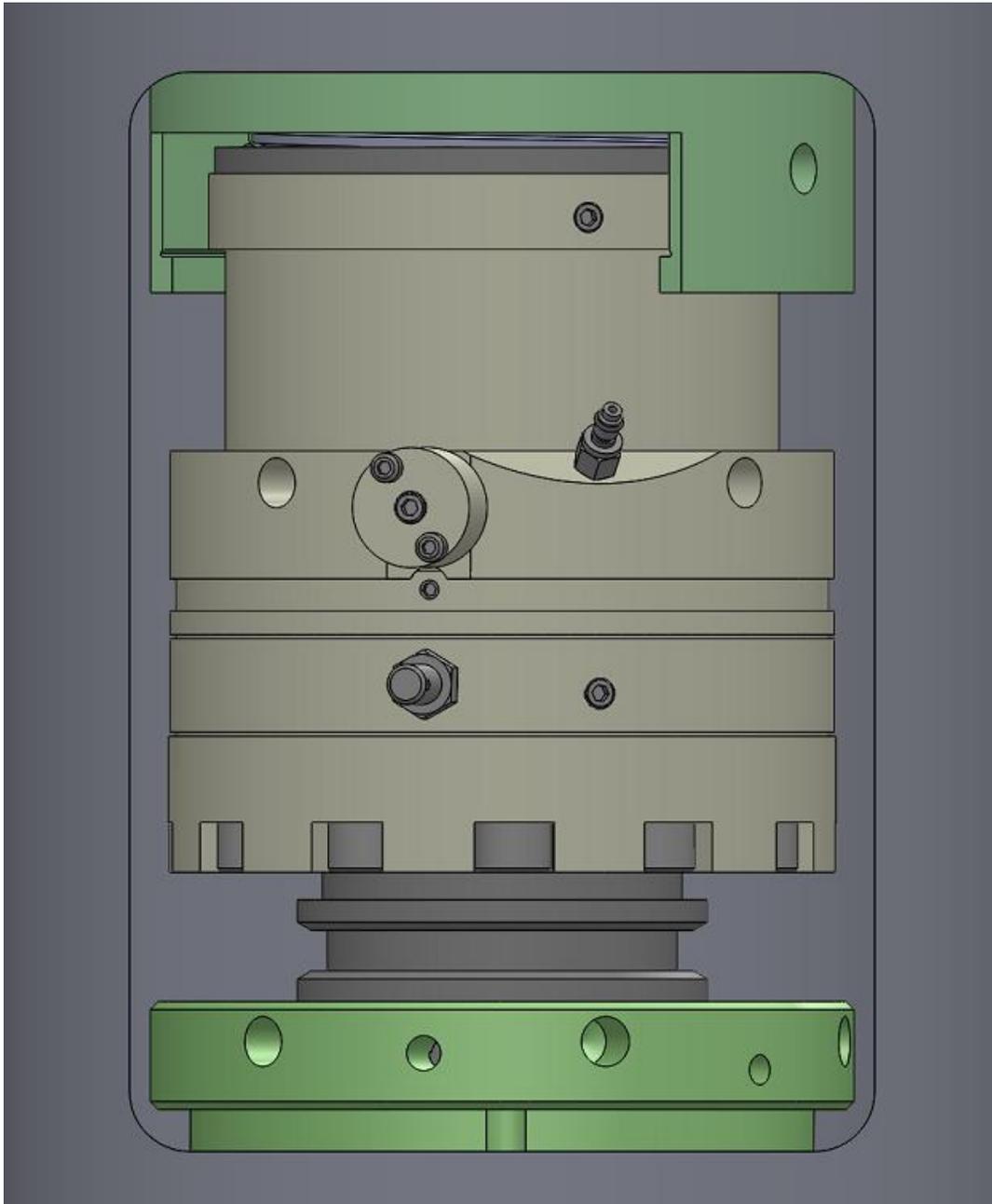
**Figure 2**

**Washpipe assembly with floating seal carrier and backup ring**

This view is taken through two of the socket head cap screws that retain the bulkhead housing to the lubricant reservoir. The bulkhead bolts are sized to withstand the hydraulic force generated by the internal pressure, and the preload necessary to resist separation due to the hydraulic force. Other critical fasteners for the washpipe assembly are also shown and need to be sized according to their specific loading.

**Figure 3****Washpipe assembly with floating seal carrier and backup ring**

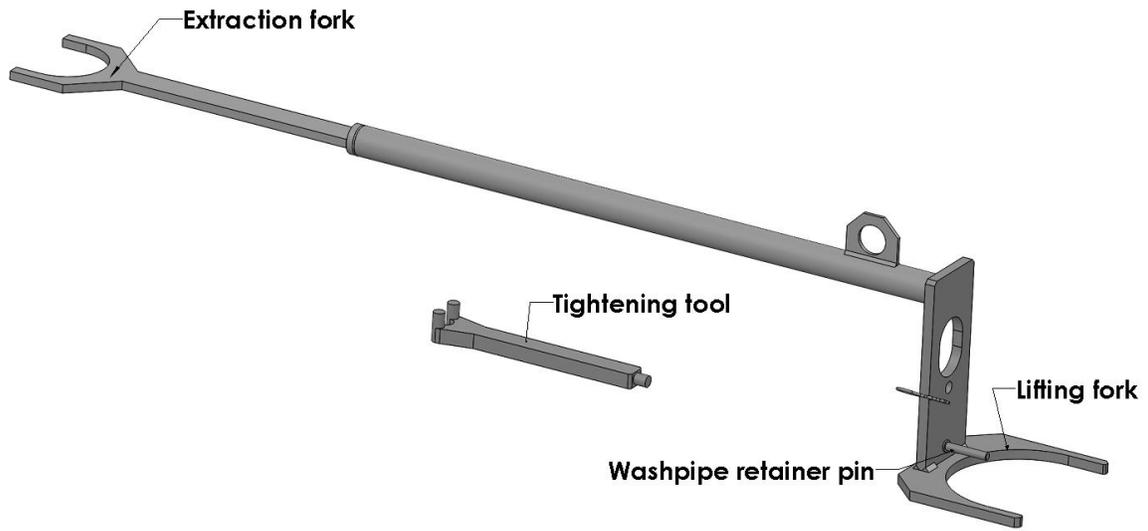
This view is taken through the barrier fluid piston. The barrier fluid piston balances barrier fluid pressure to the drilling fluid pressure.



**Figure 4**

**Washpipe assembly with floating seal carrier and backup ring**

This view shows the high pressure washpipe assembly installed in a typical gooseneck support housing.



**Figure 5**

**Washpipe assembly tools**

The lifting and tightening<sup>4</sup> tools are used to install and extract the washpipe assembly.

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<sup>4</sup> A 5/8" diameter bar can be used instead of the tightening tool.