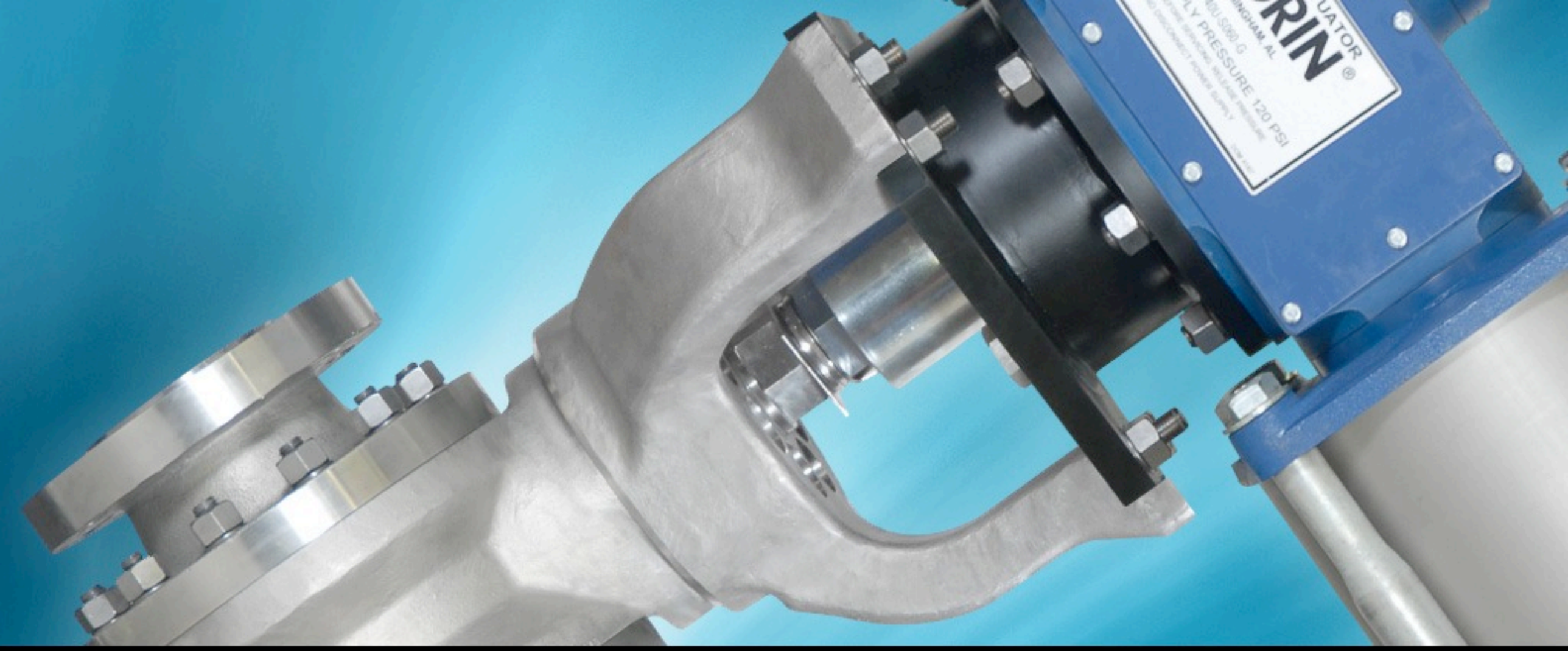

AUTOCLAVE

METAL SEATED BALL VALVE

KEYSTONE

AUTOCLAVE

METAL SEATED BALL VALVE

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KEYSTONE

THE CHALLENGE:

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THE CHALLENGE:

Severe nature of the nickel autoclave application destroys valves in a matter of weeks

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KEYSTONE

THE CHALLENGE:

Severe nature of the nickel autoclave application destroys valves in a matter of weeks

Powder infiltrates virtually every crevice of the valve, solidifies, and jams key components of the valve

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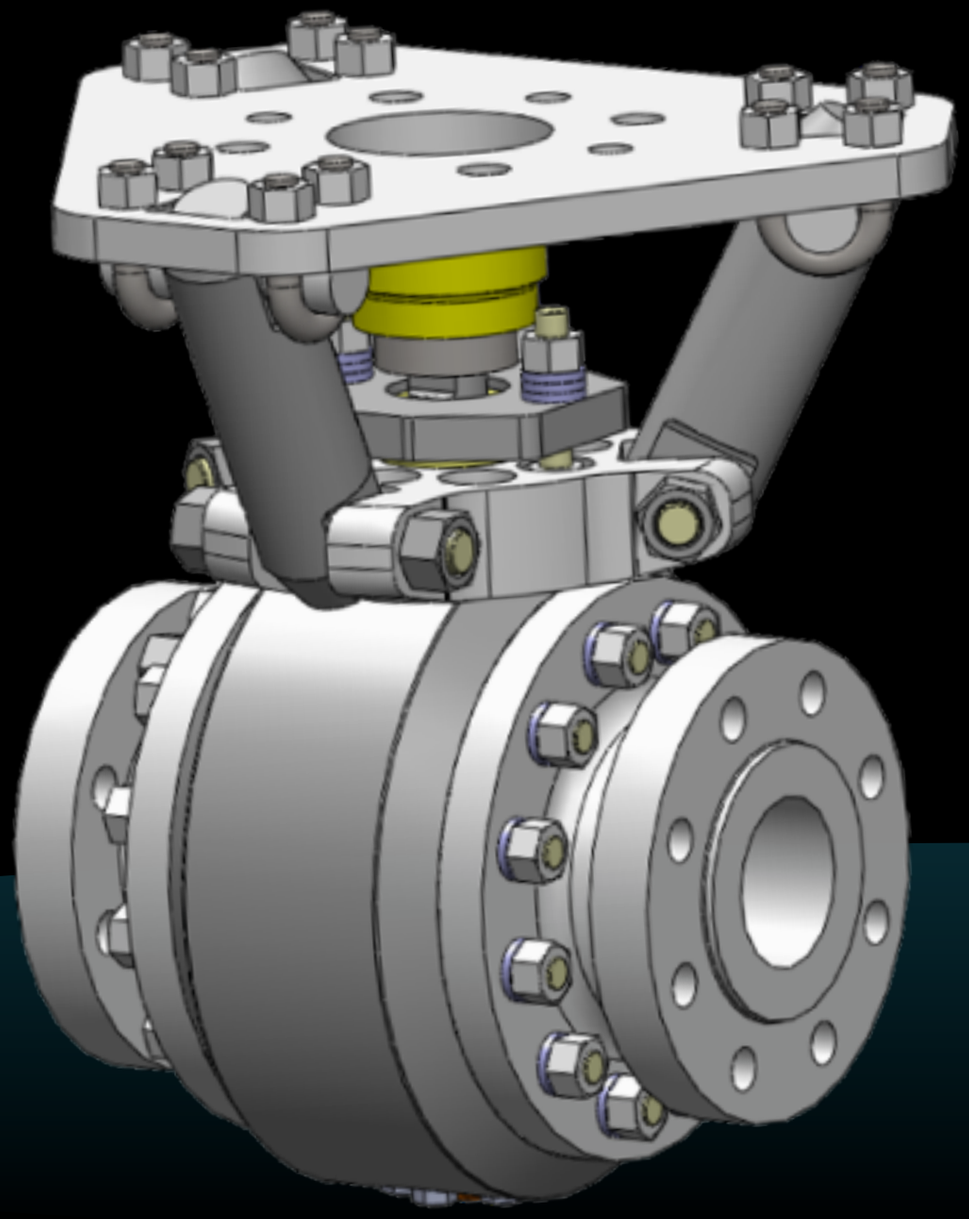
KEYSTONE



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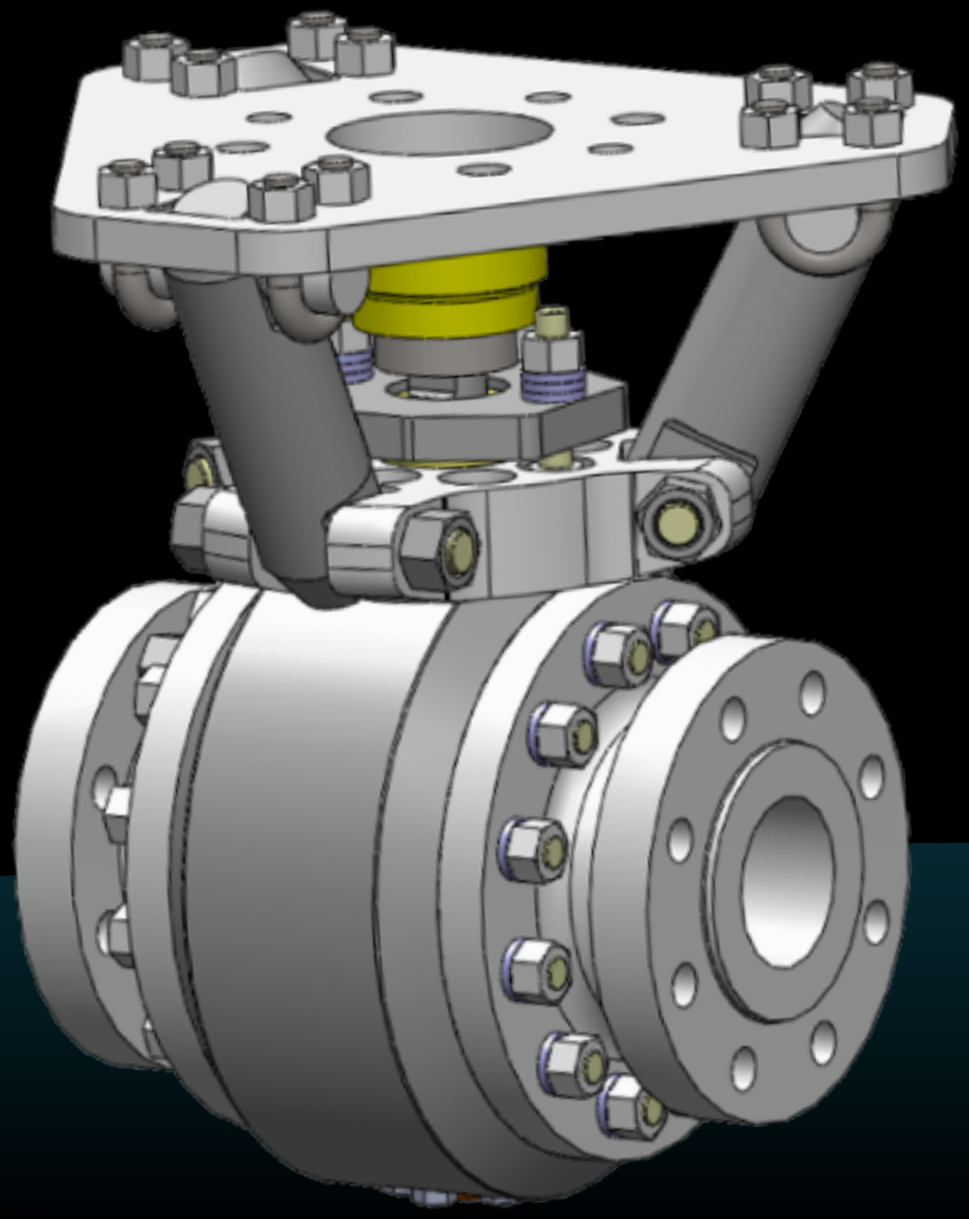

THE SOLUTION:

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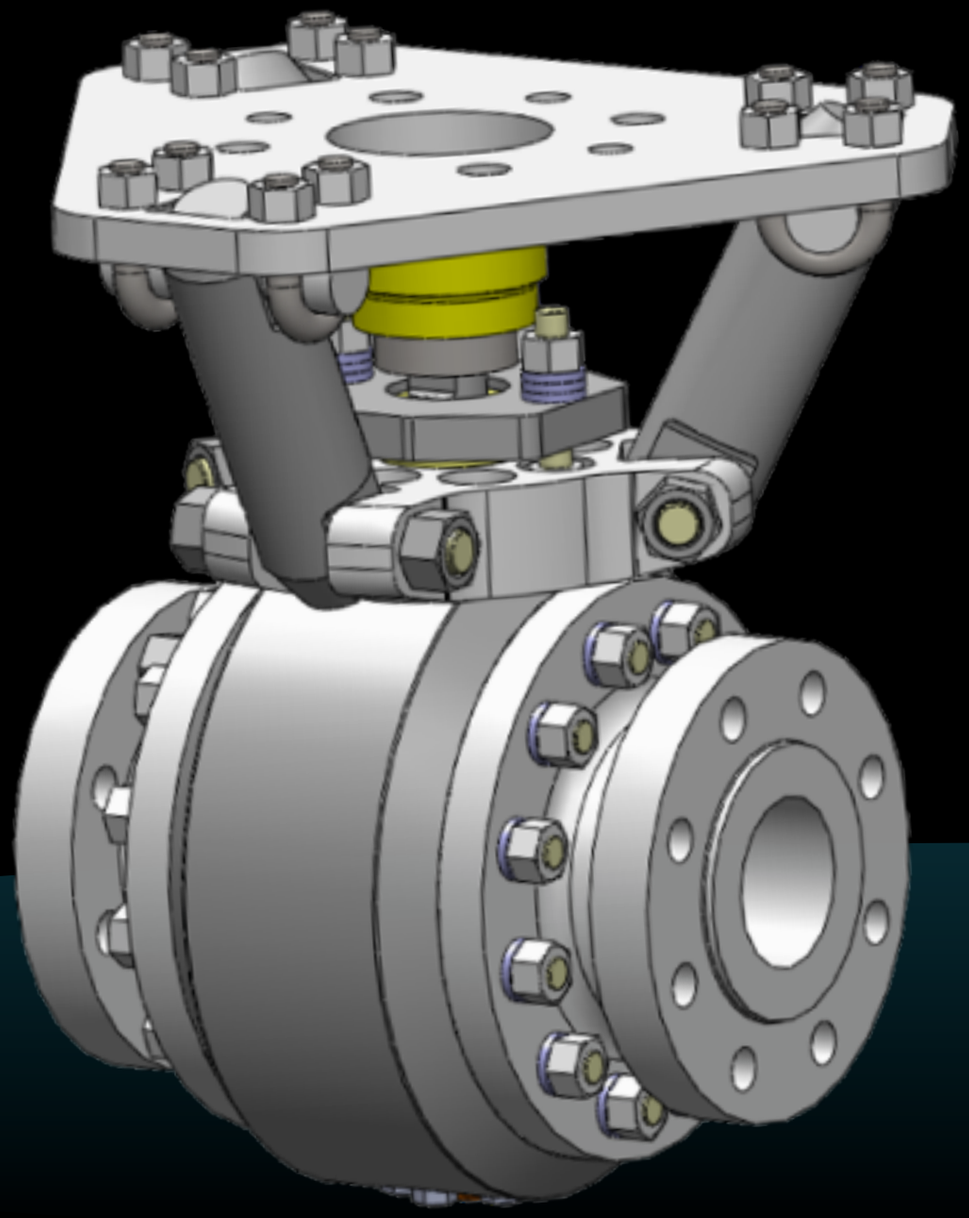
KEYSTONE



THE SOLUTION:

A Keystone Autoclave valve designed to combat the root cause of failure

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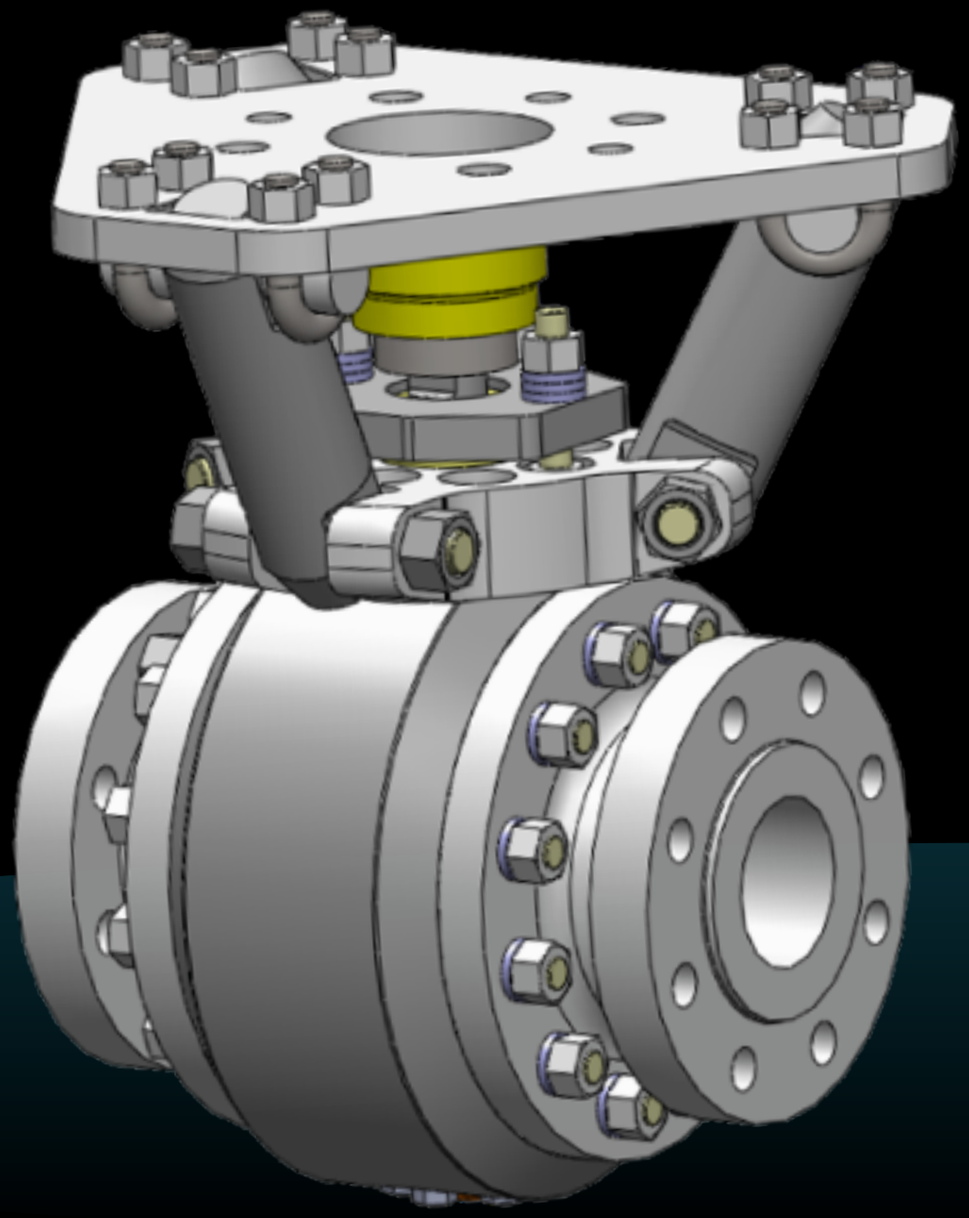
KEYSTONE



THE SOLUTION:

A Keystone Autoclave valve designed to combat the root cause of failure

Custom-engineering to delay the onset of powder infiltration into key components

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METAL SEATED BALL VALVE

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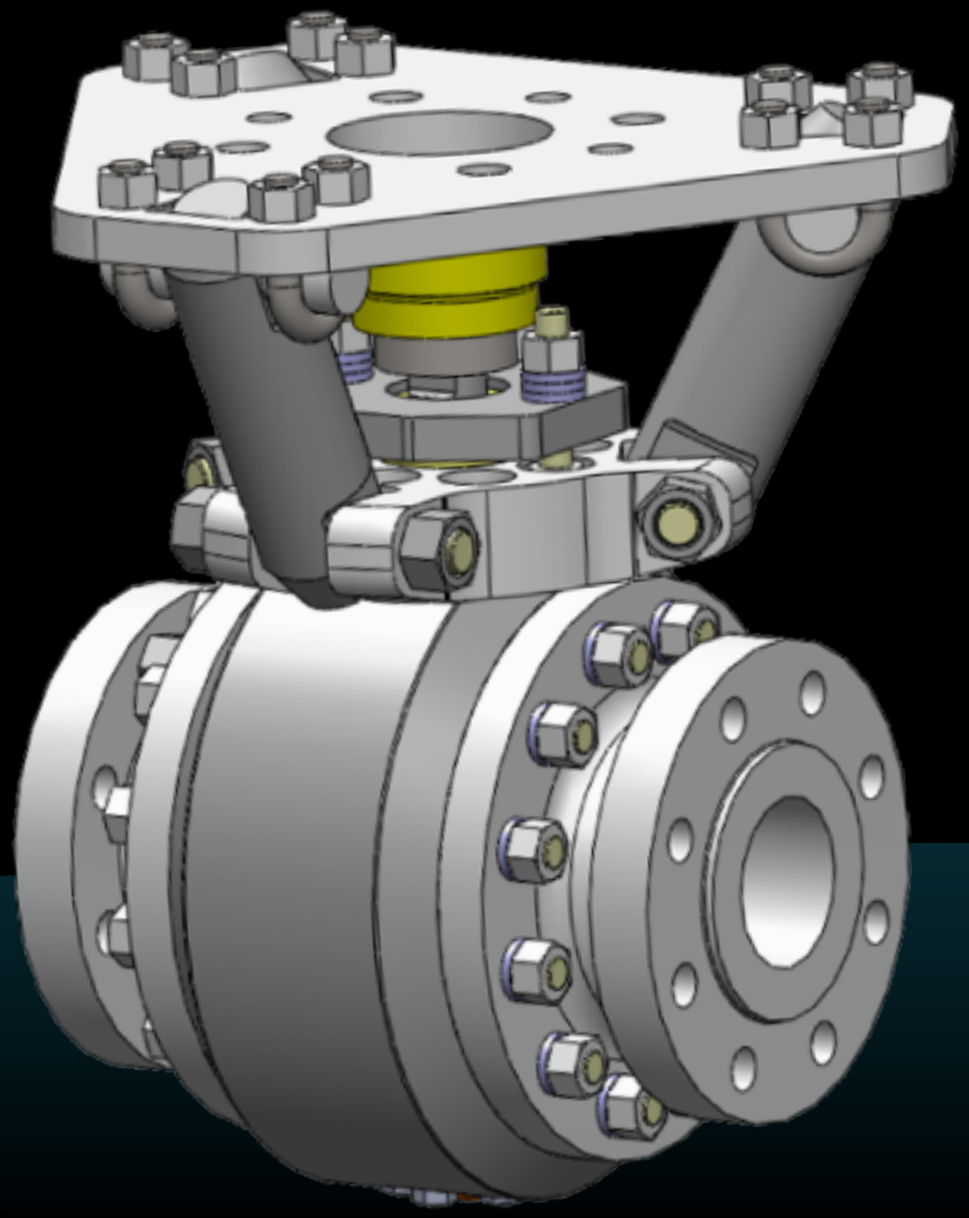
KEYSTONE



THE SOLUTION:

A Keystone Autoclave valve designed to combat the root cause of failure

Custom-engineering to delay the onset of powder infiltration into key components

A valve that will last longer

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What makes the Keystone valve better?

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AUTOCLAVE VALVE

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KEYSTONE

AUTOCLAVE VALVE

Designed to prevent buildup of catalyst

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KEYSTONE

AUTOCLAVE VALVE

Designed to prevent buildup of catalyst

Prevents scaling of material on the ball

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KEYSTONE

AUTOCLAVE VALVE

Designed to prevent buildup of catalyst

Prevents scaling of material on the ball

Metal seated (proprietary hardening process)

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KEYSTONE

AUTOCLAVE VALVE

Designed to prevent buildup of catalyst

Prevents scaling of material on the ball

Metal seated (proprietary hardening process)

Sophisticated, simplified design

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KEYSTONE

AUTOCLAVE VALVE

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Sophisticated, simplified design

Can be mounted in any orientation

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KEYSTONE

AUTOCLAVE VALVE

Designed to prevent buildup of catalyst

Prevents scaling of material on the ball

Metal seated (proprietary hardening process)

Sophisticated, simplified design

Can be mounted in any orientation

Dual stem packing

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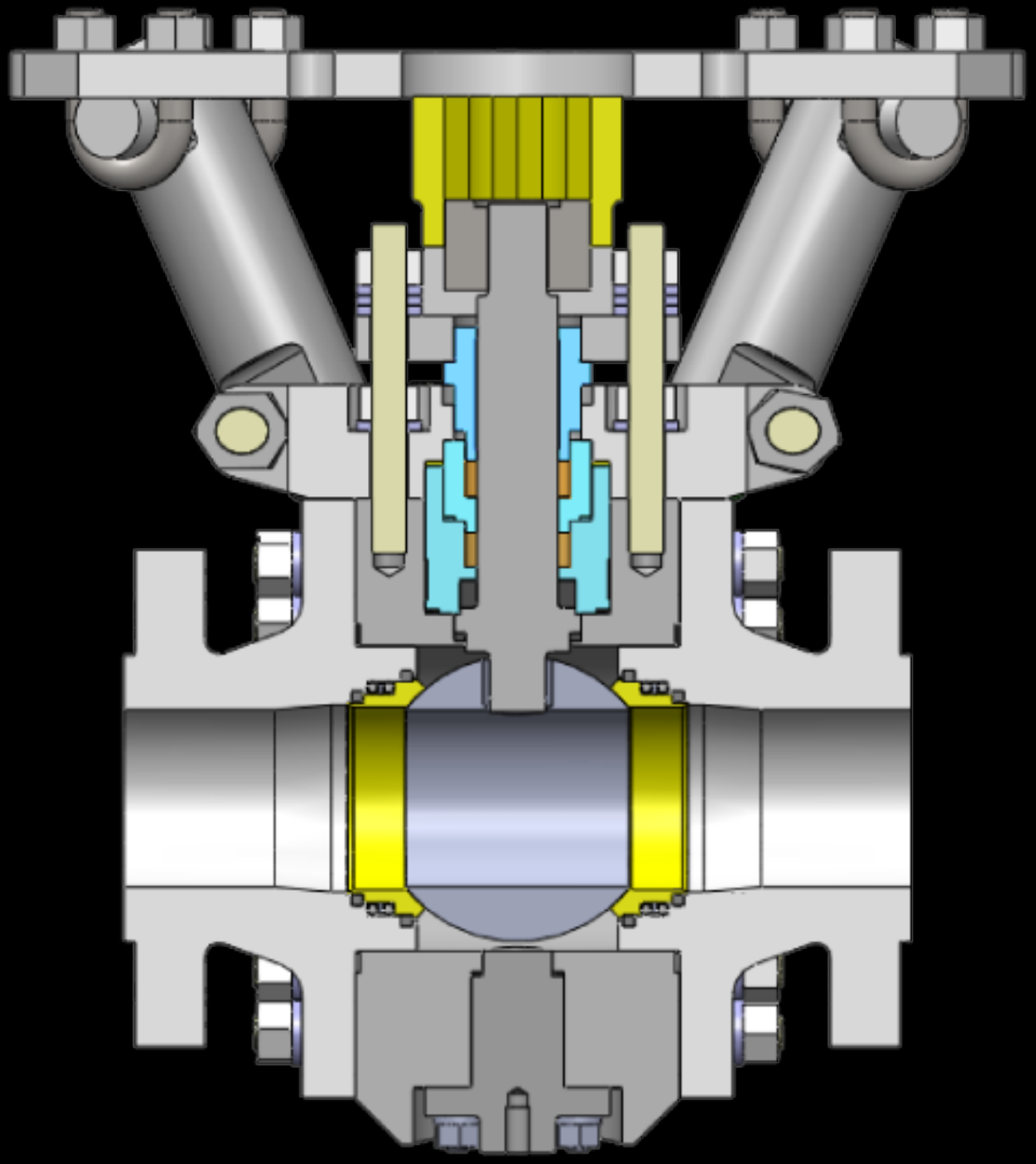

VALVE FEATURES

AUTOCLAVE

METAL SEATED BALL VALVE

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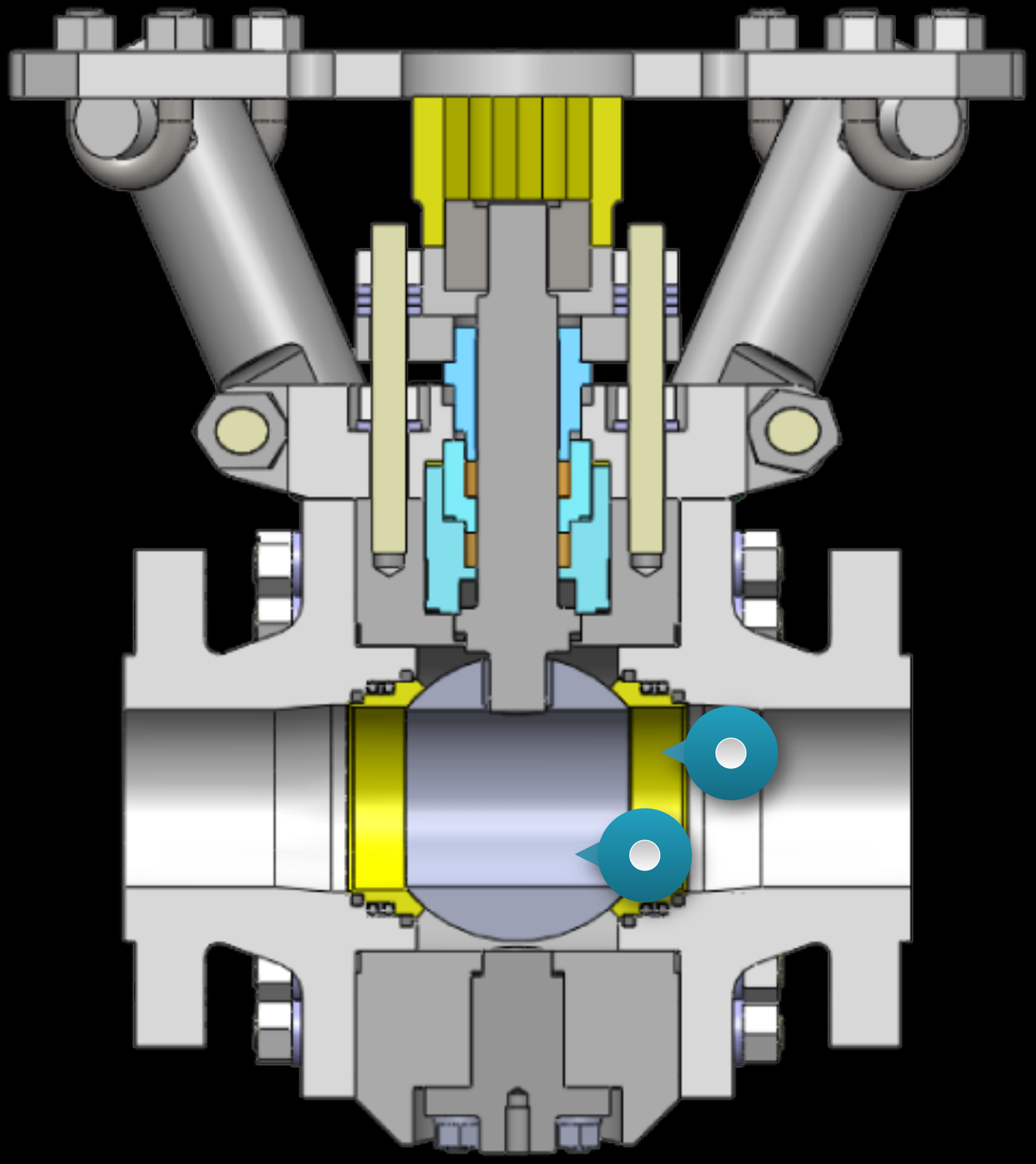
KEYSTONE



VALVE FEATURES

Superior trim hardening

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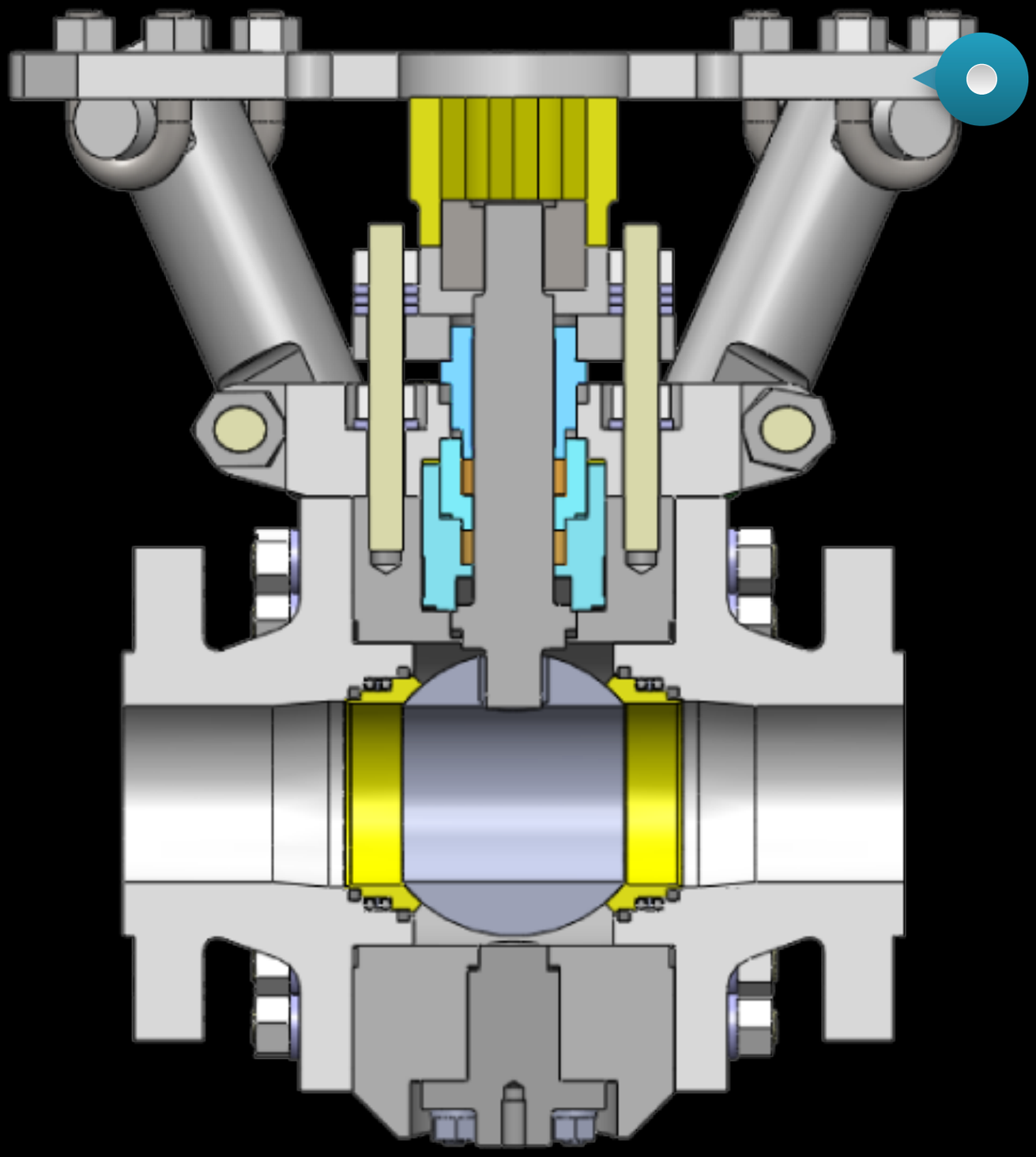
KEYSTONE



VALVE FEATURES

Superior trim hardening

Fabricated tripod mounting bracket

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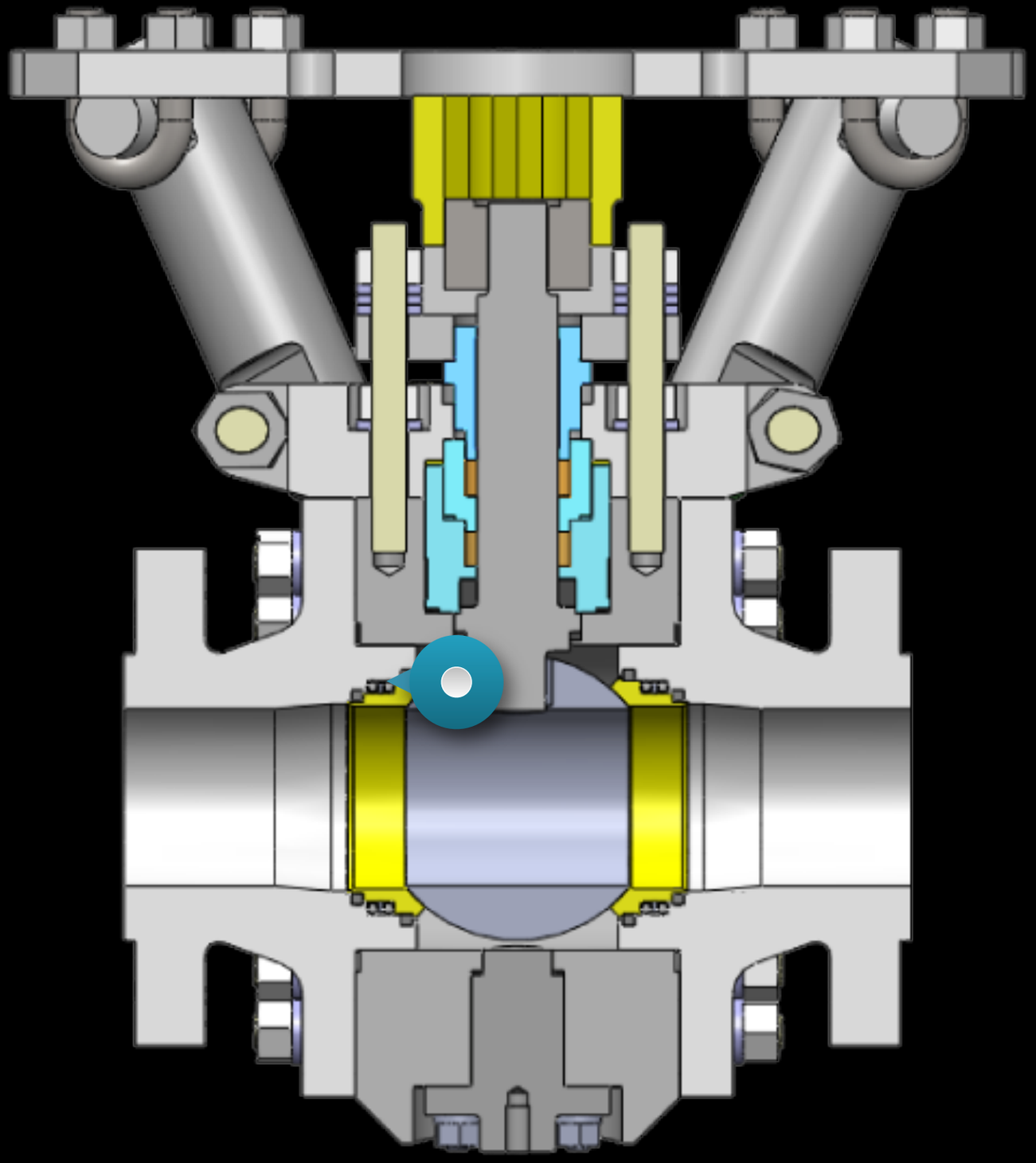
KEYSTONE



VALVE FEATURES

Superior trim hardening

Fabricated tripod mounting bracket

Dual C-ring for seal and spring

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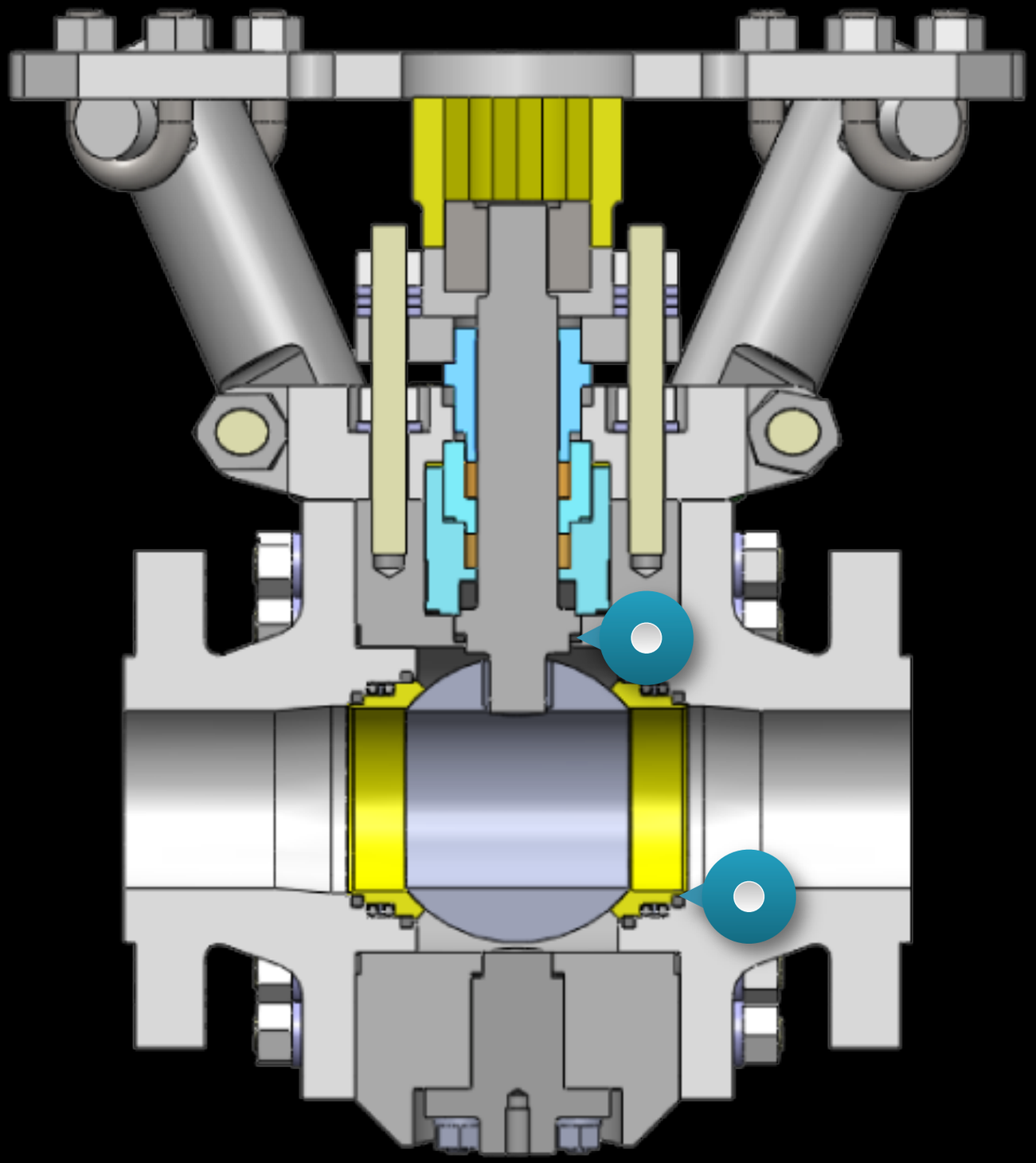
KEYSTONE



VALVE FEATURES

Superior trim hardening

Fabricated tripod mounting bracket

Dual C-ring for seal and spring

Graphite wipers for containment

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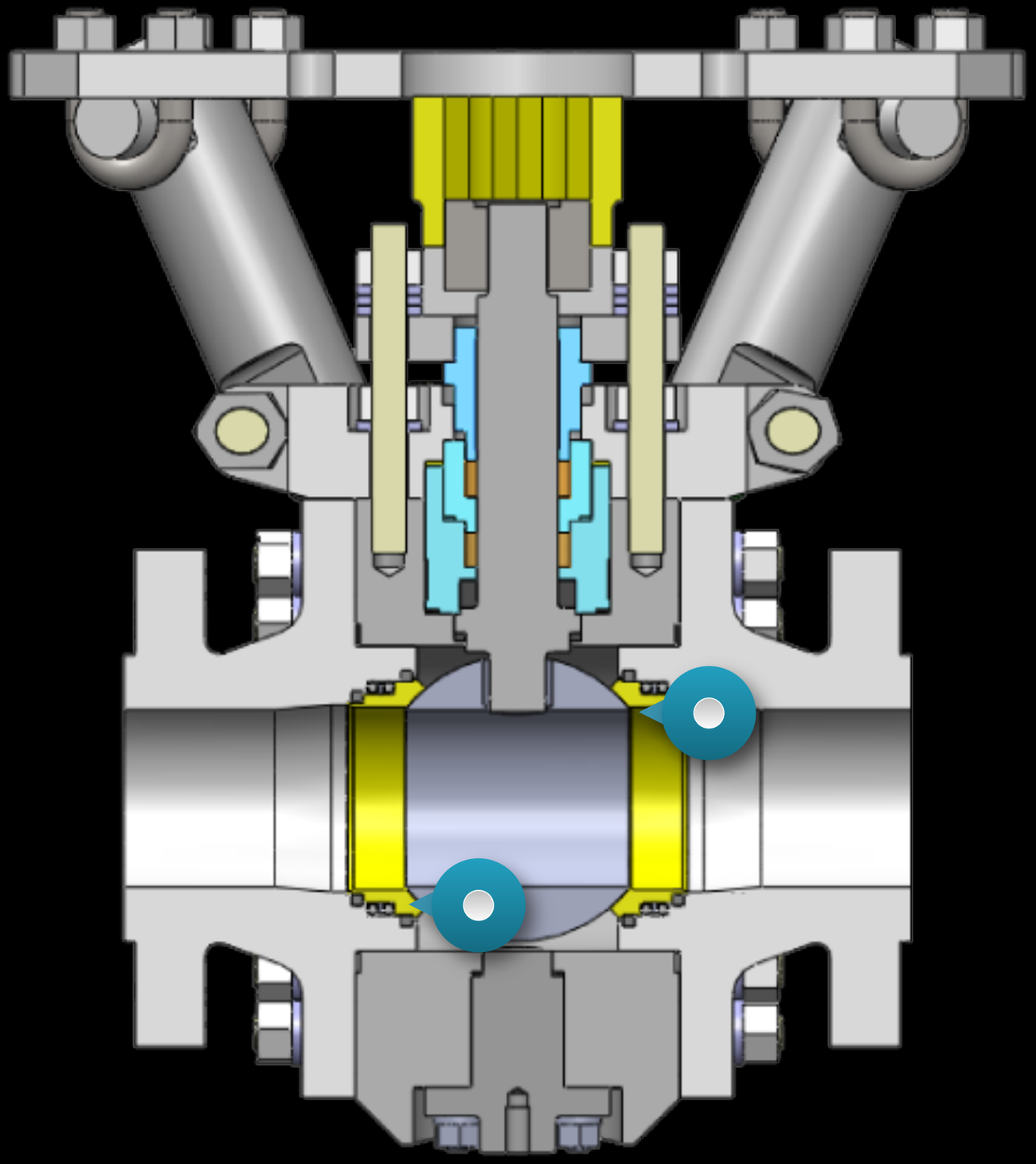
KEYSTONE



VALVE FEATURES

Superior trim hardening

Fabricated tripod mounting bracket

Dual C-ring for seal and spring

Graphite wipers for containment

Scraper seats

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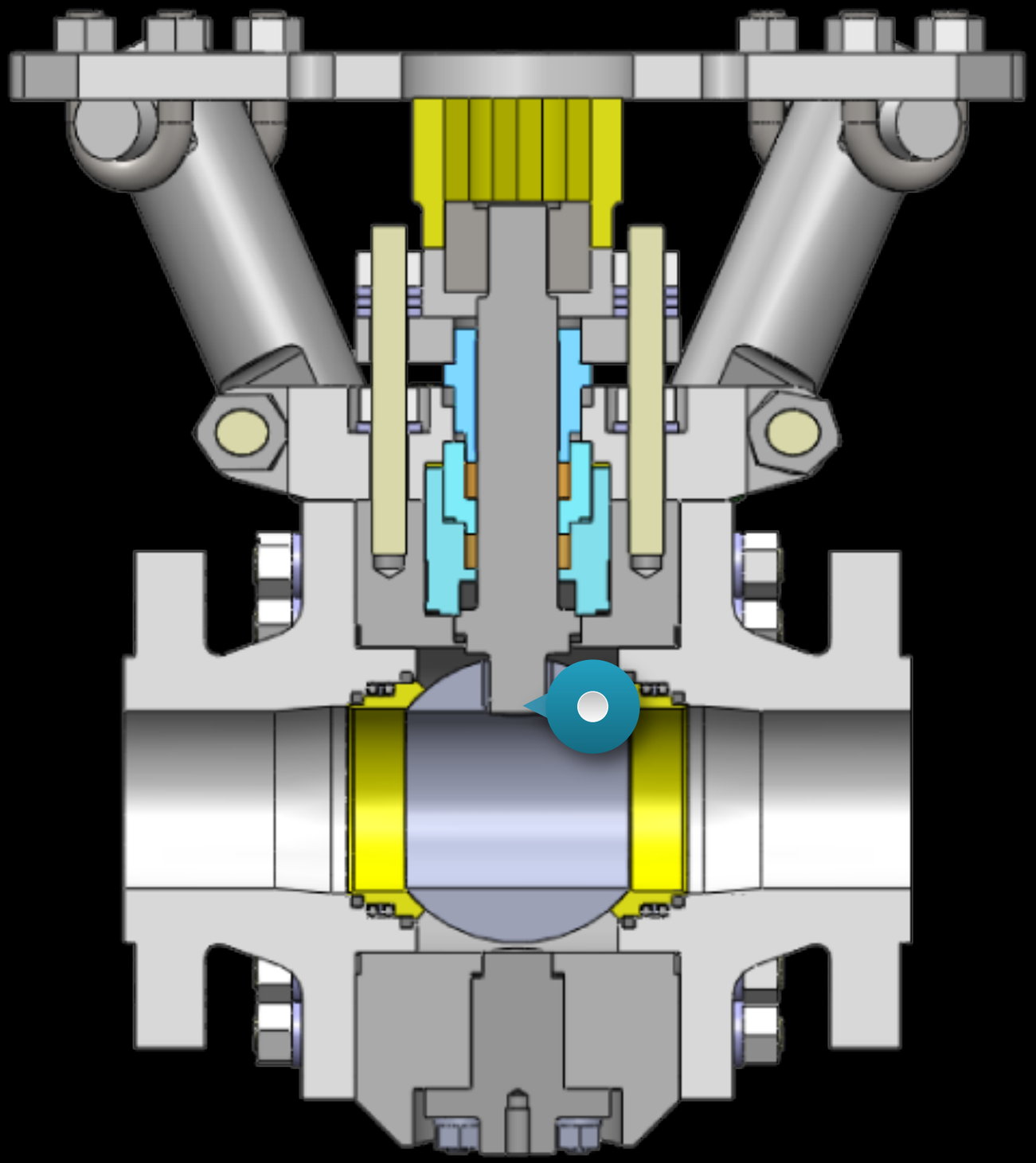
KEYSTONE



VALVE FEATURES

Superior trim hardening

Fabricated tripod mounting bracket

Dual C-ring for seal and spring

Graphite wipers for containment

Scraper seats

Scalloped ball slot

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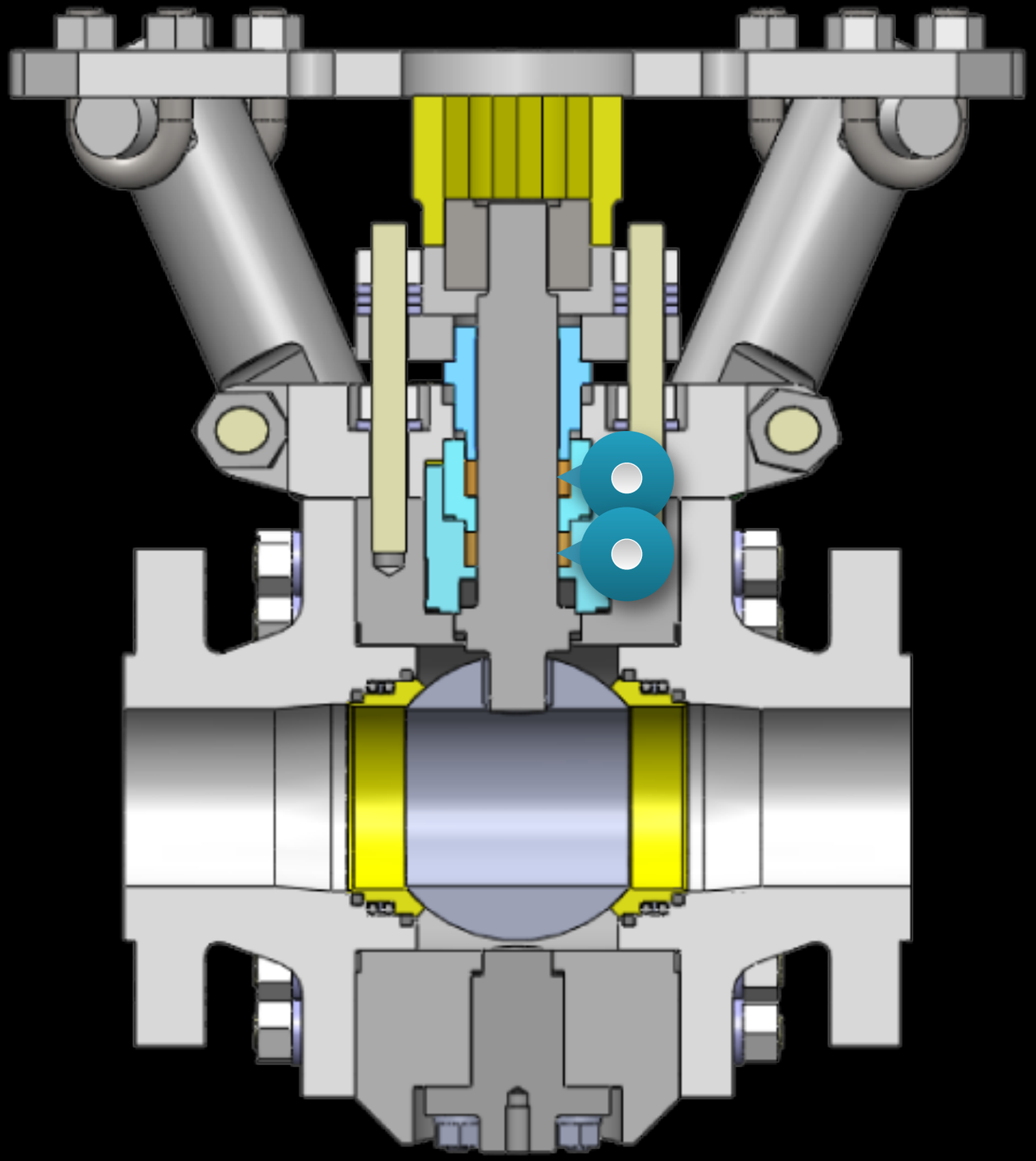
KEYSTONE



VALVE FEATURES

Superior trim hardening

Fabricated tripod mounting bracket

Dual C-ring for seal and spring

Graphite wipers for containment

Scraper seats

Scalloped ball slot

Patented dual stem sealing

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COMPETITION VS. KEYSTONE

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COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing

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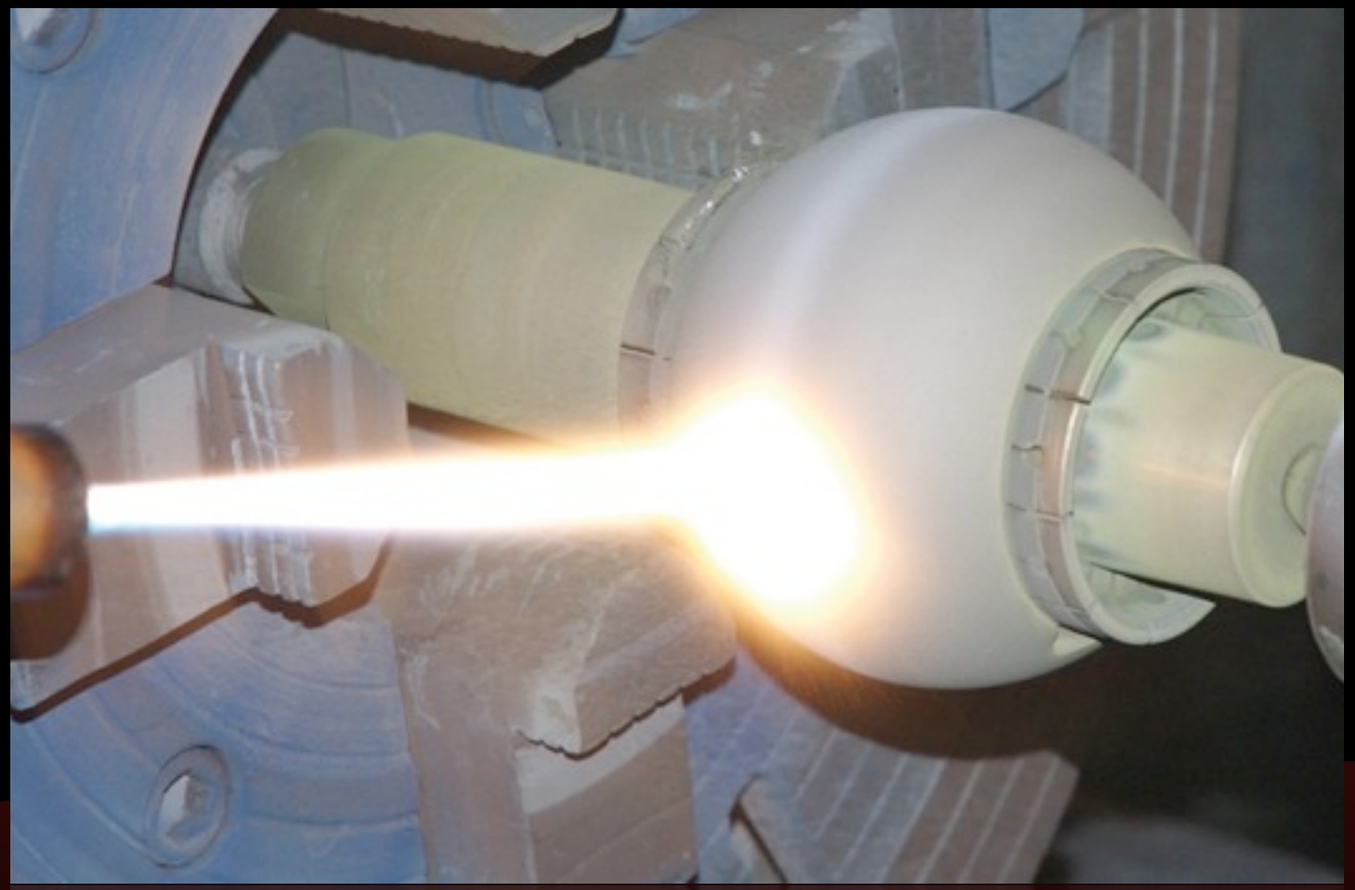
KEYSTONE



HVOF

AUTOCLAVE

METAL SEATED BALL VALVE

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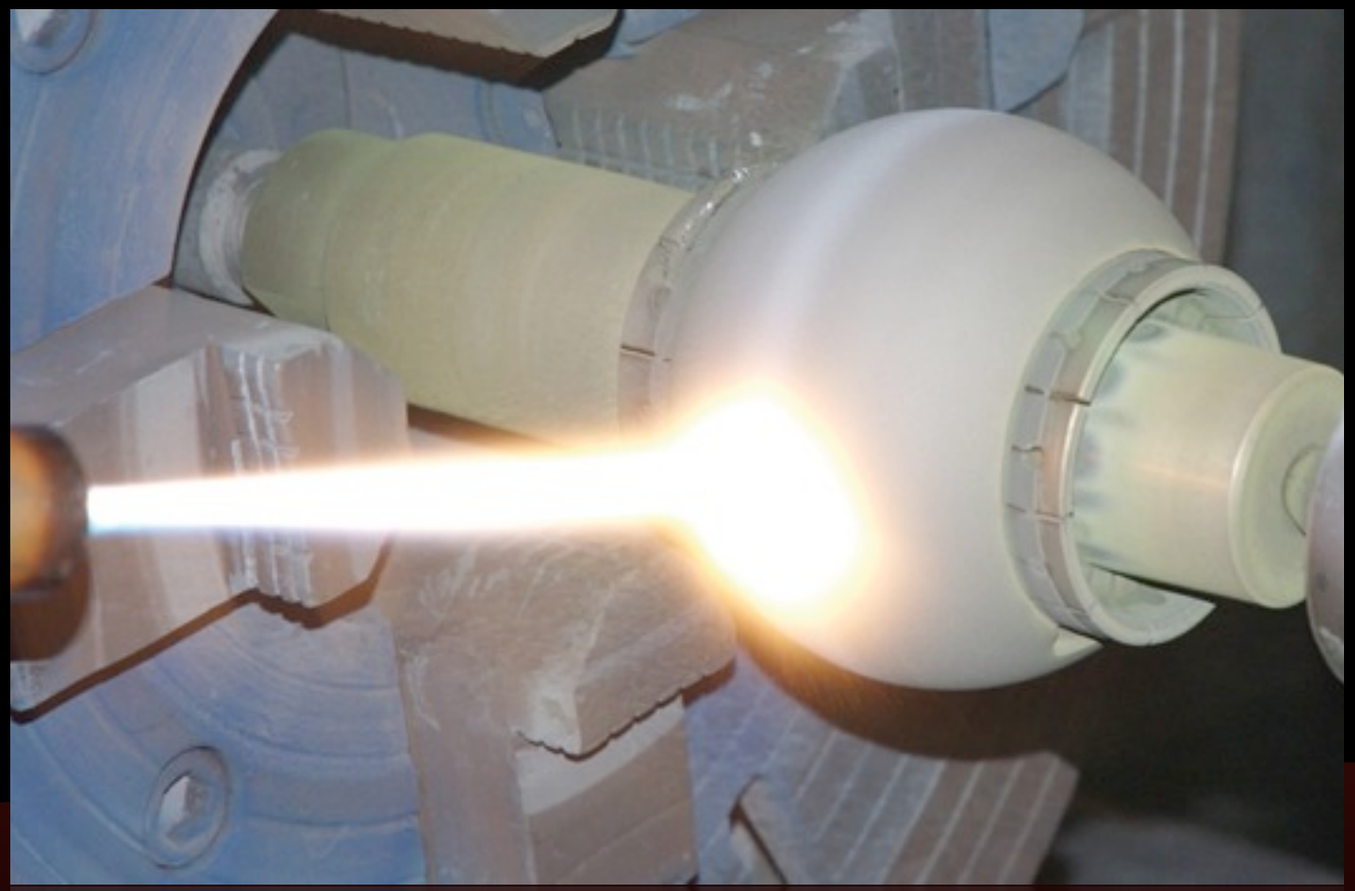
KEYSTONE



HVOF

Cheap

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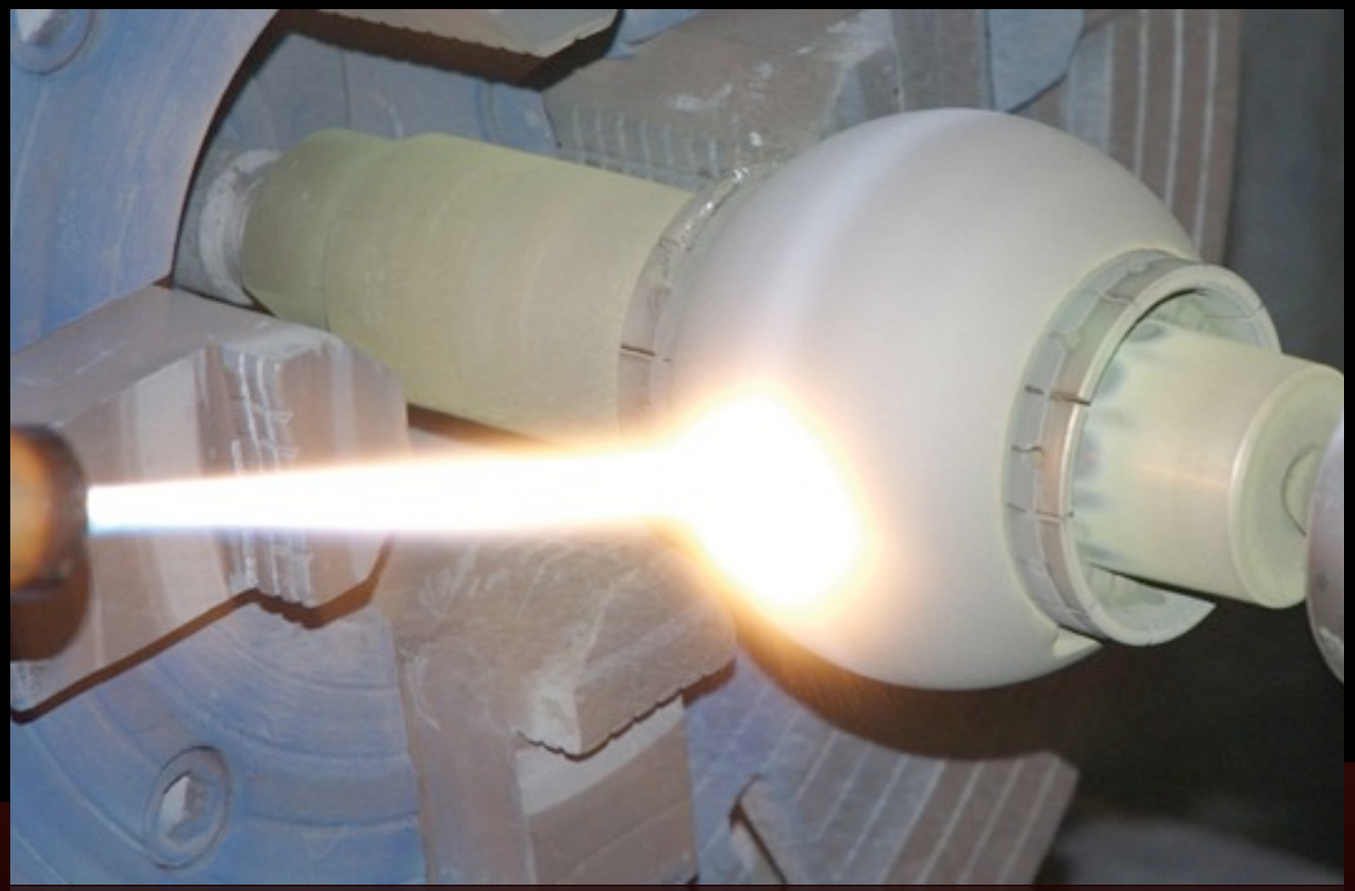
KEYSTONE



HVOF

Cheap

Cracks / Spalls

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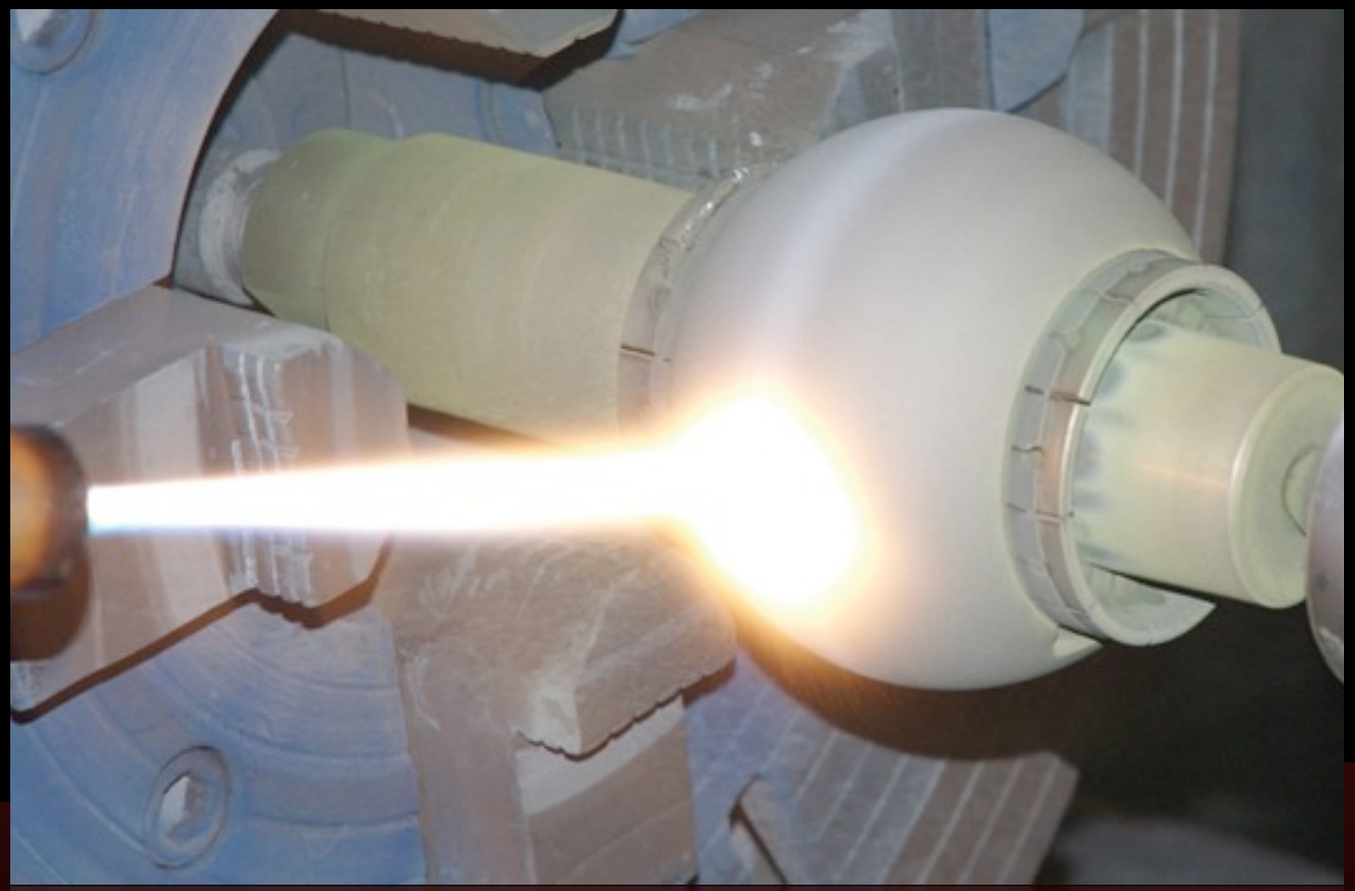
KEYSTONE



HVOF

Cheap

Cracks / Spalls

Uneven coating

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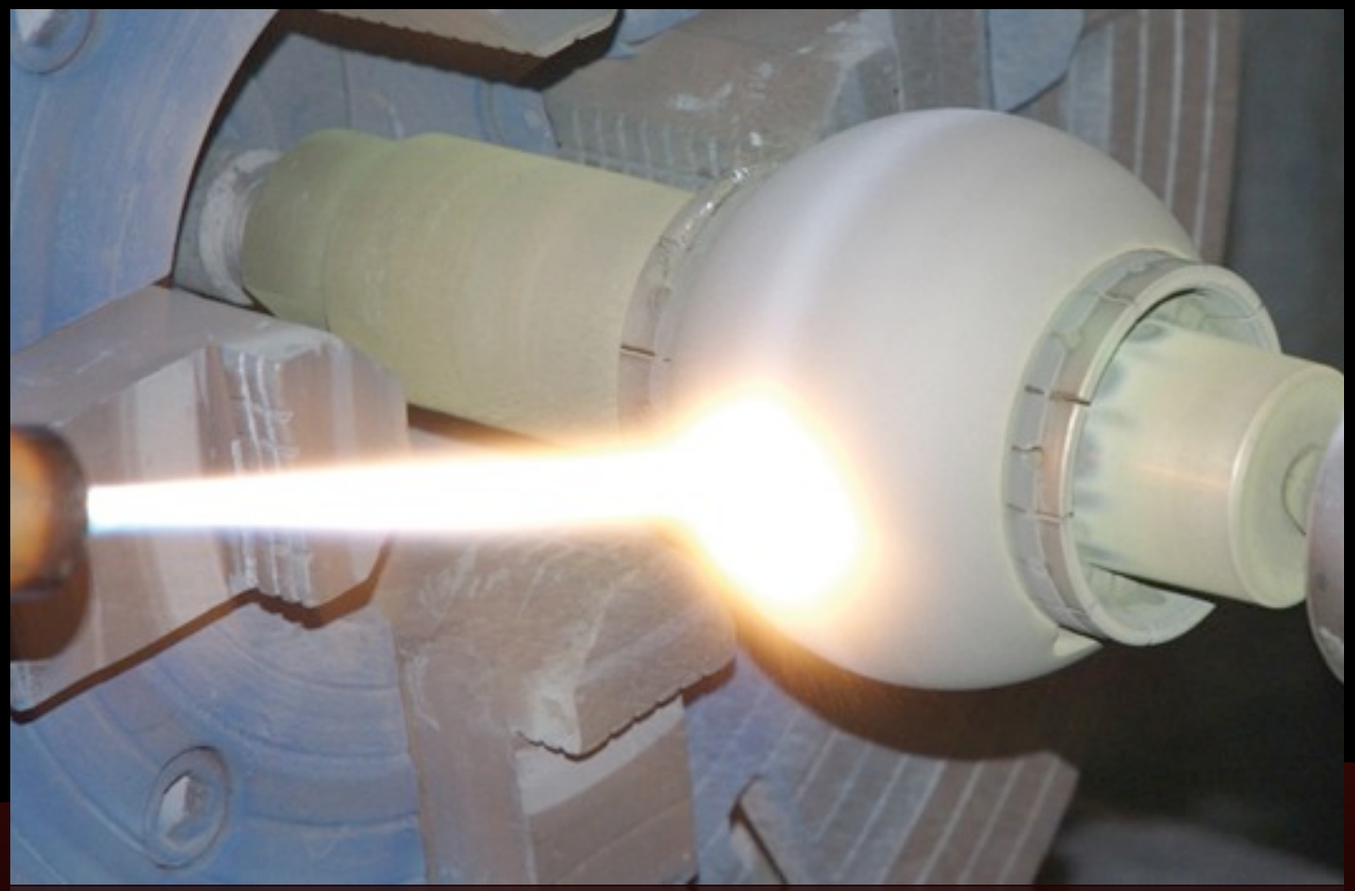
KEYSTONE



HVOF

Cheap

Cracks / Spalls

Uneven coating

No penetration of base metal

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KEYSTONE

BORONIZING

AUTOCLAVE

METAL SEATED BALL VALVE

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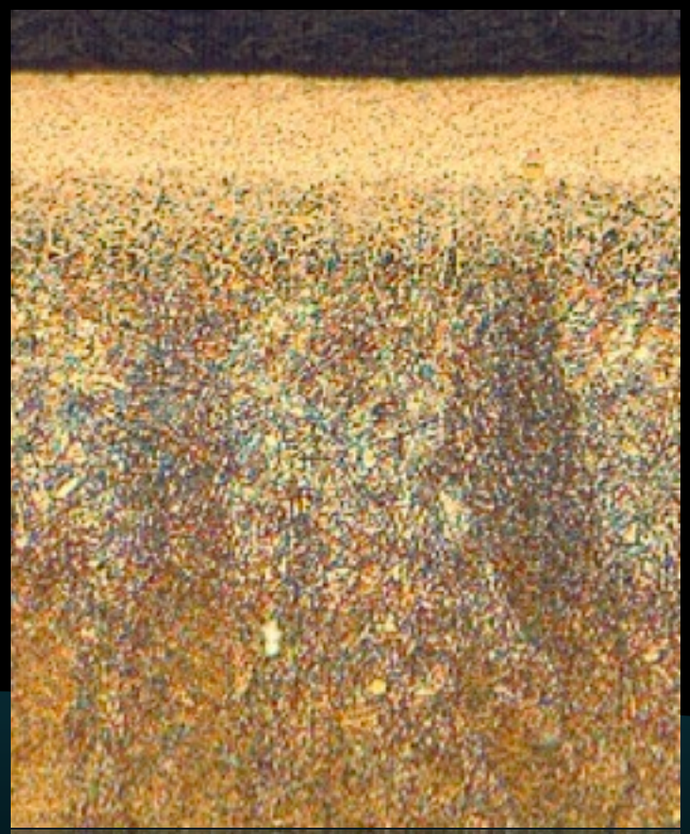
KEYSTONE

BORONIZING



Inconel 718, 200x magnification
.0017” solid layer, .0035” partial layer

BORONIZING

Thermo-chemical surface hardening process

Inconel 718, 200x magnification
.0017” solid layer, .0035” partial layer

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BORONIZING

Thermo-chemical surface hardening process

Boron atoms are diffused into surface

Inconel 718, 200x magnification
.0017” solid layer, .0035” partial layer

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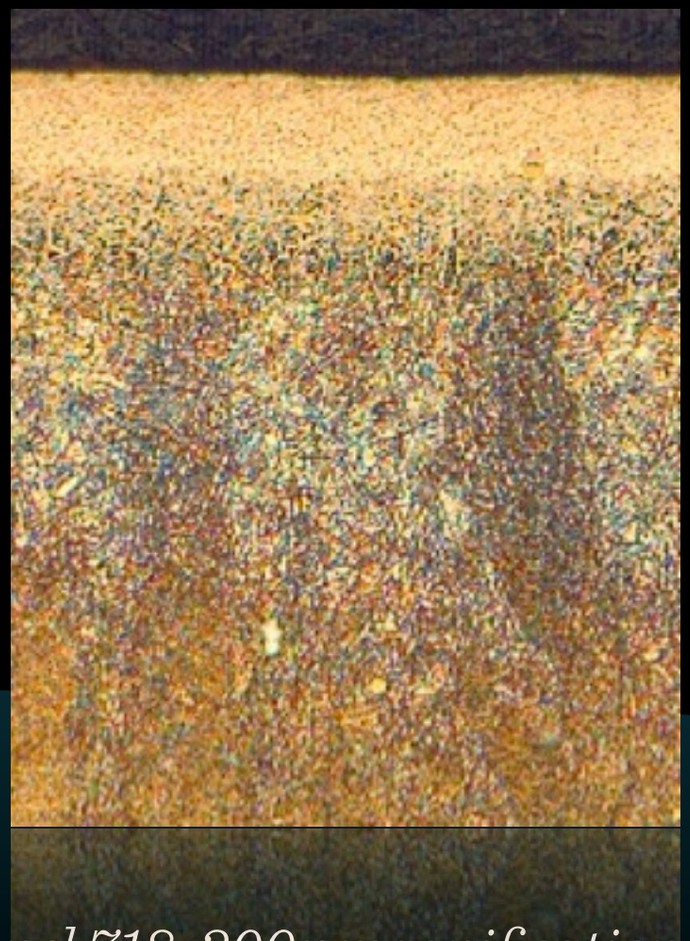
BORONIZING

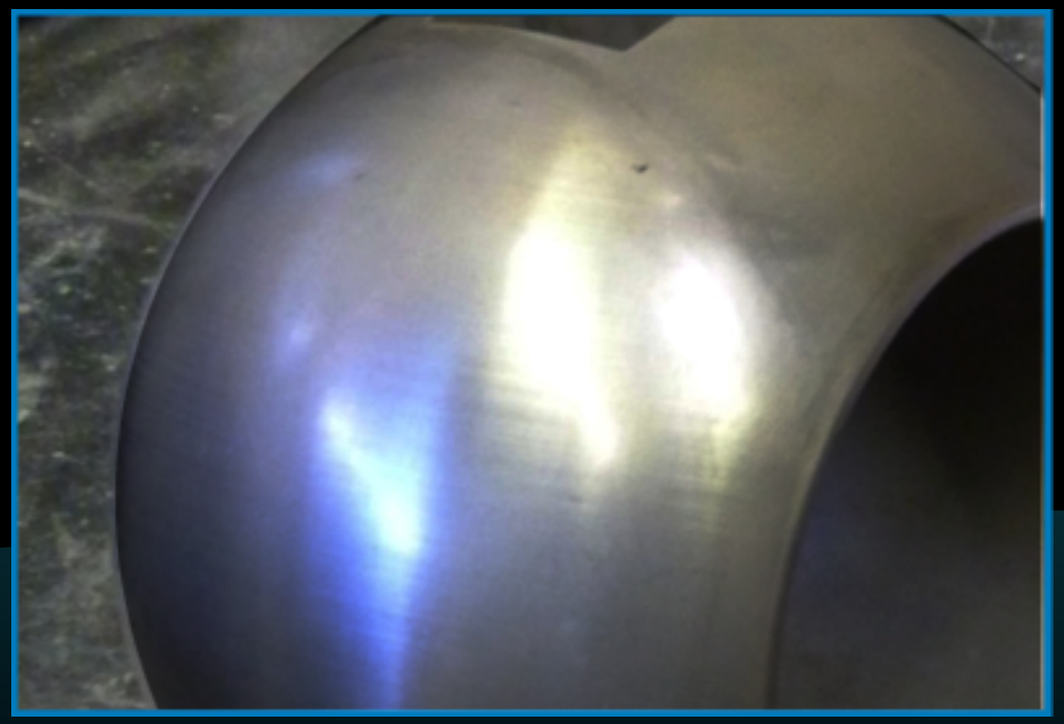
Thermo-chemical surface hardening process

Boron atoms are diffused into surface

Results in a case layer that is hard, slippery, and capable of handling temperature fluctuations



Inconel 718, 200x magnification
.0017" solid layer, .0035" partial layer



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KEYSTONE

BORONIZING VS. HVOF

Comparison of trim set surface after 1 year in high temperature application

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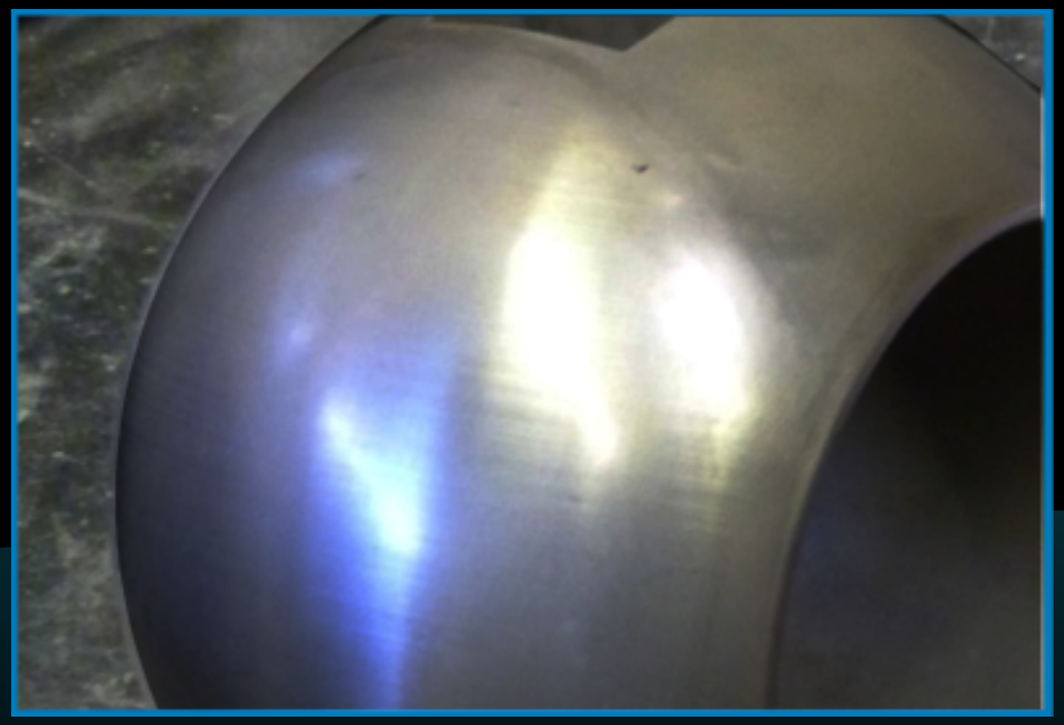

BORONIZING

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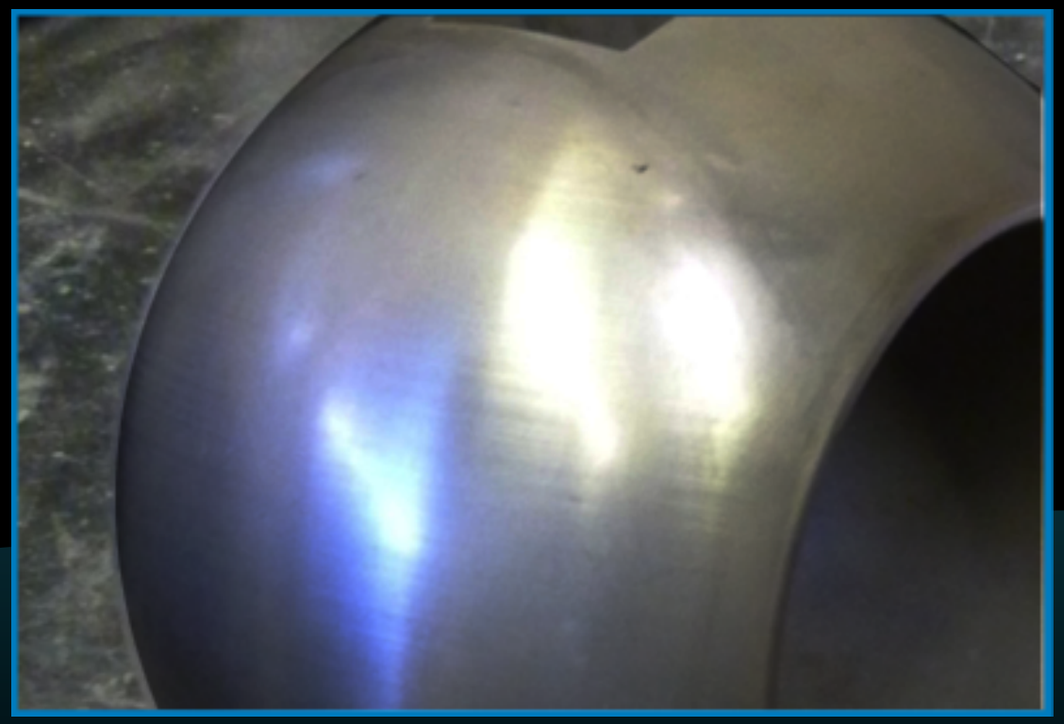
KEYSTONE

BORONIZING VS. HVOF

Comparison of trim set surface after 1 year in high temperature application



BORONIZING

HVOF

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KEYSTONE

BORONIZING VS. HVOF

Comparison of trim set surface after 1 year in high temperature application

BORONIZING

HVOF

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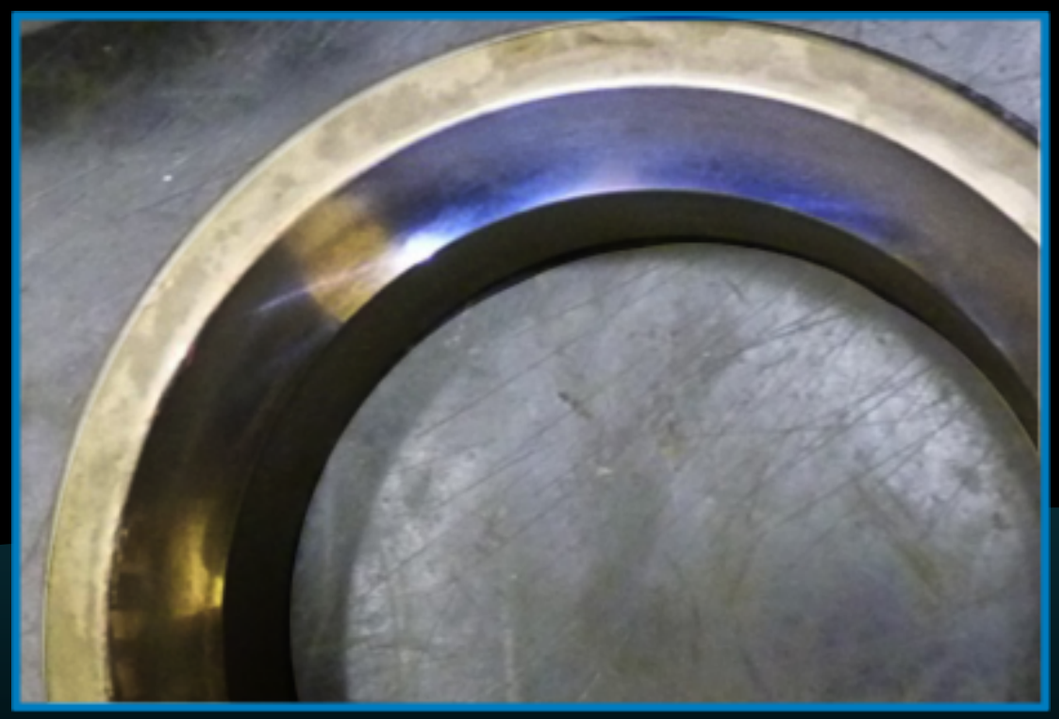
BORONIZING VS. HVOF

Comparison of trim set surface after 1 year in high temperature application



BORONIZING

HVOF

AUTOCLAVE
METAL SEATED BALL VALVE

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KEYSTONE

AUTOCLAVE

METAL SEATED BALL VALVE

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KEYSTONE

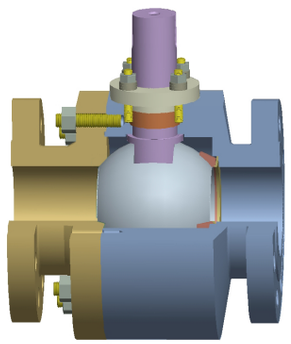
VTI ON MATERIALS:

Valvtechnologies Catalyst Withdrawal Isolation Valves

Background: Catalyst Withdrawal Valves are used to remove hot, "spent" catalyst from the unit regenerator. These are typically 4" - 6", 300# class, 347SS or 9Cr full port valves. They operate at a maximum temperature of 1400 degrees Fahrenheit and allow the hot catalyst to be removed from the regenerator section of the FCCU. After three years of testing and field experience, Valvtechnologies has developed the "Cat-Flo" valve. Special features include our unique "Slurry" seat to prevent catalyst solids from locking up the valves, RAM 31 on all valve internals parts subject to wear, stem bearings and extra-wide internal gaps to prevent thermal lock-up.

A virtually identical application in terms of operating conditions and technical requirement are 3rd and 4th stage separator isolation valves. These valves are typically 8" - 18", 300# class 304SS or 5Cr. material. The only additional challenge is the additional internal gap required to prevent thermal lock-up in these larger bore valves.

Valvtechnologies “Cat-Flo” Isolation Valve for High Temperature:



There are a number of technical features included in this design:

1. Internal Gaps: In evaluating necessary internal gaps, we made use of Paulin Research’s “Caesar” program. In the 4”, 347SS valves, it was determined that the maximum gap requirement is between 3 minutes and 5 minutes from the time 1400^{o} F catalyst enters the valve that was closed and at ambient temperature. This is a worst-case situation, but caused the design to be changed to allow 200% of the 60 mils calculated in the 4” size. In the larger valves, the gap clearance is always between 150% and 200% of calculated requirements.
2. Slurry Seat: Originally designed for low-temperature iron ore and copper slurries, the slurry upstream seat eliminates the flat upstream surfaces that can trap catalyst. We feel this is the most important feature of the Valvtechnologies design. Much of the testing on this design was done at the ConocoPhillips refinery in Bayway, NJ. Four different designs were evaluated using required torque measurement and condition of the valve internals after a year in service. The Slurry Seat was by far the best internal choice and allowed the valve to be smoothly cycled at any time after the catalyst flow began.
3. Chromium Carbide Coatings: At the high temperatures present in this service, the choices of coatings to resist erosion and allow the necessary seat loads of metal-seated ball valves is very limited. Materials such as Stellite VI overlays and Nitrite (QPQ) treatments quickly degrade. Valvtechnologies has tested Nickel-Boron coatings, Boron Diffusion treatment and Fused Carbide in this service. However, the coating with the longest life and best performance is Chromium carbide with a Chrome/Nickel binder applied using a modified HVOF plasma spray. This coating is thermally stable up to 1800^{o} F and (very important) has a coefficient of expansion very closely matched to the 300 series stainless used in the valve body and trim material. It is also important to note that this coating, which we call RAM 31, is also used on the valve stem and all internal surfaces requiring coating.
4. Material: At the operating temperature of the hot catalyst valves, the absolute best choice for body and trim material is probably Inconel. However, at the present high cost of Inconel, it appears that any extended life does not justify the 3X – 5X

VTI ON MATERIALS:

VALVTECHNOLOGIES

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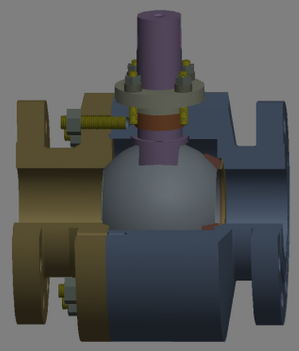
Valvtechnologies “Cat-Flo” Isolation Valve for High Te



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3. Chromium Carbide Coatings: At the high temperatures present in this service, the choices of coatings to resist erosion and allow the necessary seat loads of metal seated ball valves is material. It is also important to note that this coating, which we call RAM 31, is also used on the valve stem and all internal surfaces requiring coating.
4. **Material: At the operating temperature of the hot catalyst valves, the absolute best choice for body and trim material is probably Inconel. However, at the present high cost of Inconel, it appears that any extended life does not justify the 3X – 5X price factor.**

AUTOCLAVE

METAL SEATED BALL VALVE

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KEYSTONE

MOGAS ON COATINGS:

APPLICATION NOTE ON COATINGS

Common Coatings Used by MOGAS

MOGAS® SEVERE SERVICE BALL VALVES

Method of Application	HVOF		Fusion	Plasma	Diffused		Patented
Material	Chromium Carbide	Tungsten Carbide	Chromium Carbide	Chromuim Oxide	Nitride	Boride	Nano Titanium Dioxide
Uses	General Severe Service, Power, Slurry Mining, Chemical	Specialized Severe Service, Mining, Food Processing, Corrosive Chemical	Specialized Severe Service, Power, Thermal Shock, Extreme Temperature	Corrosive Service, Gold Mining	General Service, Bearings, Hot Gas	Specialized Severe Service, Power Corrosive Services, Thermal Shock	Corrosive Service, Gold Mining, Nickel Mining, High Pressure Acid Leach
Base Metals	Any	Any	300 Series Stainless Nickel Alloys	Any, Duplex SS & Ti Typical	Iron-Based Alloys	Nickel-Based Alloys	Any, Duplex SS & Ti Typical
Advantages	High Strain to Fracture, Erosion-Resistant, Extreme Temperature	Erosion-Resistant, Wear-Resistant	Erosion-Resistant, Non-Porous, Thermal Shock, Metallurgical Bond, Corrosion Resistant	Very Corrosion Resistant at lower temperatures	Inexpensive Metallurgical Bond	Extremely Hard, Metallurgical Bond, Non-Porous, Corrosion Resistant	Very Corrosion Resistant at low and high temperatures, superior wear to conventional ceramic coatings
Disadvantages	Some Porosity, Mechanical Bond	Some Porosity, Mechanical Bond, Thermal Cycling Can Produce Cracking	Not Suitable on 410 SS 17-4PH Carbon Steel, Expensive	Poor Thermal Shock, Poor Bond Strength, Porosity, & Cracking are Typical	Reduces Corrosion Resistance, Lower Abrasion & Wear Resistance than HVOF Coatings	Very Thin .001" Finished, Bore Size Limit 1.5"	Ceramic coatings are not as tough as HVOF cermets

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MOGAS ON COATINGS:

Method of Application	HVOF	
Material	Chromium Carbide	Tungsten Carbide
Uses	General Severe Service, Power, Slurry Mining, Chemical	Specialized Severe Service, Mining, Food Processing, Corrosive Chemical
Base Metals	Any	Any
Advantages	High Strain to Fracture, Erosion-Resistant, Extreme Temperature	Erosion-Resistant, Wear-Resistant
Disadvantages	Some Porosity, Mechanical Bond	Some Porosity, Mechanical Bond, Thermal Cycling Can Produce Cracking

MOGAS
SEVERE SERVICE BALL VALVES

	Diffused		Patented
m Oxide	Nitride	Boride	Nano Titanium Dioxide
Gold	General Service, Bearings, Hot Gas	Specialized Severe Service, Power Corrosive Services, Thermal Shock	Corrosive Service, Gold Mining, Nickel Mining, High Pressure Acid Leach
lex SS al	Iron-Based Alloys	Nickel-Based Alloys	Any, Duplex SS & Ti Typical
osion tures	Inexpensive Metallurgical Bond	Extremely Hard, Metallurgical Bond, Non-Porous, Corrosion Resistant	Very Corrosion Resistant at low and high temperatures, superior wear to conventional ceramic coatings
rmal or ength, & are	Reduces Corrosion Resistance, Lower Abrasion & Wear Resistance than HVOF Coatings	Very Thin .001" Finished, Bore Size Limit 1.5"	Ceramic coatings are not as tough as HVOF cermets

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MOGAS ON COATINGS:

Method of Application	HVOF	
Material	Chromium Carbide	Tungsten Carbide
Uses	General Severe Service, Power, Slurry Mining, Chemical	Specialized Severe Service, Mining, Food Processing, Corrosive Chemical
Base Metals	Any	Any
Advantages	High Strain to Fracture, Erosion-Resistant, Extreme Temperature	Erosion-Resistant, Wear-Resistant
Disadvantages	Some Porosity, Mechanical Bond	Some Porosity, Mechanical Bond, Thermal Cycling Can Produce Cracking

MOGAS
SEVERE SERVICE BALL VALVES

	Diffused		Patented
m Oxide	Nitride	Boride	Nano Titanium Dioxide
Gold	General Service, Bearings, Hot Gas	Specialized Severe Service, Power Corrosive Services, Thermal Shock	Corrosive Service, Gold Mining, Nickel Mining, High Pressure Acid Leach
lex SS al	Iron-Based Alloys	Nickel-Based Alloys	Any, Duplex SS & Ti Typical
osion tures	Inexpensive Metallurgical Bond	Extremely Hard, Metallurgical Bond, Non-Porous, Corrosion Resistant	Very Corrosion Resistant at low and high temperatures, superior wear to conventional ceramic coatings
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Method of Application	HVOF	
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Uses	General Severe Service, Power, Slurry Mining, Chemical	Specialized Severe Service, Mining, Food Processing, Corrosive Chemical
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MOGAS
SEVERE SERVICE BALL VALVES

	Diffused		Patented
m Oxide	Nitride	Boride	Nano Titanium Dioxide
Gold	General Service, Bearings, Hot Gas	Specialized Severe Service, Power Corrosive Services, Thermal Shock	Corrosive Service, Gold Mining, Nickel Mining, High Pressure Acid Leach
lex SS al	Iron-Based Alloys	Nickel-Based Alloys	Any, Duplex SS & Ti Typical
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MOGAS ON COATINGS:

Method of Application	HVOF	
Material	Chromium Carbide	Tungsten Carbide
Uses	General Severe Service, Power, Slurry Mining, Chemical	Specialized Severe Service, Mining, Food Processing, Corrosive Chemical
Base Metals	Any	Any
Advantages	High Strain to Fracture, Erosion-Resistant, Extreme Temperature	Erosion-Resistant, Wear-Resistant
Disadvantages	Some Porosity, Mechanical Bond	Some Porosity, Mechanical Bond, Thermal Cycling Can Produce Cracking

MOGAS
SEVERE SERVICE BALL VALVES

	Diffused		Patented
m Oxide	Nitride	Boride	Nano Titanium Dioxide
Gold	General Service, Bearings, Hot Gas	Specialized Severe Service, Power Corrosive Services, Thermal Shock	Corrosive Service, Gold Mining, Nickel Mining, High Pressure Acid Leach
lex SS al	Iron-Based Alloys	Nickel-Based Alloys	Any, Duplex SS & Ti Typical
osion tures	Inexpensive Metallurgical Bond	Extremely Hard, Metallurgical Bond, Non-Porous, Corrosion Resistant	Very Corrosion Resistant at low and high temperatures, superior wear to conventional ceramic coatings
rmal or ength, & are	Reduces Corrosion Resistance, Lower Abrasion & Wear Resistance than HVOF Coatings	Very Thin .001" Finished, Bore Size Limit 1.5"	Ceramic coatings are not as tough as HVOF cermets

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MOGAS ON COATINGS:

APPLICATION NOTE ON COATINGS

Common Coatings Used by MOGAS

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Method of Application	HVOF		Fusion	Plasma	Diffused		Patented
Material	Chromium Carbide	Tungsten Carbide	Chromium Carbide	Chromuim Oxide	Nitride	Boride	Nano Titanium Dioxide
Uses	General Severe Service, Power, Slurry Mining, Chemical	Specialized Severe Service, Mining, Food Processing, Corrosive Chemical	Specialized Severe Service, Power, Thermal Shock, Extreme Temperature	Corrosive Service, Gold Mining	General Service, Bearings, Hot Gas	Specialized Severe Service, Power Corrosive Services, Thermal Shock	Corrosive Service, Gold Mining, Nickel Mining, High Pressure Acid Leach
Base Metals	Any	Any	300 Series Stainless Nickel Alloys	Any, Duplex SS & Ti Typical	Iron-Based Alloys	Nickel-Based Alloys	Any, Duplex SS & Ti Typical
Advantages	High Strain to Fracture, Erosion-Resistant, Extreme Temperature	Erosion-Resistant, Wear-Resistant	Erosion-Resistant, Non-Porous, Thermal Shock, Metallurgical Bond, Corrosion Resistant	Very Corrosion Resistant at lower temperatures	Inexpensive Metallurgical Bond	Extremely Hard, Metallurgical Bond, Non-Porous, Corrosion Resistant	Very Corrosion Resistant at low and high temperatures, superior wear to conventional ceramic coatings
Disadvantages	Some Porosity, Mechanical Bond	Some Porosity, Mechanical Bond, Thermal Cycling Can Produce Cracking	Not Suitable on 410 SS 17-4PH Carbon Steel, Expensive	Poor Thermal Shock, Poor Bond Strength, Porosity, & Cracking are Typical	Reduces Corrosion Resistance, Lower Abrasion & Wear Resistance than HVOF Coatings	Very Thin .001" Finished, Bore Size Limit 1.5"	Ceramic coatings are not as tough as HVOF cermets

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MOGAS ON COATINGS:

APPLICATION NOTE ON COATINGS

Common Coatings Used by MOGAS

Method of Application	HVOF		Fusion
Material	Chromium Carbide	Tungsten Carbide	Chrom Carbid
Uses	General Severe Service, Power, Slurry Mining, Chemical	Specialized Severe Service, Mining, Food Processing, Corrosive Chemical	Specia Severe Power Shock Tempe
Base Metals	Any	Any	300 Se Stainle Alloys
Advantages	High Strain to Fracture, Erosion-Resistant, Extreme Temperature	Erosion-Resistant, Wear-Resistant	Erosio Resist Non-P Therm Metall Bond, Resist
Disadvantages	Some Porosity, Mechanical Bond	Some Porosity, Mechanical Bond, Thermal Cycling Can Produce Cracking	Not Su 410 SS Carbo Expen

Method of Application	Diffused	
Material	Nitride	Boride
Uses	General Service, Bearings, Hot Gas	Specialized Severe Service, Power Corrosive Services, Thermal Shock
Base Metals	Iron-Based Alloys	Nickel-Based Alloys
Advantages	Inexpensive Metallurgical Bond	Extremely Hard, Metallurgical Bond, Non-Porous, Corrosion Resistant
Disadvantages	Reduces Corrosion Resistance, Lower Abrasion & Wear Resistance than HVOF Coatings	Very Thin .001" Finished, Bore Size Limit 1.5"

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MOGAS ON COATINGS:

APPLICATION NOTE ON COATINGS

Common Coatings Used by MOGAS

Method of Application	HVOF		Fusion
Material	Chromium Carbide	Tungsten Carbide	Chrom Carbid
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Method of Application	Diffused	
Material	Nitride	Boride
Uses	General Service Bearings, Hot Gas	Specialized Severe Service, Power Corrosive Services, Thermal Shock
Base Metals	Iron-Based Alloys	Nickel-Based Alloys
Advantages	Inexpensive Metallurgical Bond	Extremely Hard, Metallurgical Bond, Non-Porous, Corrosion Resistant
Disadvantages	Reduces Corrosion Resistance, Lower Abrasion & Wear Resistance than HVOF Coatings	Very Thin .001" Finished, Bore Size Limit 1.5"

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MOGAS ON COATINGS:

APPLICATION NOTE ON COATINGS

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MOGAS ON COATINGS:

APPLICATION NOTE ON COATINGS

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KEYSTONE PROPRIETARY BORONIZING PROCESS

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KEYSTONE PROPRIETARY BORONIZING PROCESS

0.005” to 0.008” depth

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KEYSTONE PROPRIETARY BORONIZING PROCESS

0.005” to 0.008” depth

No size limit

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KEYSTONE PROPRIETARY BORONIZING PROCESS

0.005” to 0.008” depth

No size limit

Thermal stability

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KEYSTONE PROPRIETARY BORONIZING PROCESS

0.005” to 0.008” depth

No size limit

Thermal stability

Extreme abrasion resistance

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KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	Graphite wipers
SEAT LOADING	Belleville Washer	C-Ring
SEAT DESIGN	Standard	Scraper
STEM SLOT	Standard	Scalloped
STEM SEALING	Single Packing	Dual Packing

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COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	Graphite wipers
SEAT LOADING	Belleville Washer	C-Ring
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COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount

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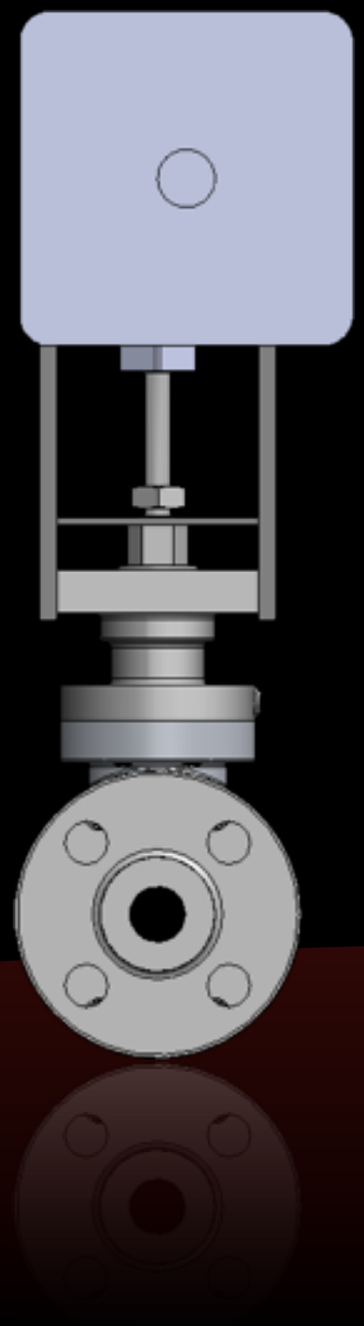
KEYSTONE



BENT BRACKET

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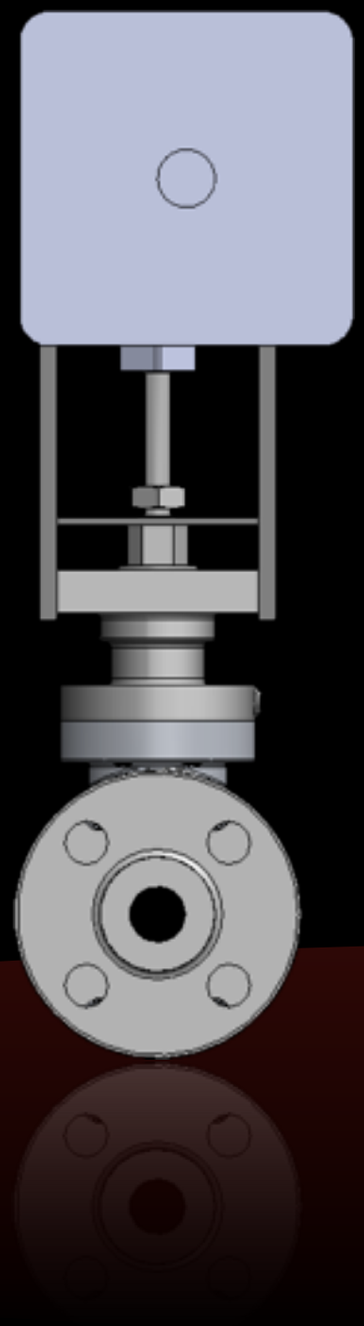

BENT BRACKET

Not accurate

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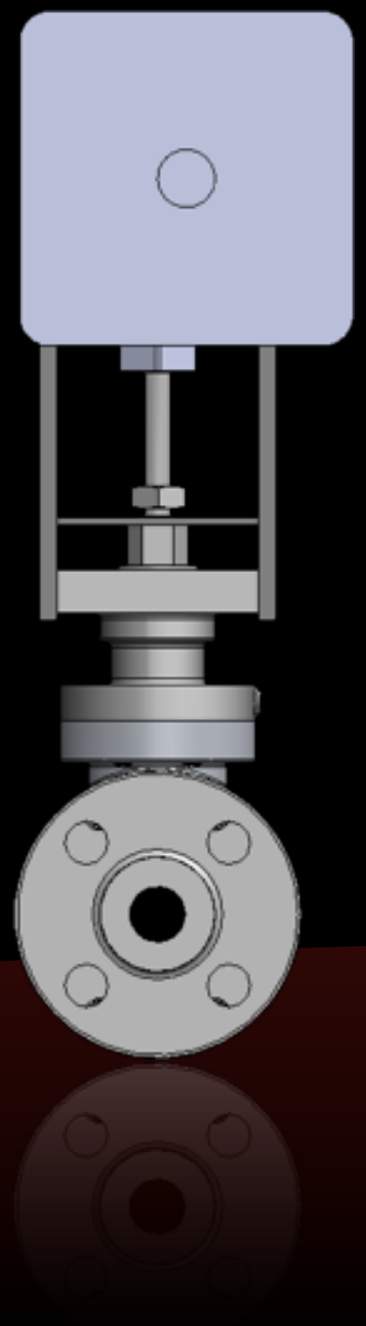
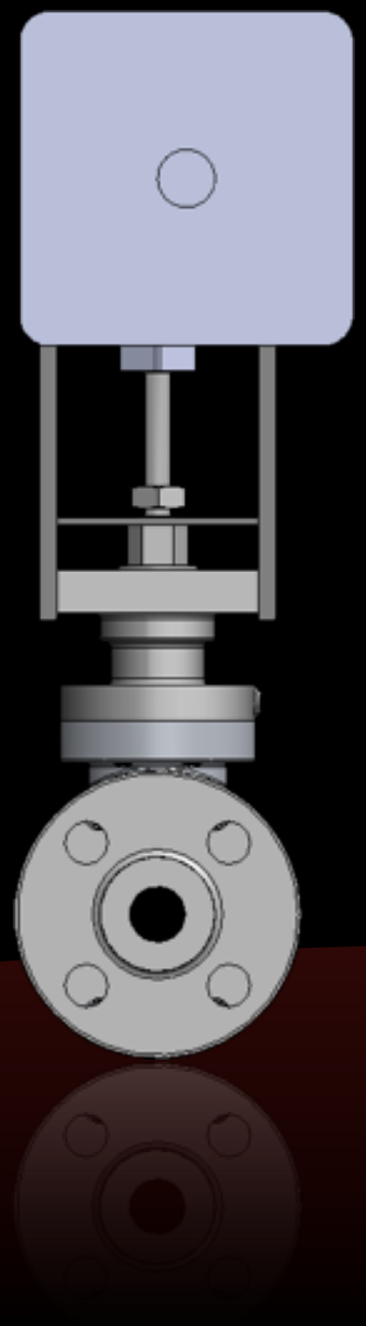


BENT BRACKET

Not accurate

Access to packing adjustments is limited



BENT BRACKET

Not accurate

Access to packing adjustments is limited

No ISO 5211 mounting pad

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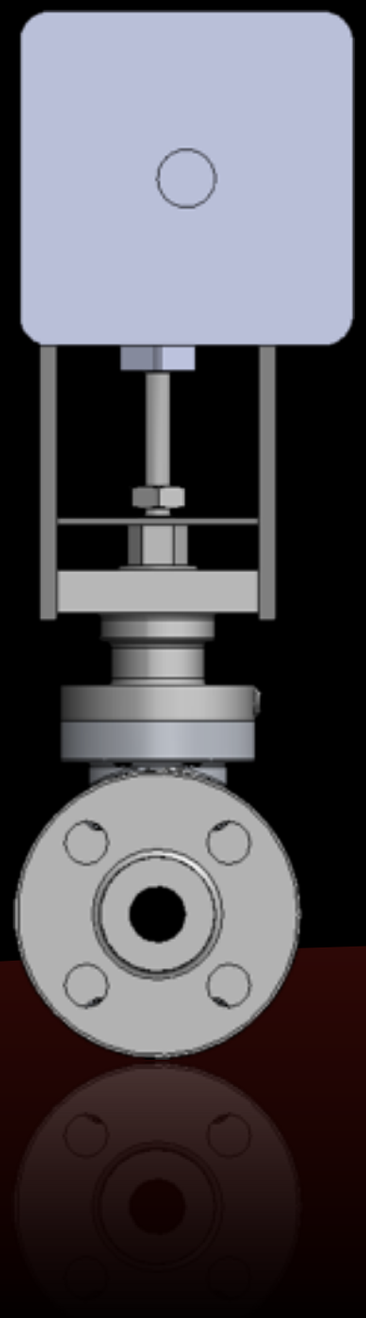
KEYSTONE



BENT BRACKET

Not accurate

Access to packing adjustments is limited

No ISO 5211 mounting pad

Bracket is weak in certain orientations

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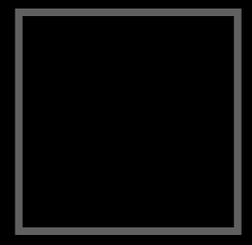

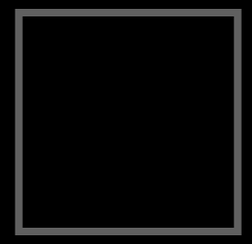

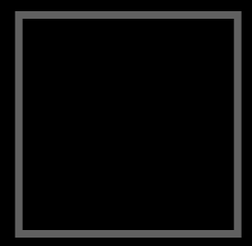

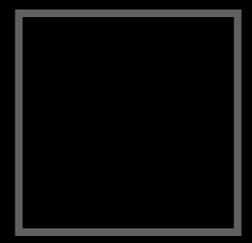

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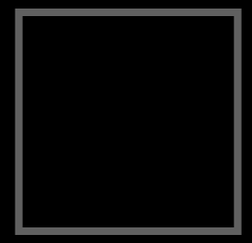

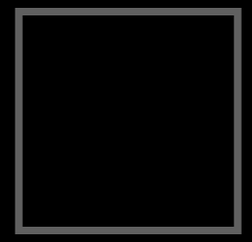

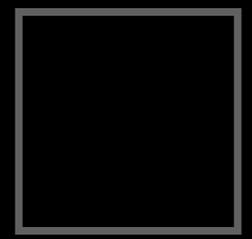

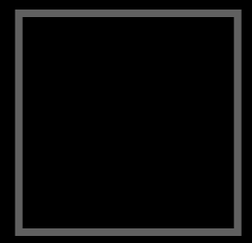

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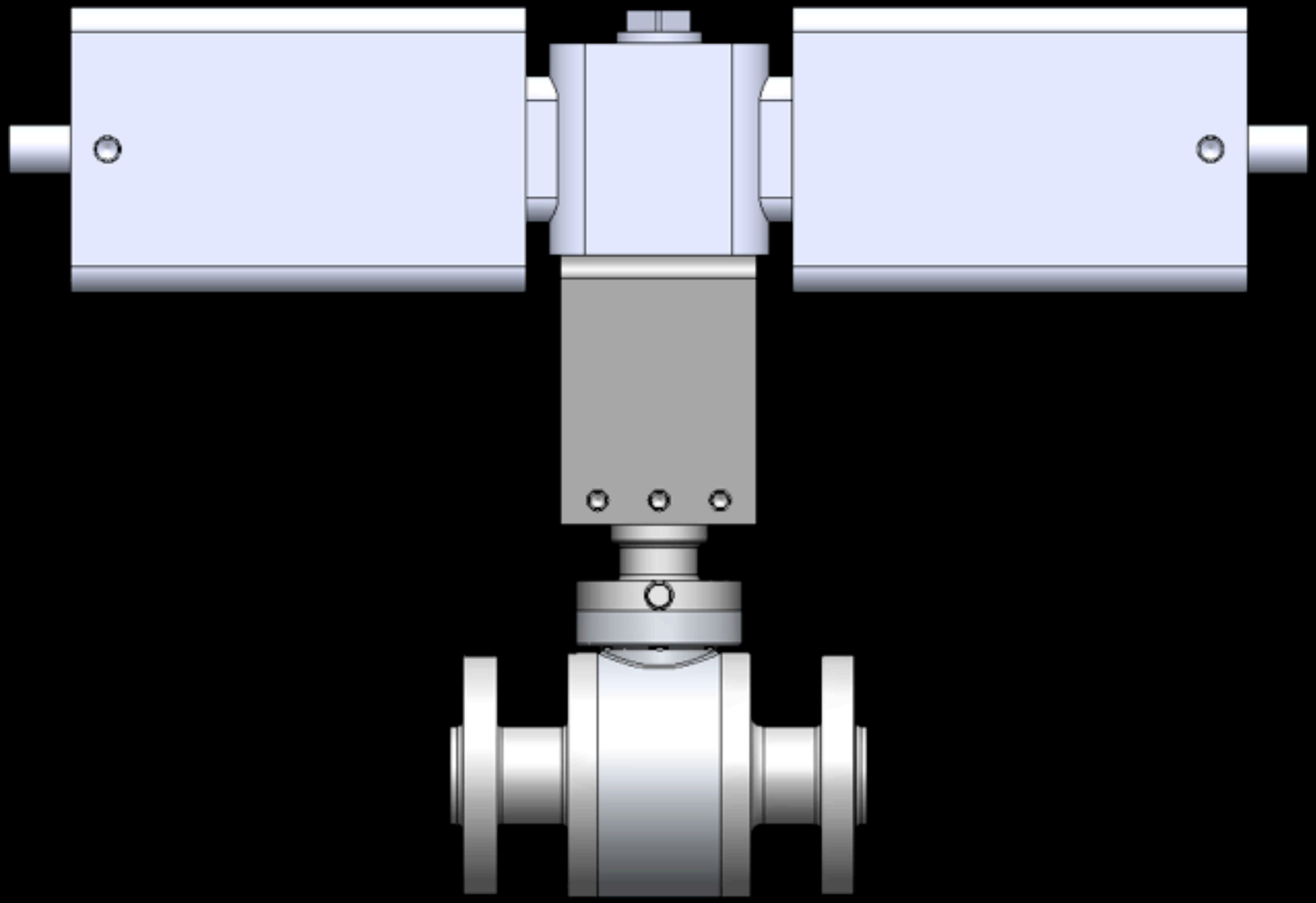

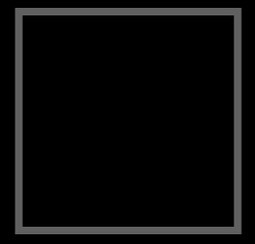

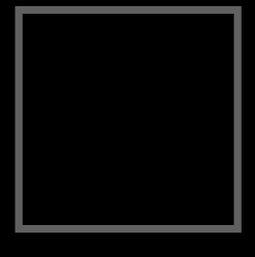

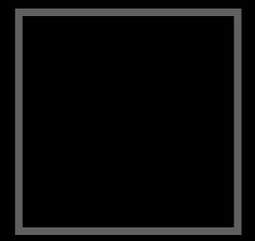

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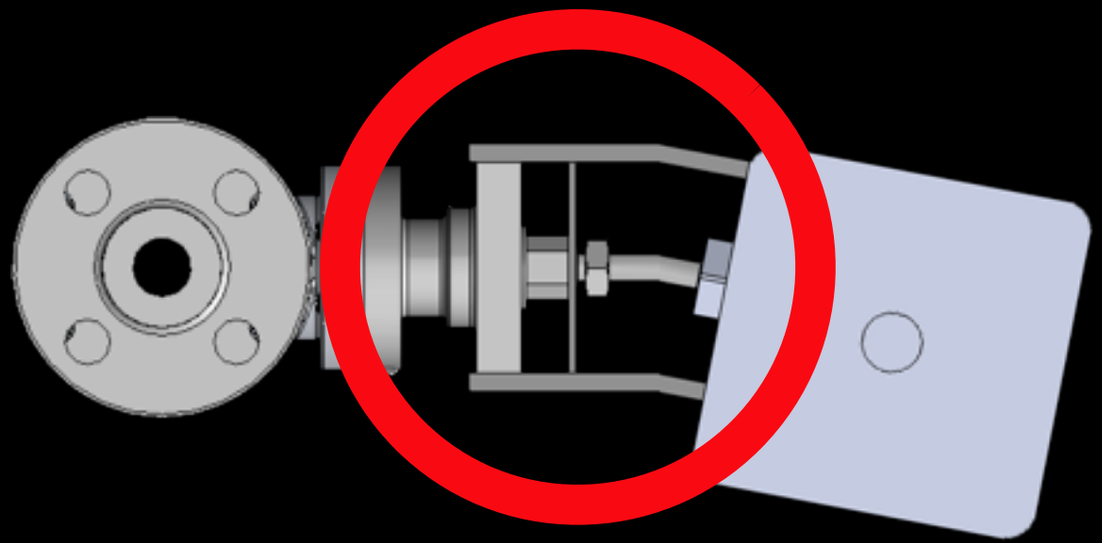

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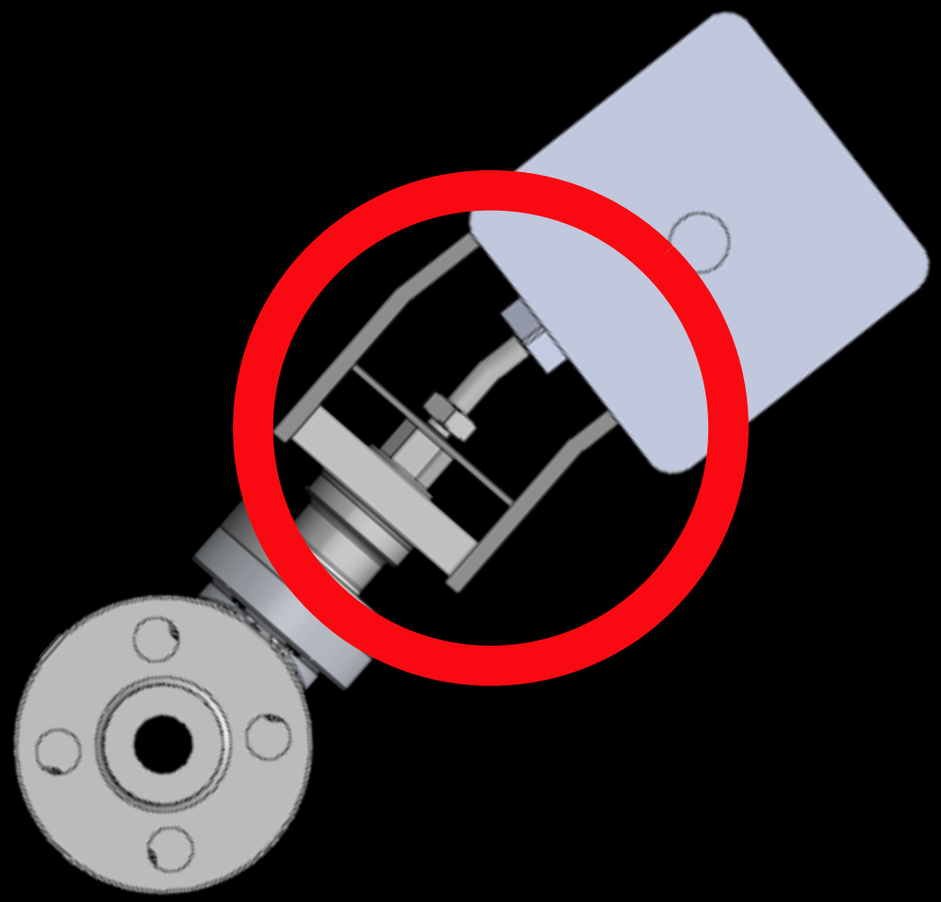

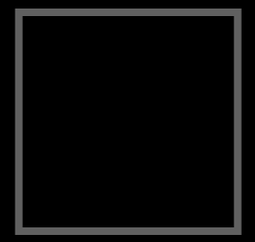

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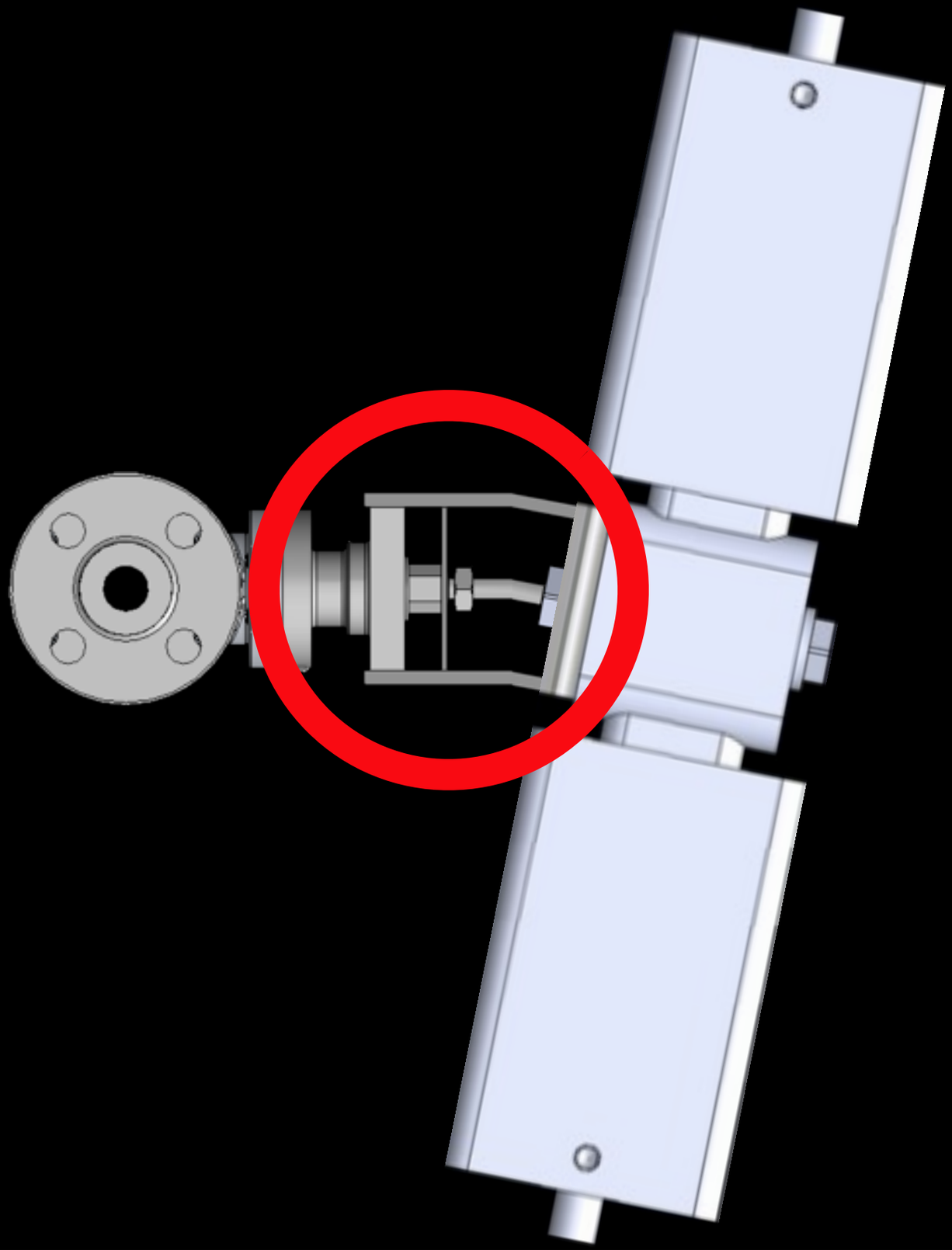

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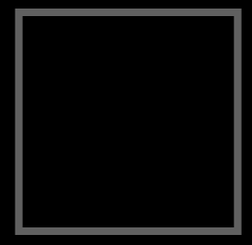
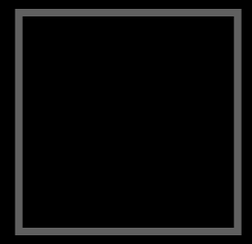
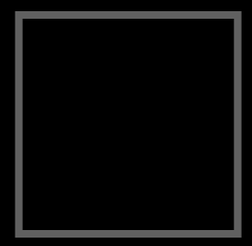
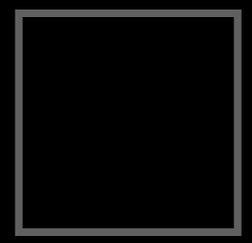
KEYSTONE









AUTOCLAVE

METAL SEATED BALL VALVE

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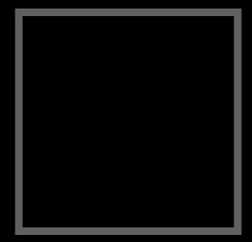
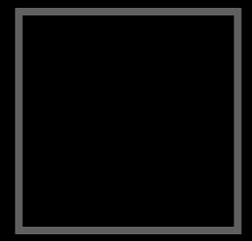
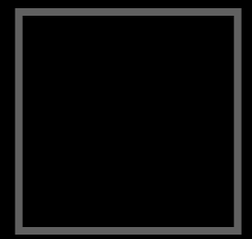
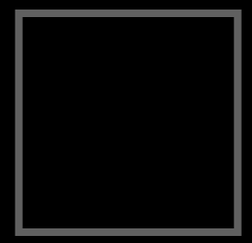
KEYSTONE

TRIPOD MOUNT









AUTOCLAVE
METAL SEATED BALL VALVE

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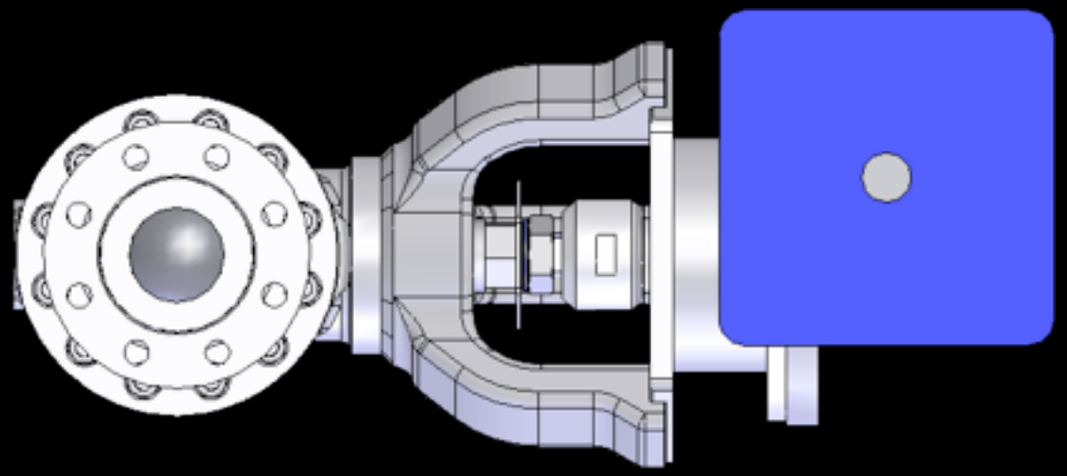
KEYSTONE

TRIPOD MOUNT



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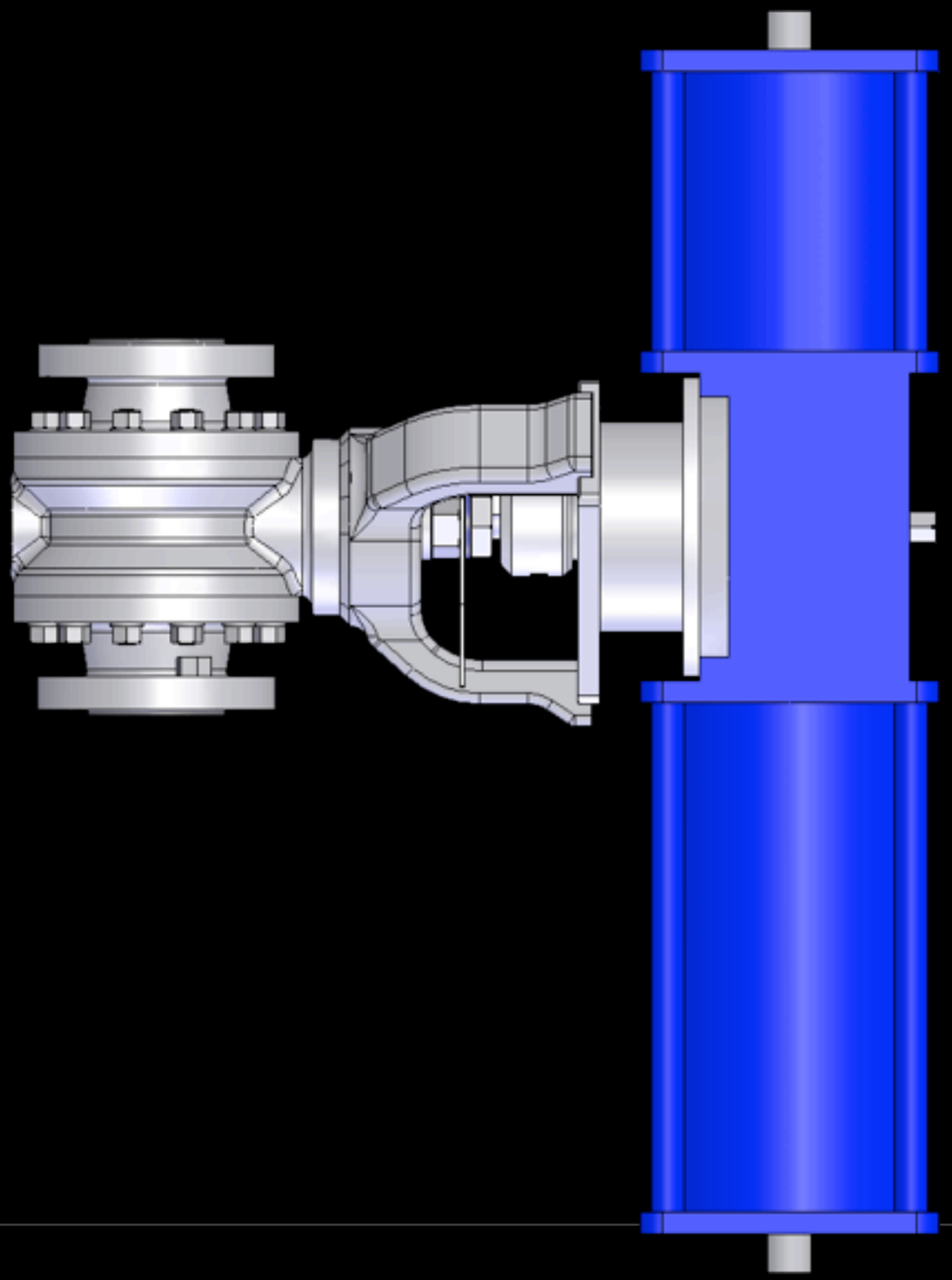
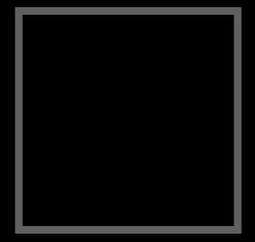
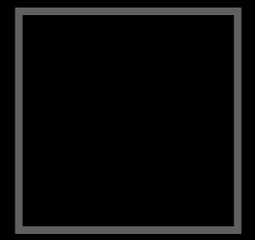
KEYSTONE

TRIPOD MOUNT







AUTOCLAVE

METAL SEATED BALL VALVE

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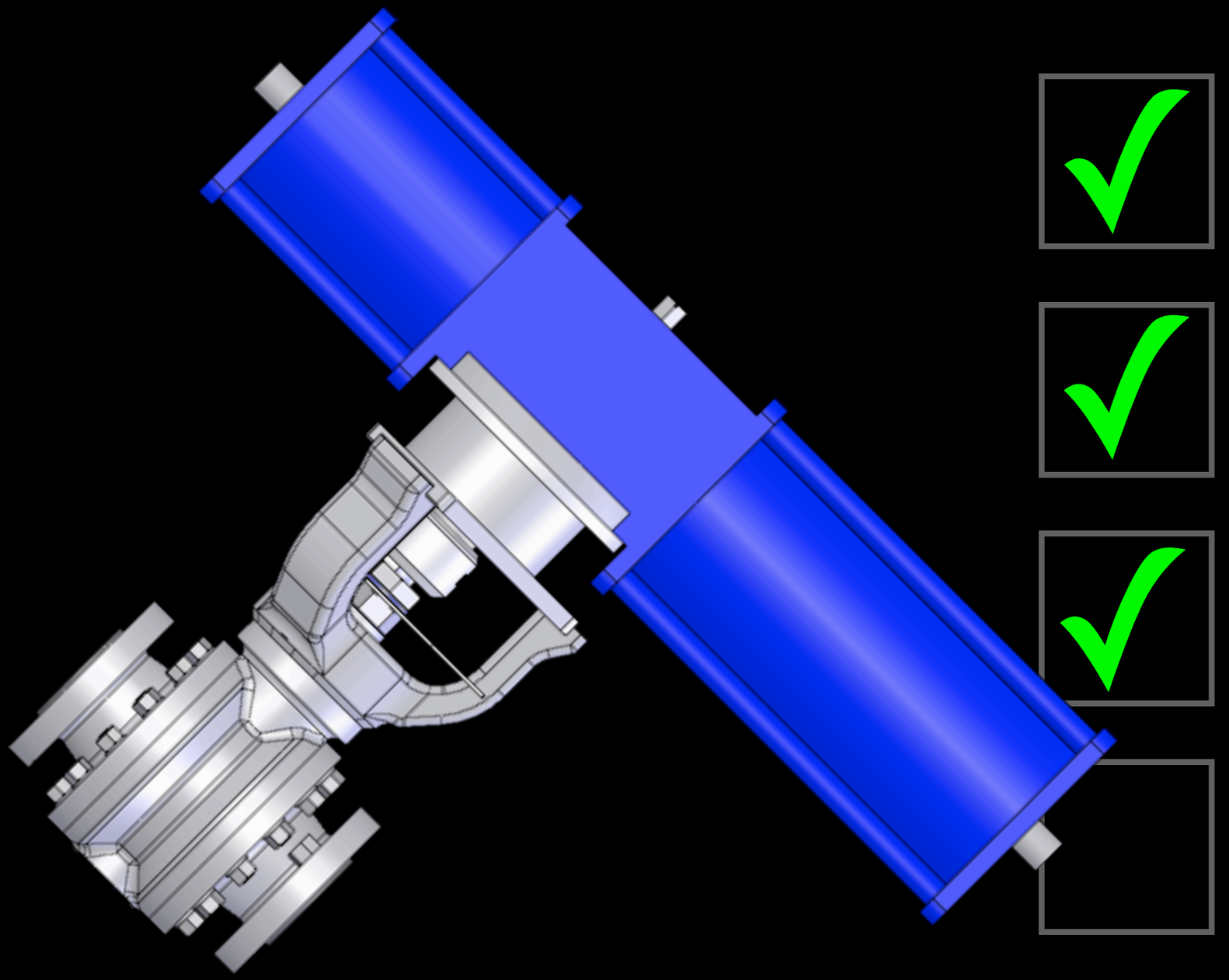
KEYSTONE

TRIPOD MOUNT



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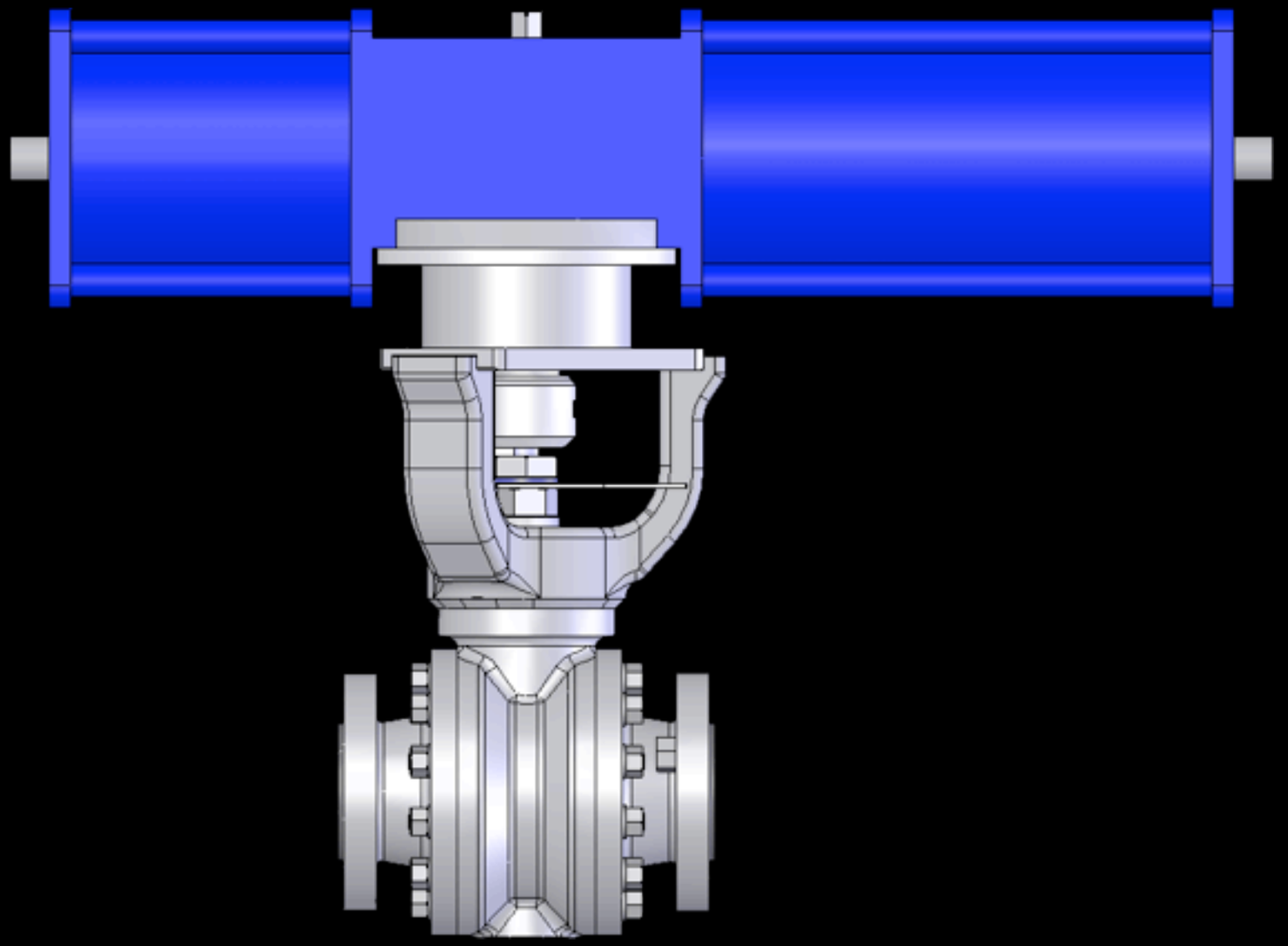
KEYSTONE

TRIPOD MOUNT



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KEYSTONE

TRIPOD MOUNT

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KEYSTONE

AUTOCLAVE

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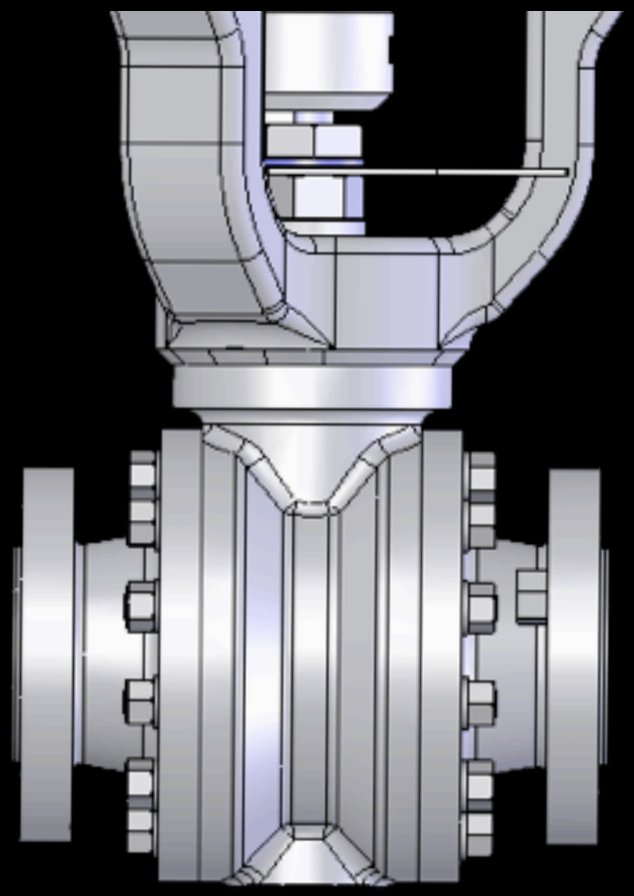
KEYSTONE

TRIPOD MOUNT EVOLUTION



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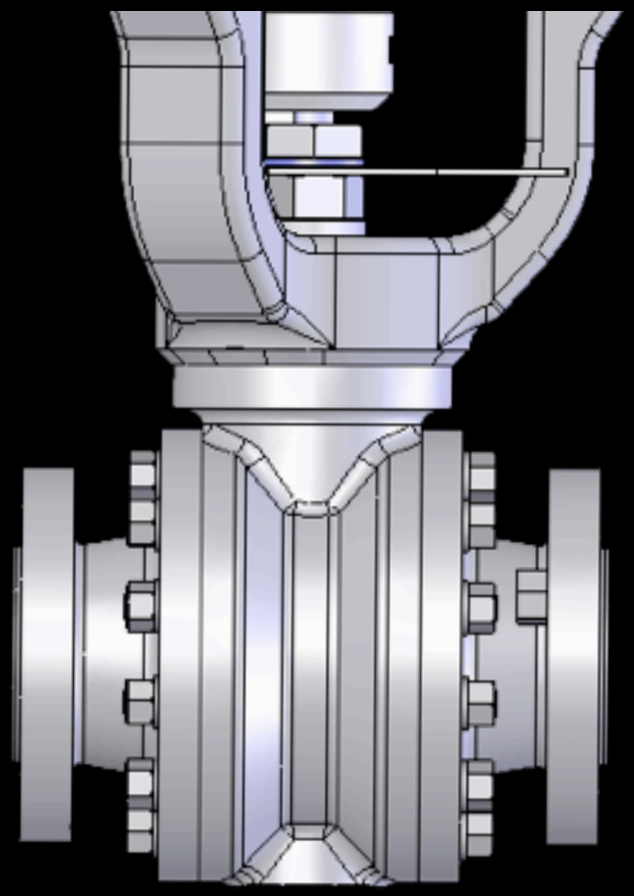
KEYSTONE

TRIPOD MOUNT EVOLUTION



Original design was a cast tripod bracket

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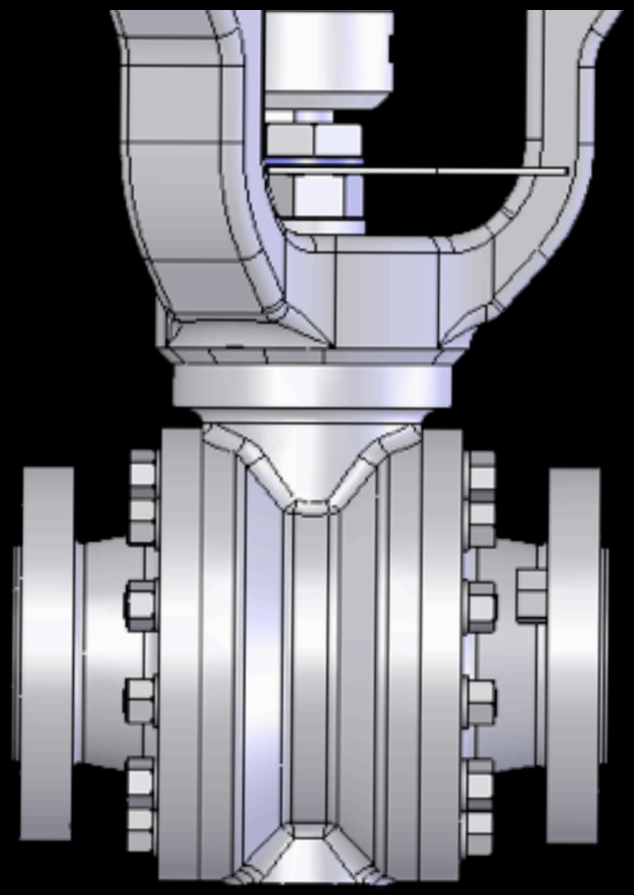
TRIPOD MOUNT EVOLUTION



Original design was a cast tripod bracket

Concerns with weight and material cost

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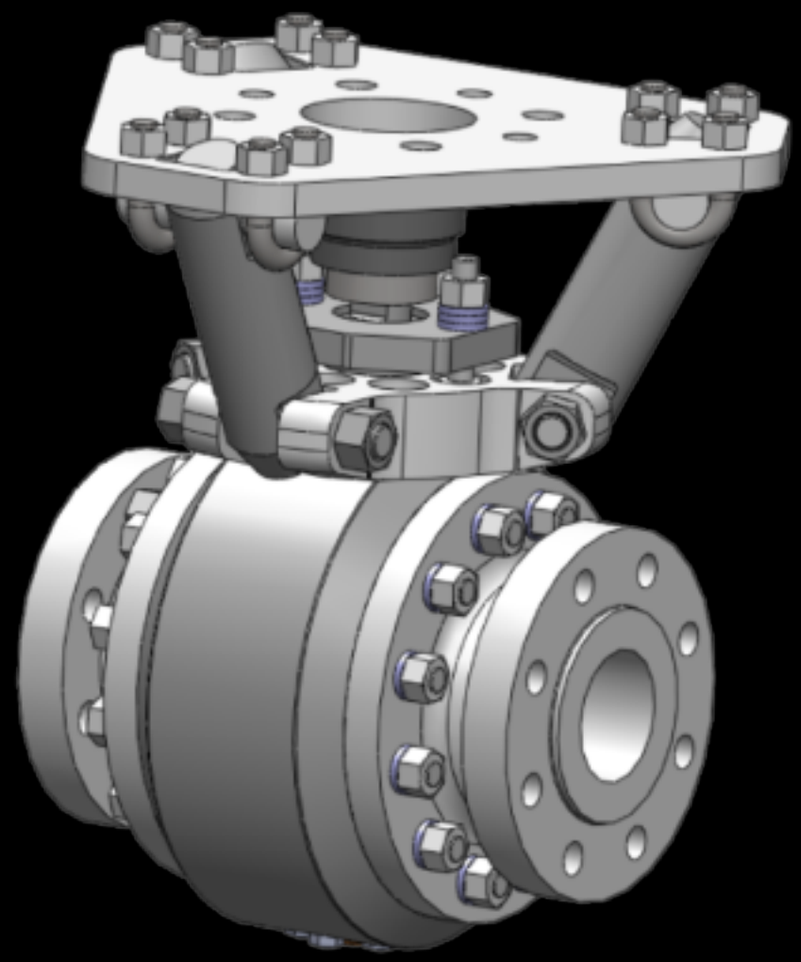
TRIPOD MOUNT EVOLUTION



AUTOCLAVE

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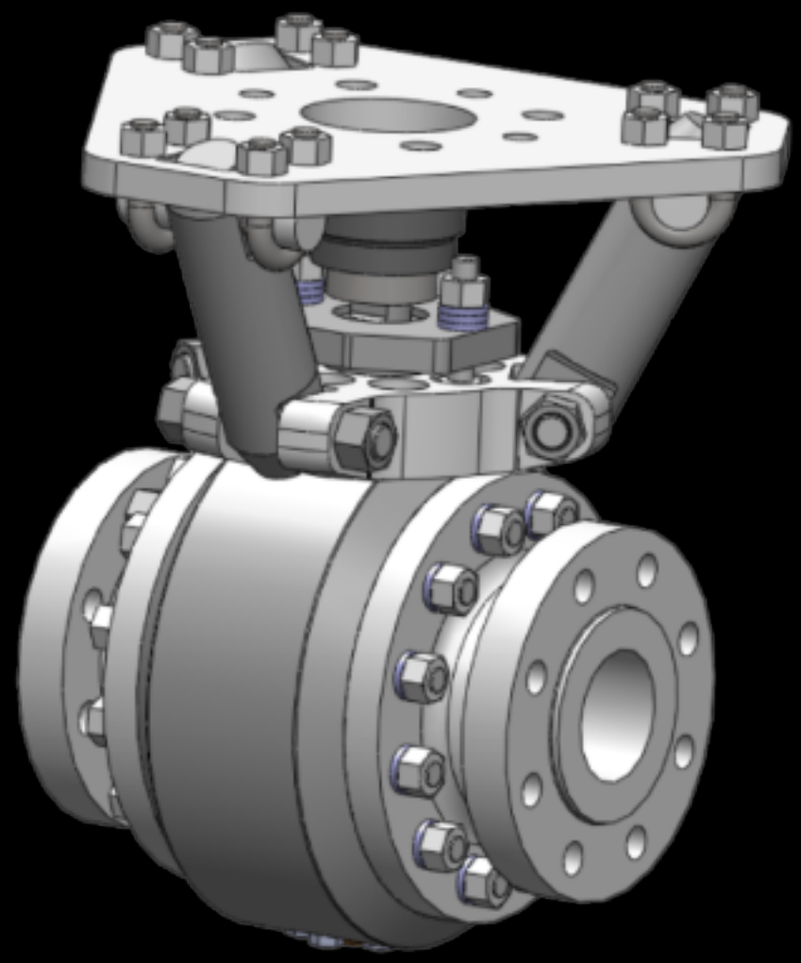
KEYSTONE

TRIPOD MOUNT EVOLUTION

Fabricated tripod design



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KEYSTONE

FABRICATED TRIPOD MOUNT

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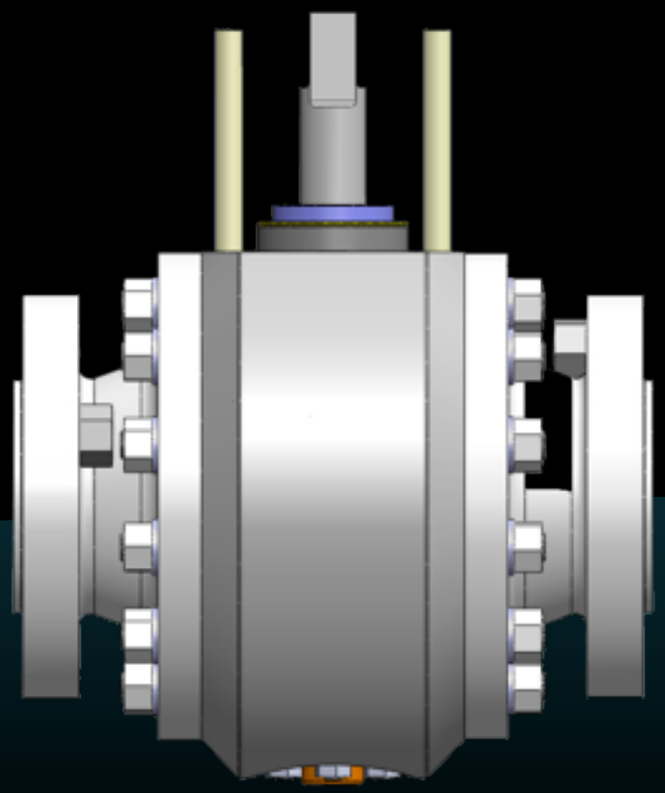
KEYSTONE

FABRICATED TRIPOD MOUNT



Assembled easily in components

AUTOCLAVE

METAL SEATED BALL VALVE

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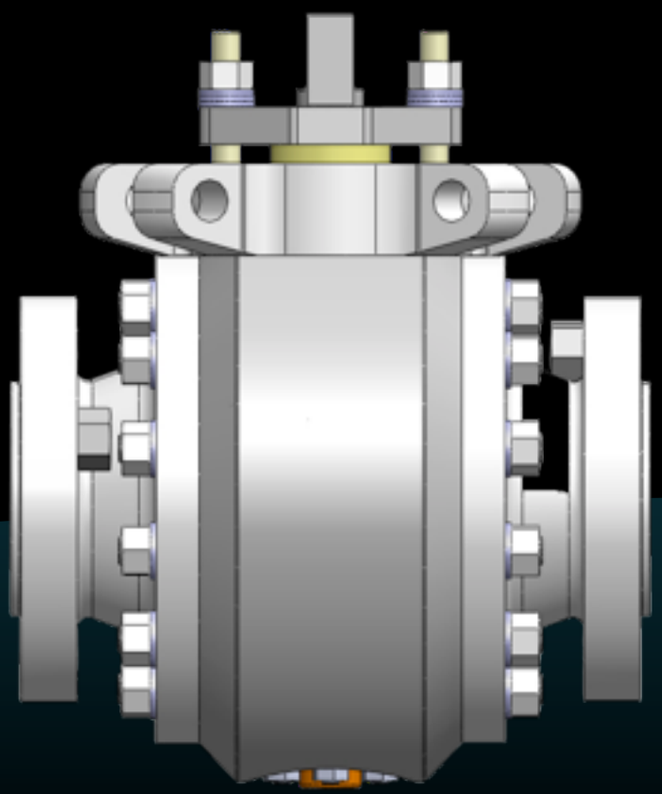
KEYSTONE

FABRICATED TRIPOD MOUNT



Assembled easily in components

AUTOCLAVE

METAL SEATED BALL VALVE

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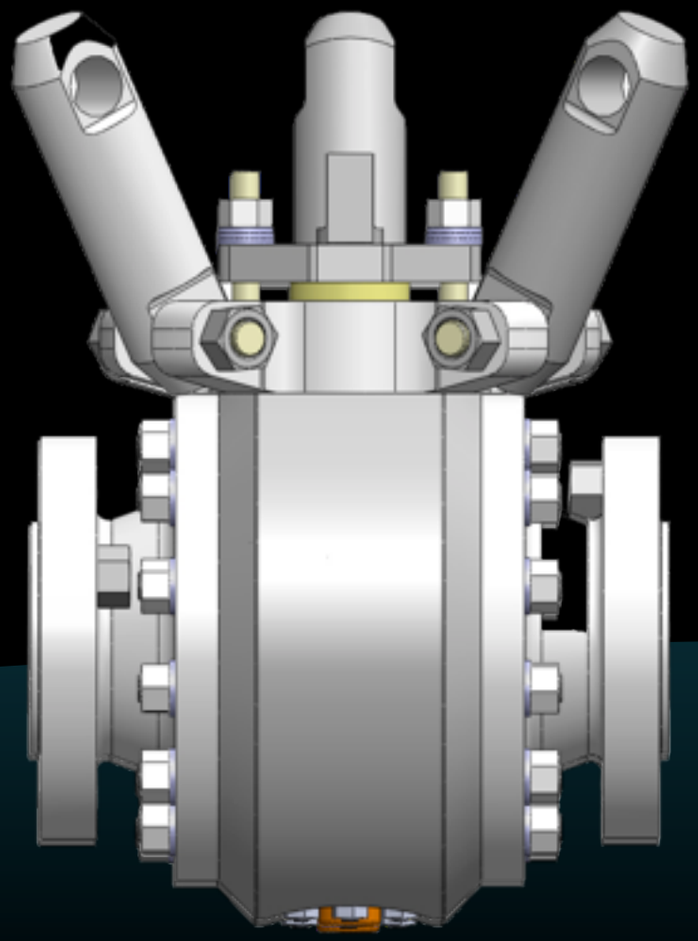
KEYSTONE

FABRICATED TRIPOD MOUNT



Assembled easily in components

AUTOCLAVE

METAL SEATED BALL VALVE

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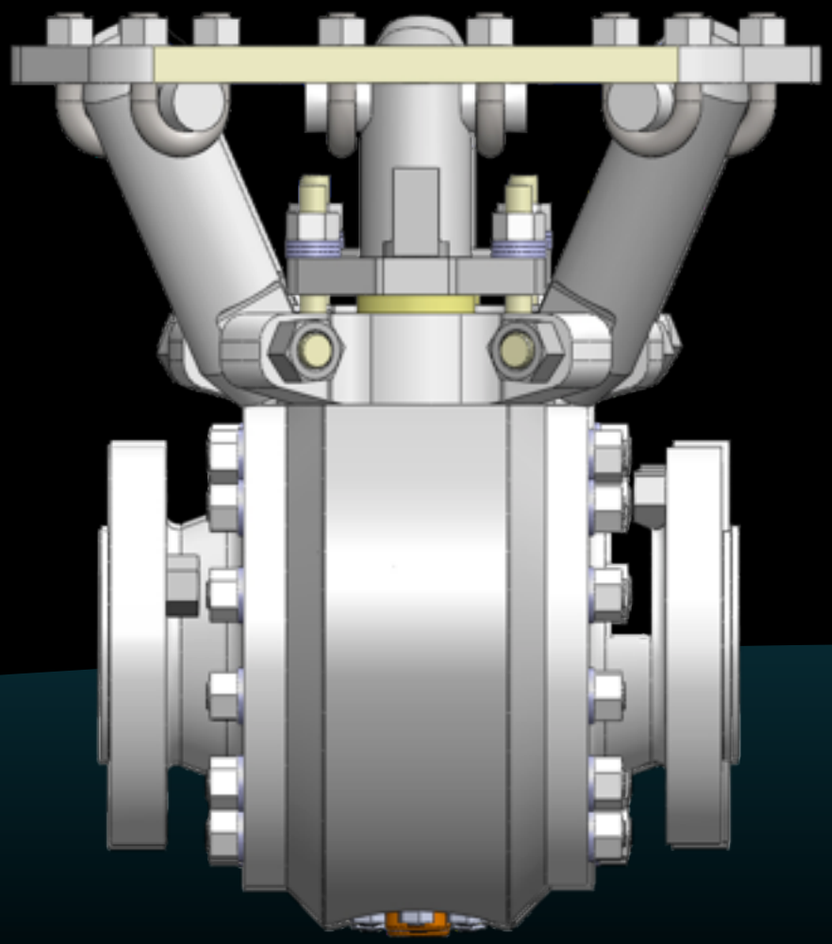
KEYSTONE

FABRICATED TRIPOD MOUNT



Assembled easily in components

AUTOCLAVE

METAL SEATED BALL VALVE

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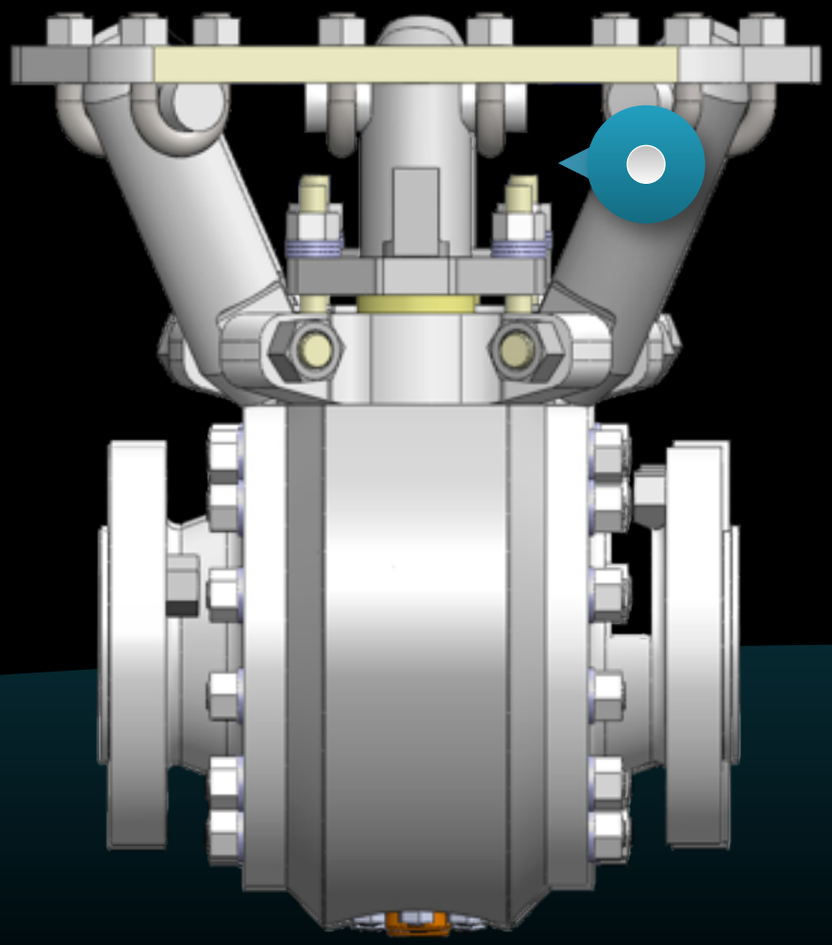
KEYSTONE

FABRICATED TRIPOD MOUNT



Assembled easily in components

Open between the prongs

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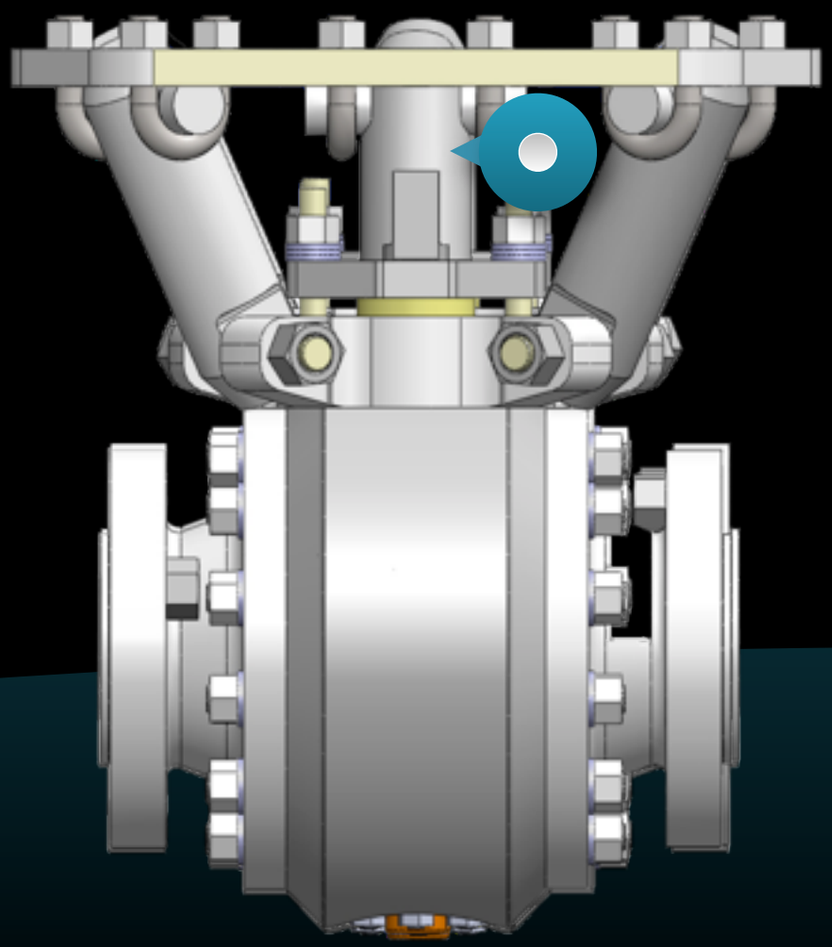
KEYSTONE

FABRICATED TRIPOD MOUNT



Assembled easily in components

Open between the prongs

Stem flats fully visible

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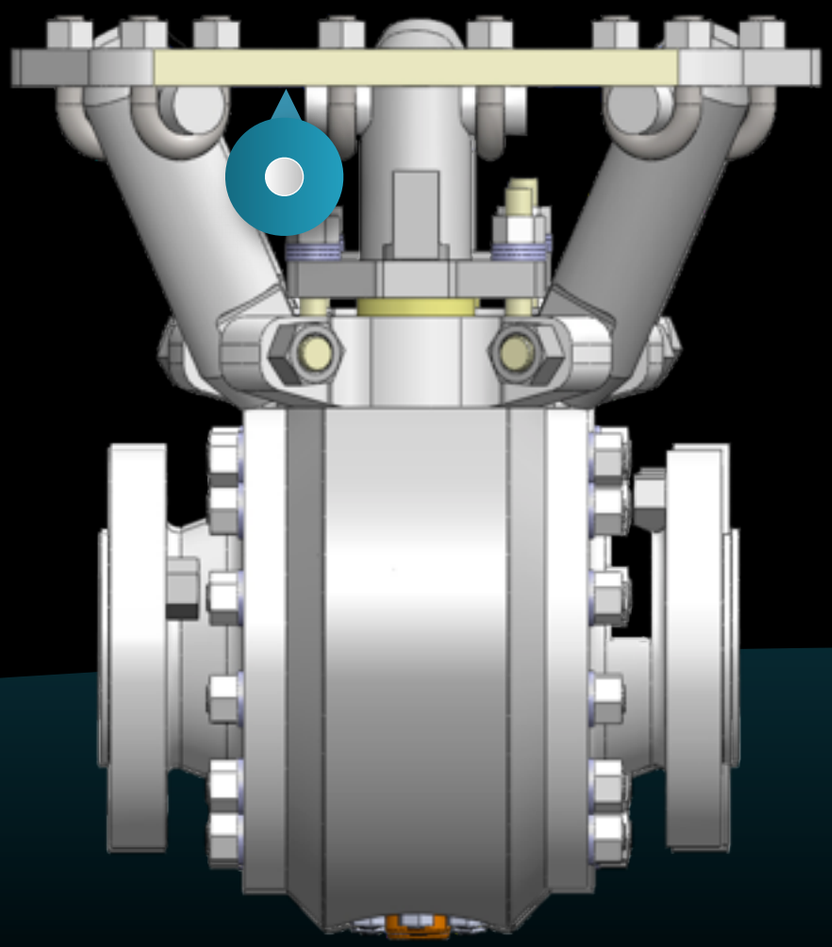
KEYSTONE

FABRICATED TRIPOD MOUNT



Assembled easily in components

Open between the prongs

Stem flats fully visible

Perfectly flat - will not rock

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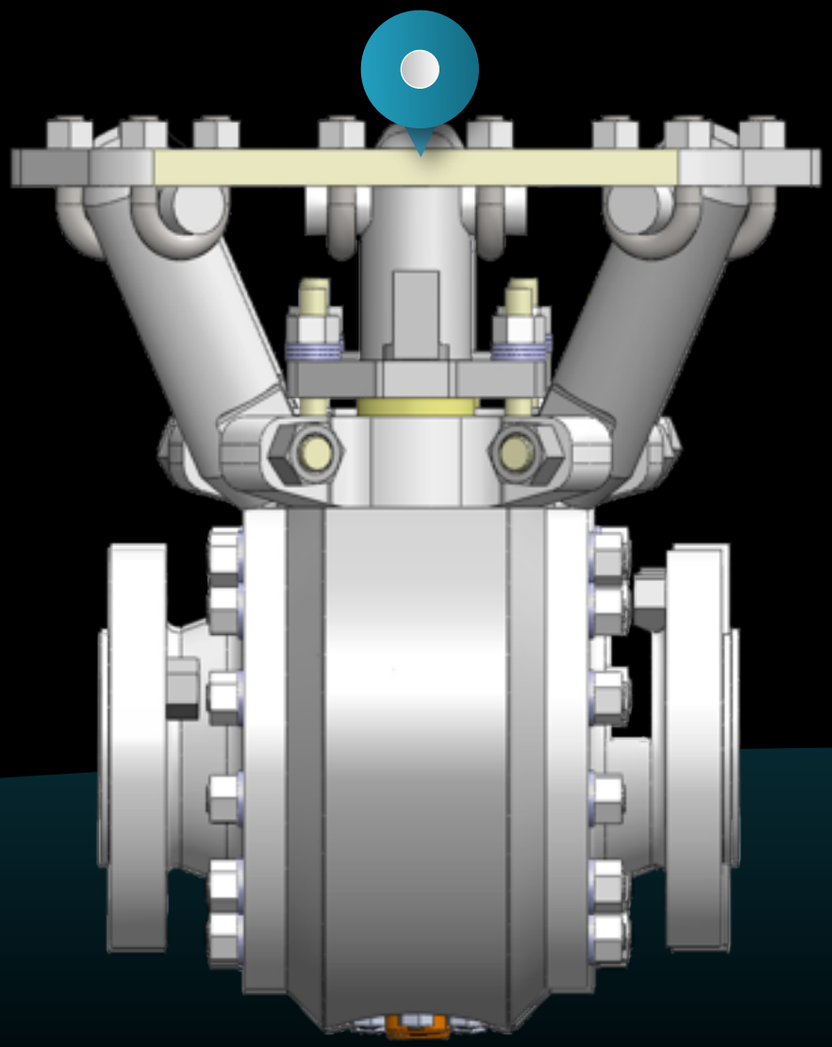
KEYSTONE

FABRICATED TRIPOD MOUNT



- Assembled easily in components
- Open between the prongs
- Stem flats fully visible
- Perfectly flat - will not rock
- Plate is centered between prongs

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KEYSTONE

AUTOCLAVE

METAL SEATED BALL VALVE

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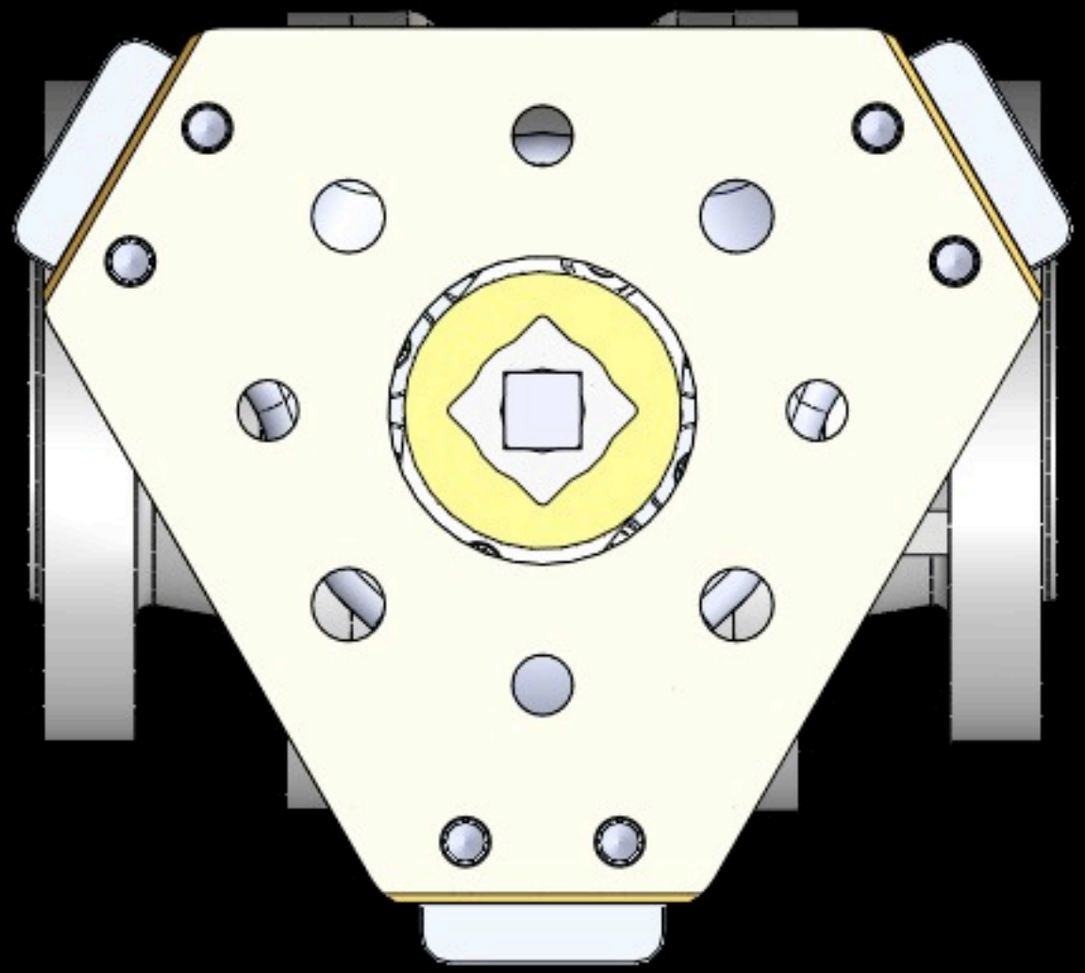
KEYSTONE



AUTOCLAVE

METAL SEATED BALL VALVE

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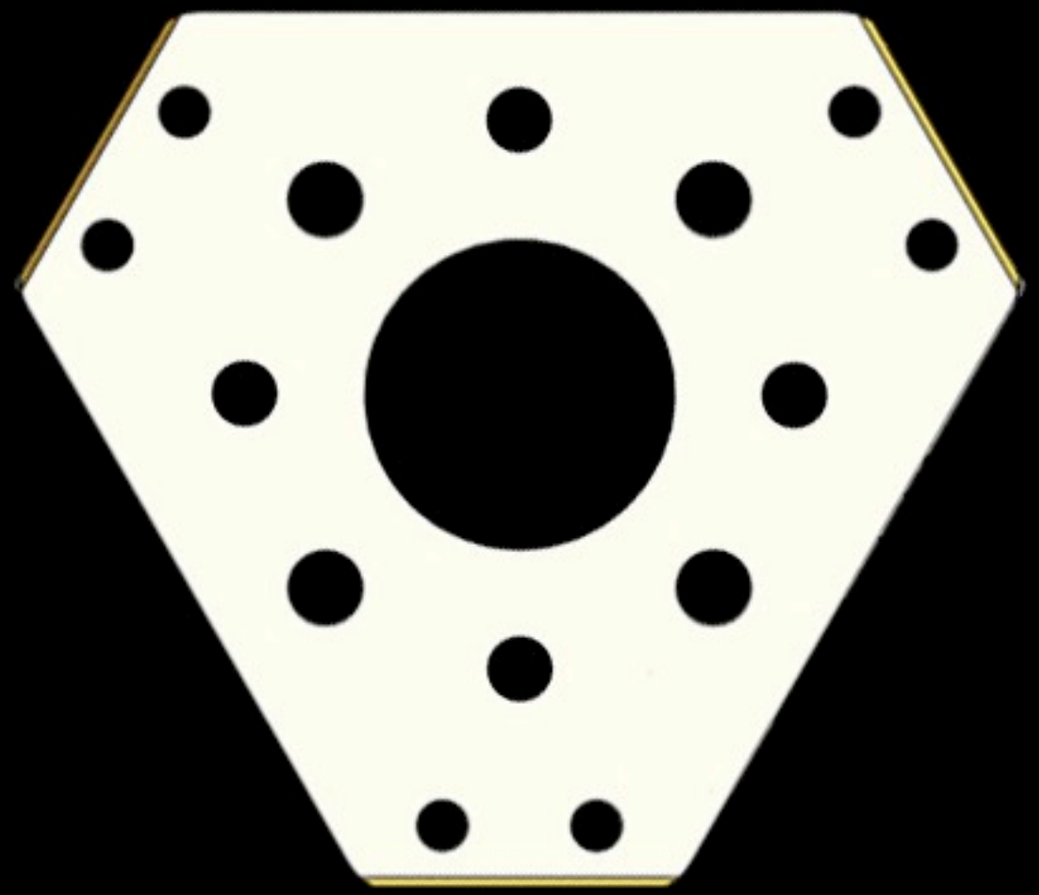
KEYSTONE



AUTOCLAVE

METAL SEATED BALL VALVE

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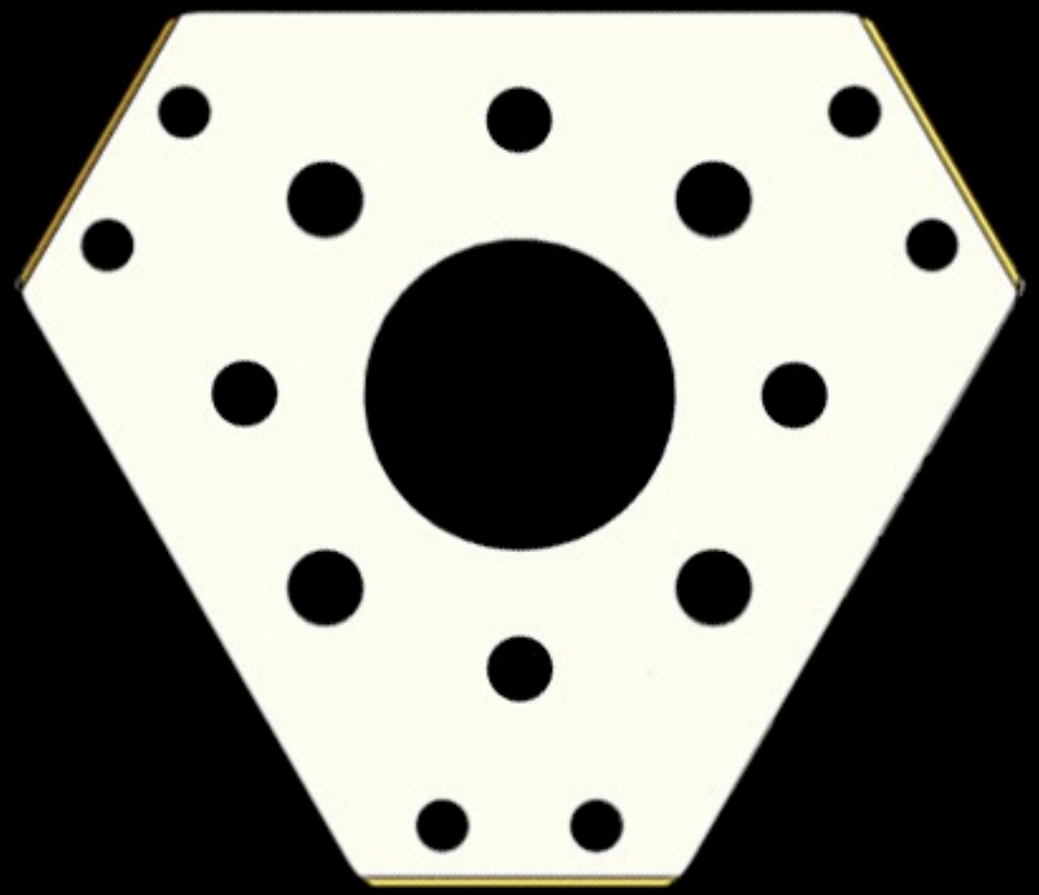
KEYSTONE



AUTOCLAVE

METAL SEATED BALL VALVE

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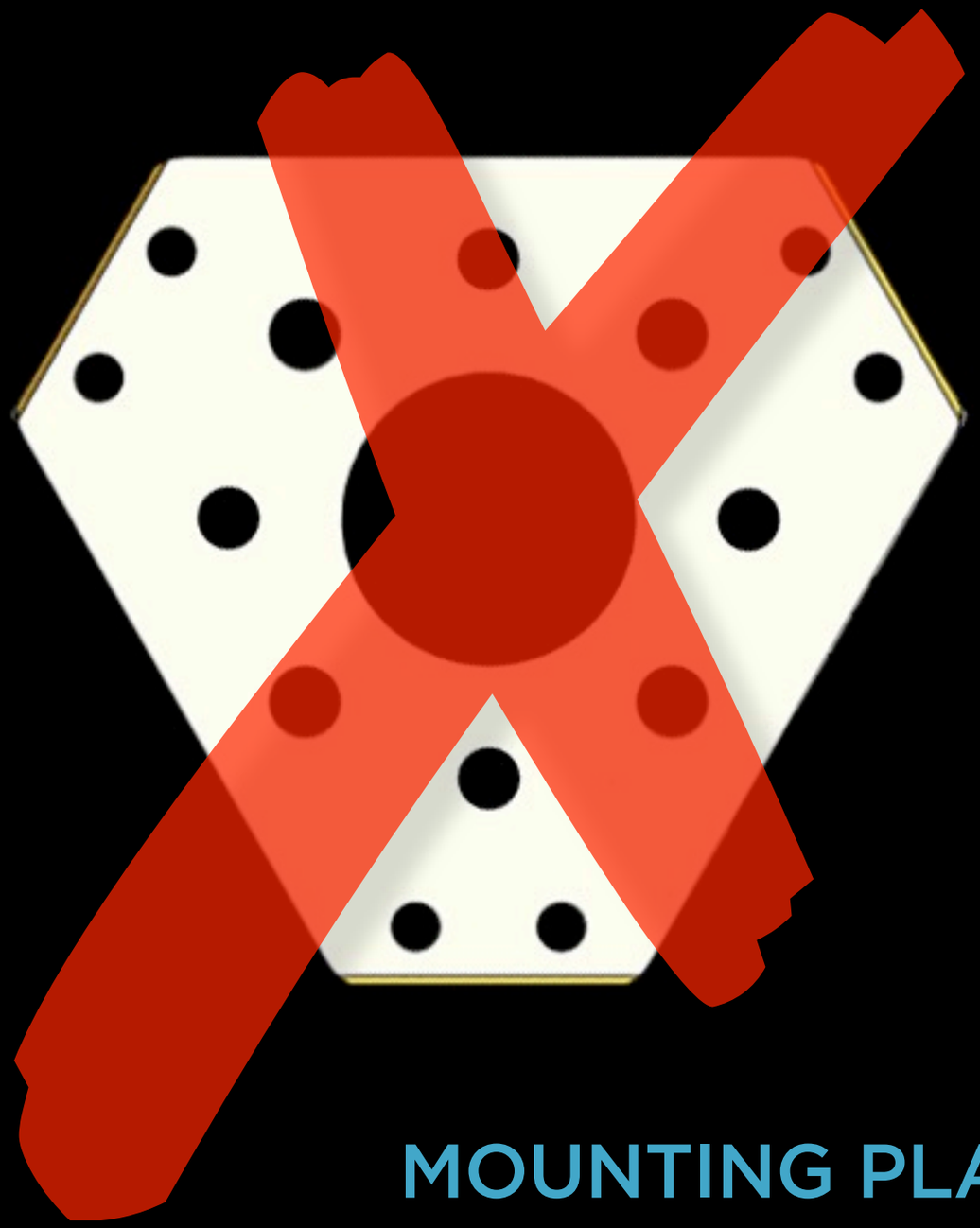
KEYSTONE



MOUNTING PLATE ALIGNMENT

AUTOCLAVE
METAL SEATED BALL VALVE

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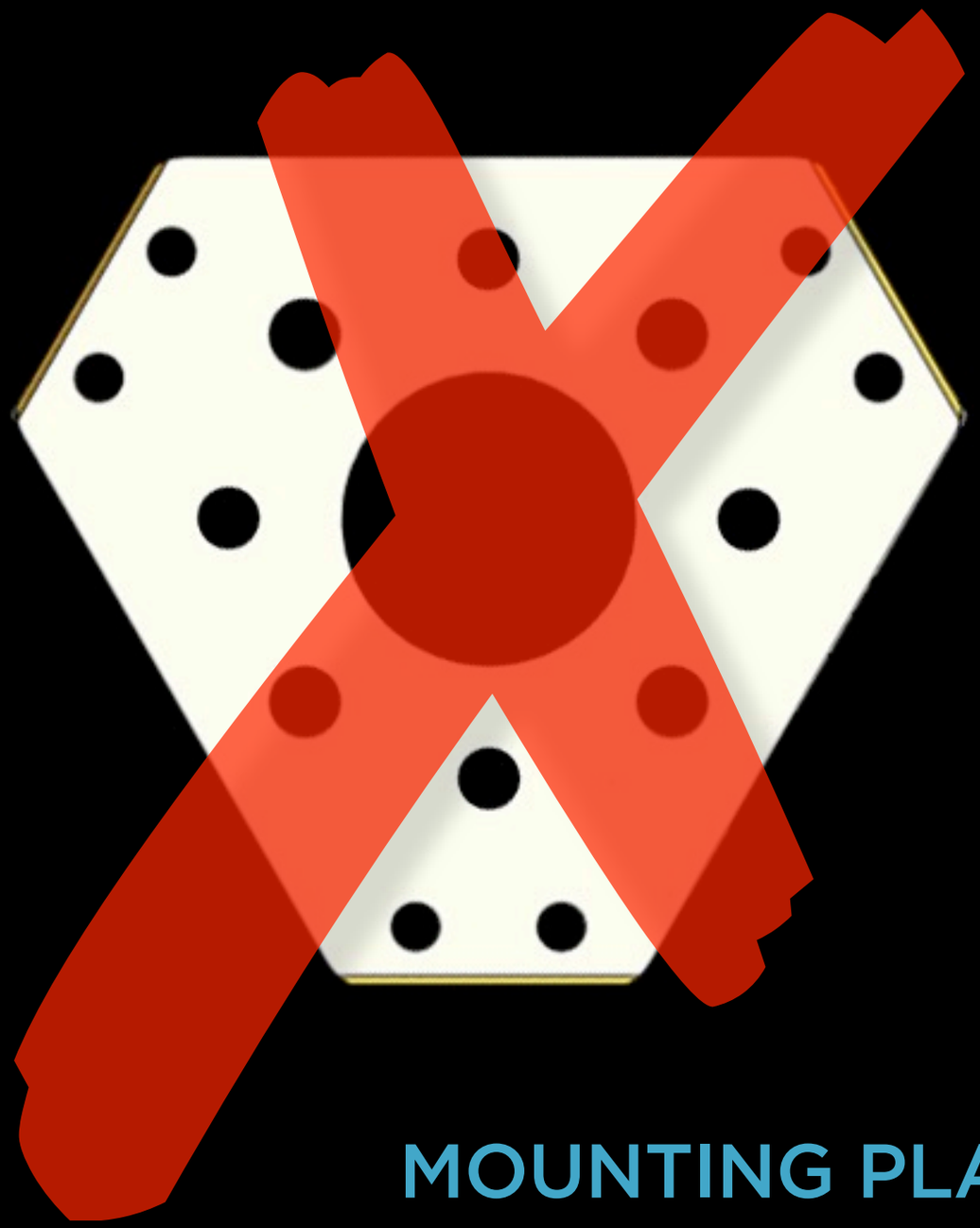
KEYSTONE



MOUNTING PLATE ALIGNMENT

AUTOCLAVE
METAL SEATED BALL VALVE

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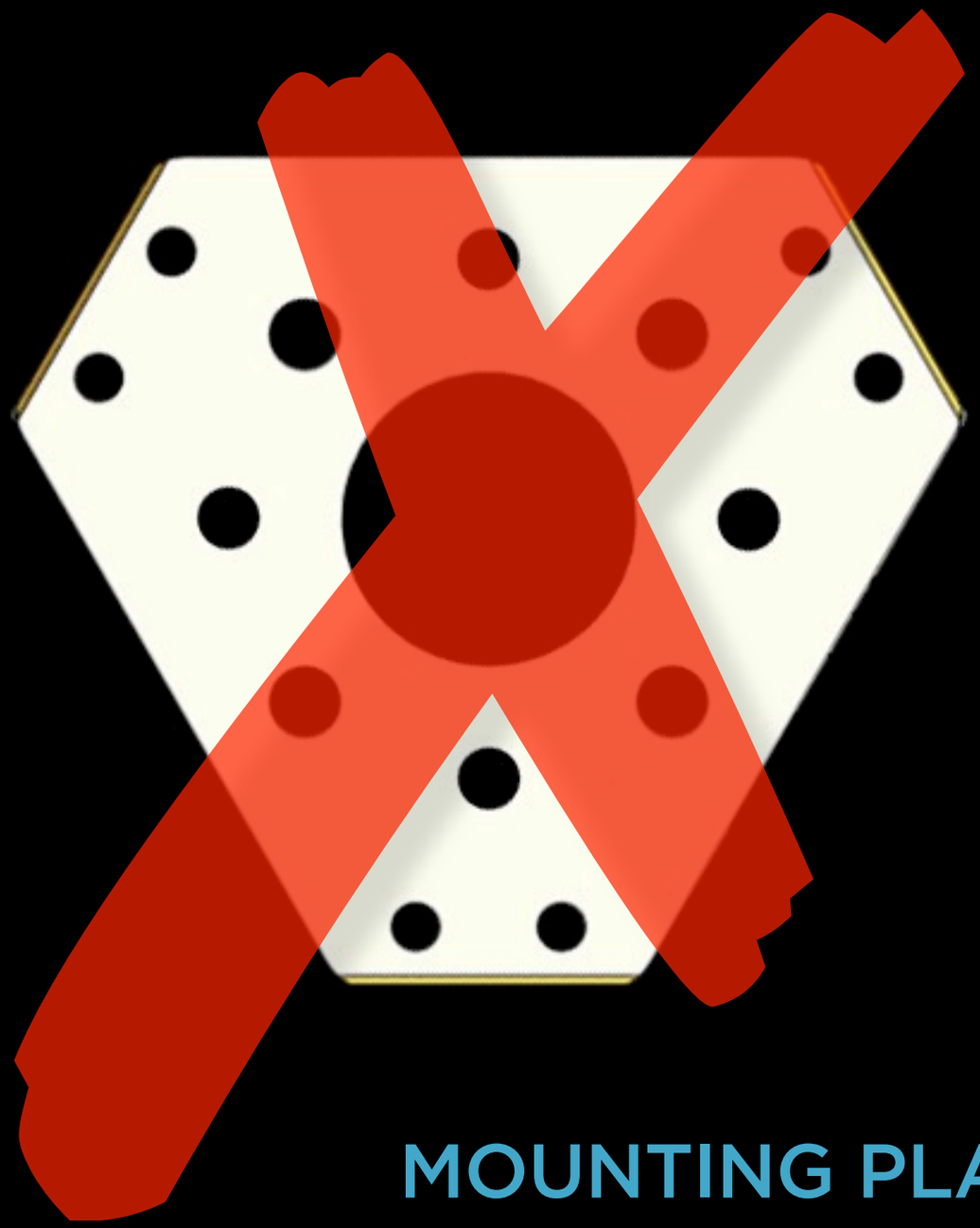
KEYSTONE



MOUNTING PLATE ALIGNMENT

AUTOCLAVE
METAL SEATED BALL VALVE

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KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	Scalloped Seats
SEAT LOADING	Belleville Washer	Helicoflex / Wavo
SEAT DESIGN	Standard	Scraper
STEM SLOT	Standard	Scalloped
STEM SEALING	Single Packing	Dual Packing

COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	Scalloped Seats
SEAT LOADING	Belleville Washer	Helicoflex / Wavo
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STEM SLOT	Standard	Scalloped
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COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	Scalloped Seats

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KEYSTONE

COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	Scalloped Seats
SEAT LOADING	Belleville Washer	Helicoflex / Wavo

COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	C-Ring
SEAT LOADING	Belleville Washer	

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KEYSTONE

STANDARD SEATS

AUTOCLAVE

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KEYSTONE

STANDARD SEATS

Material builds up between the seats and the spring

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KEYSTONE

AUTOCLAVE

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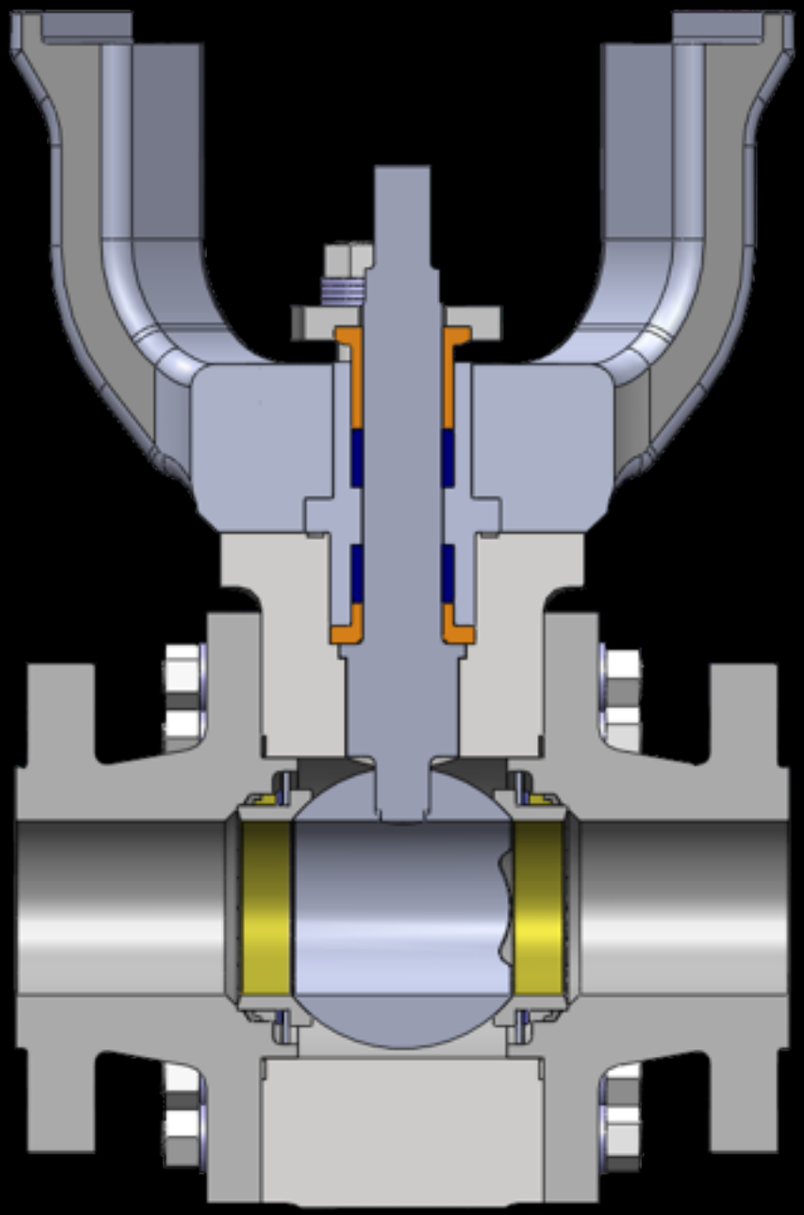
KEYSTONE

SEAL AND SPRING EVOLUTION



OLD DESIGN

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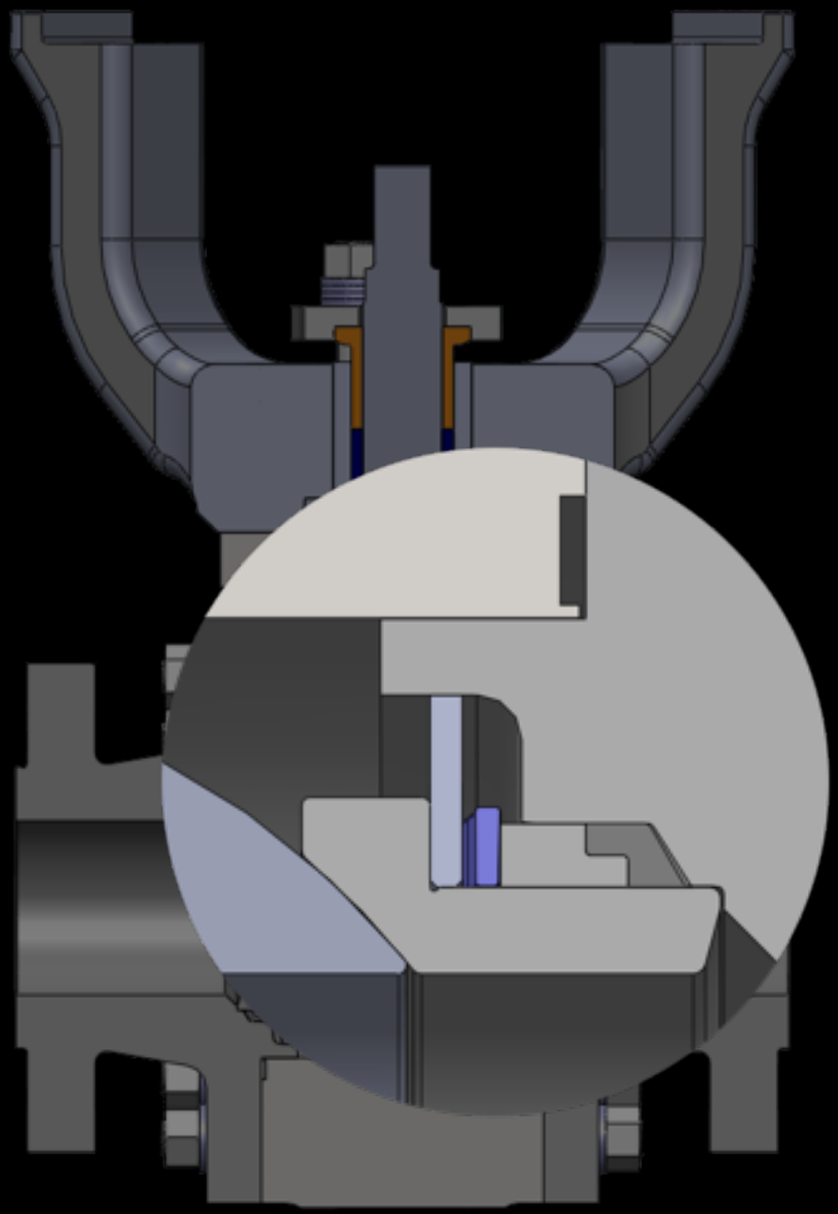
KEYSTONE

SEAL AND SPRING EVOLUTION



OLD DESIGN

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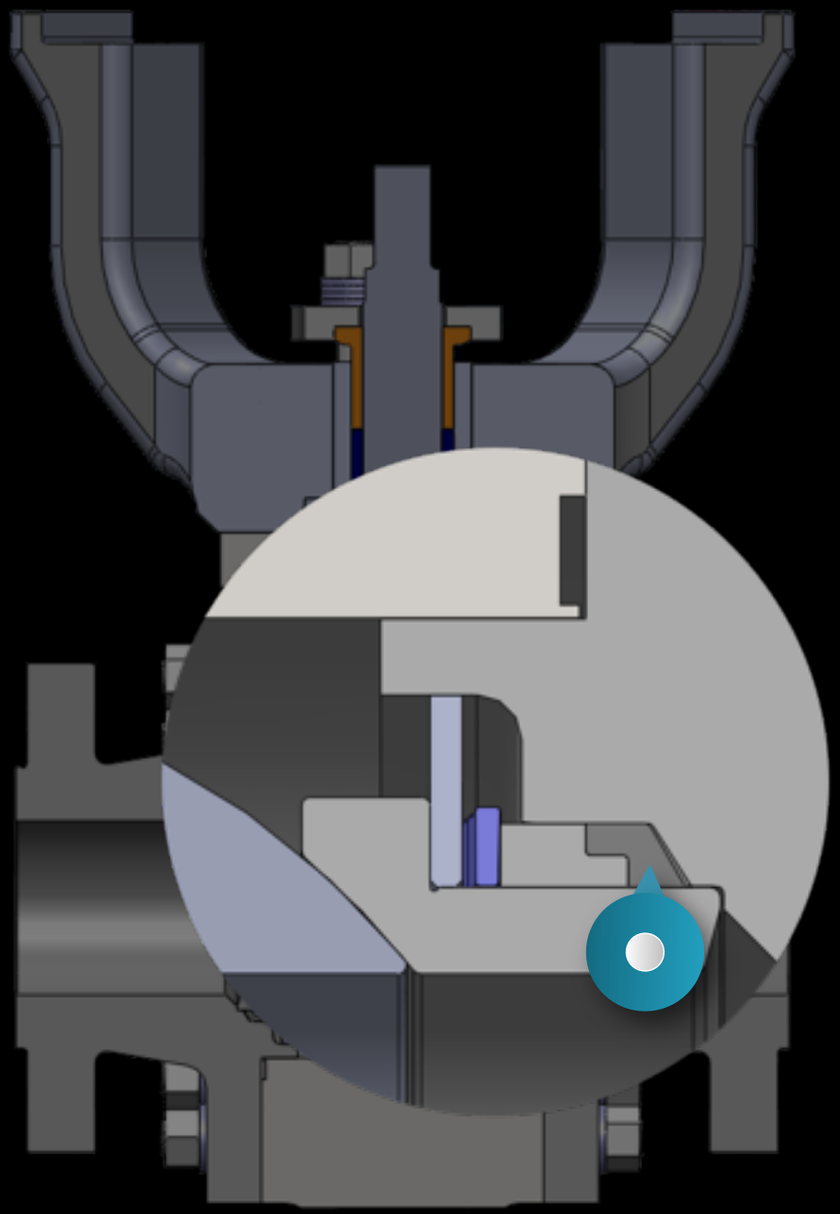
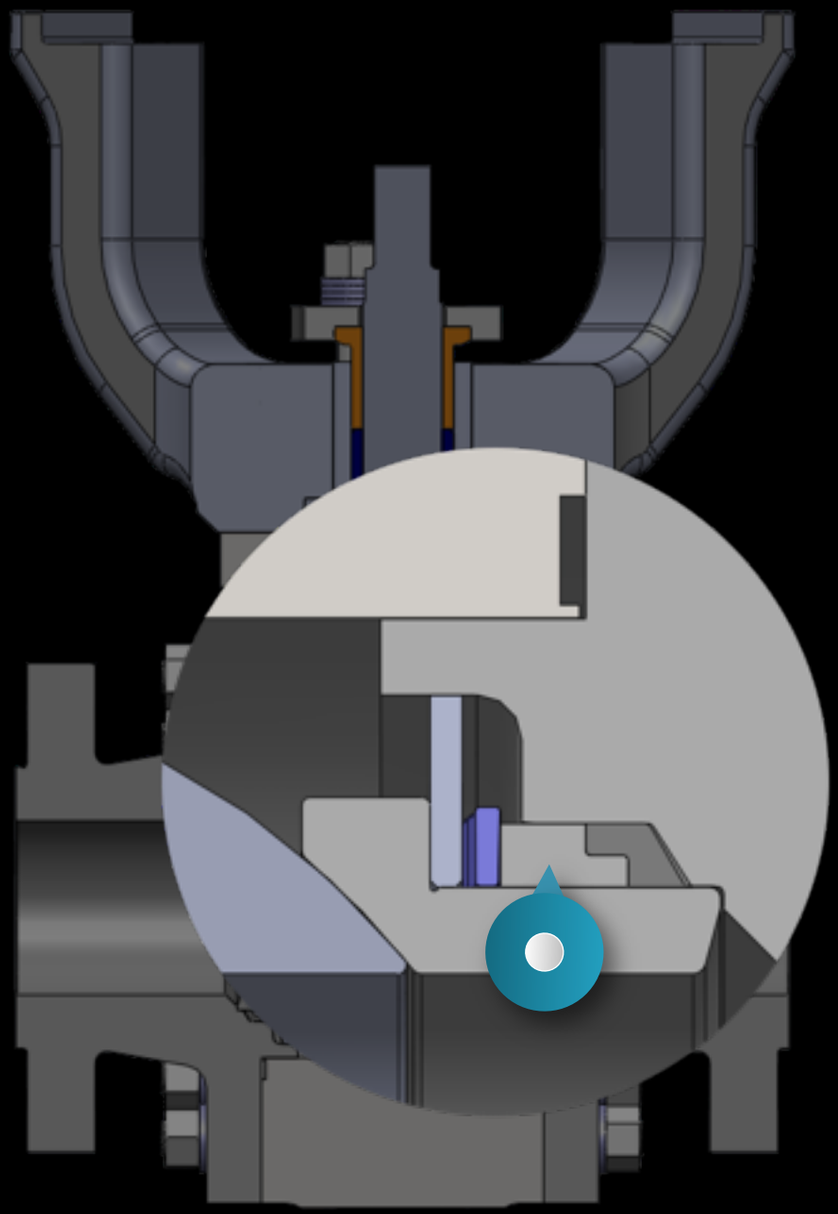
SEAL AND SPRING EVOLUTION



OLD DESIGN

Wedge seal

SEAL AND SPRING EVOLUTION



OLD DESIGN

Wedge seal

Compression ring

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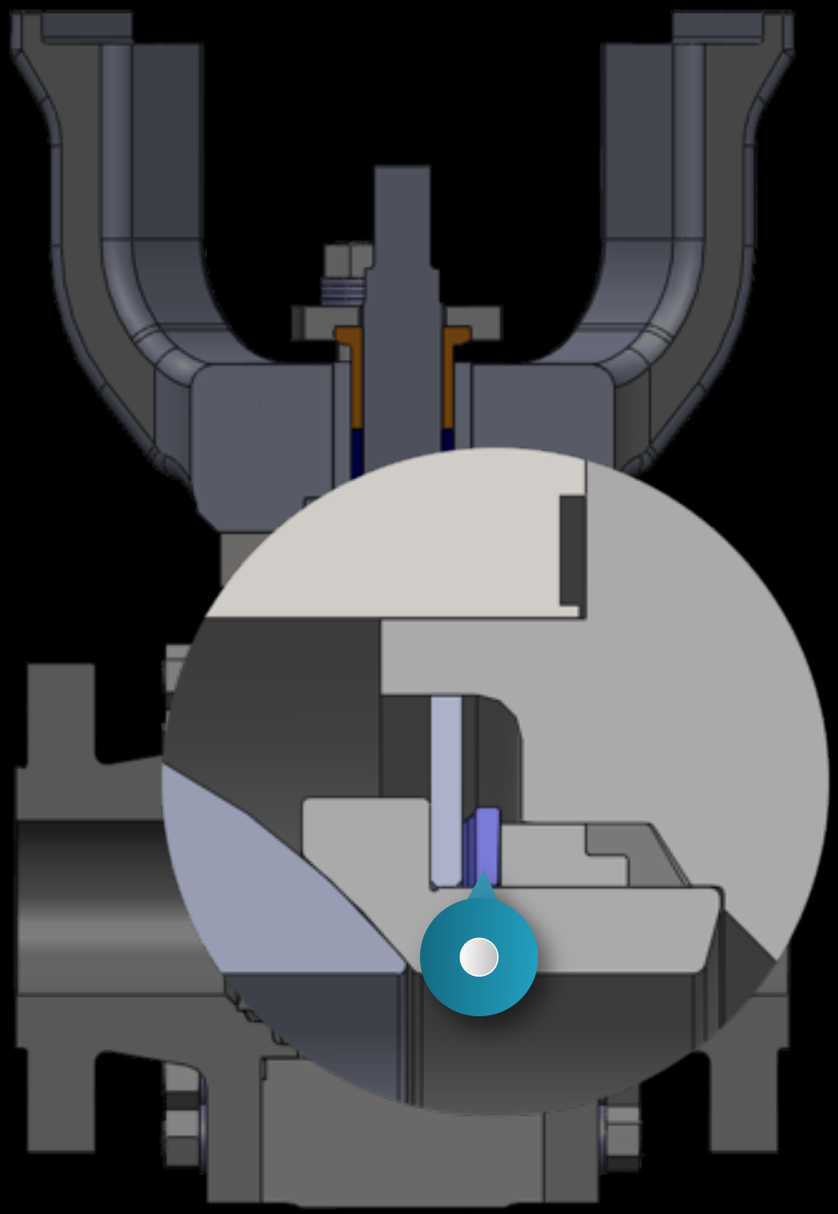
KEYSTONE

SEAL AND SPRING EVOLUTION



OLD DESIGN

Wedge seal

Compression ring

Wave spring

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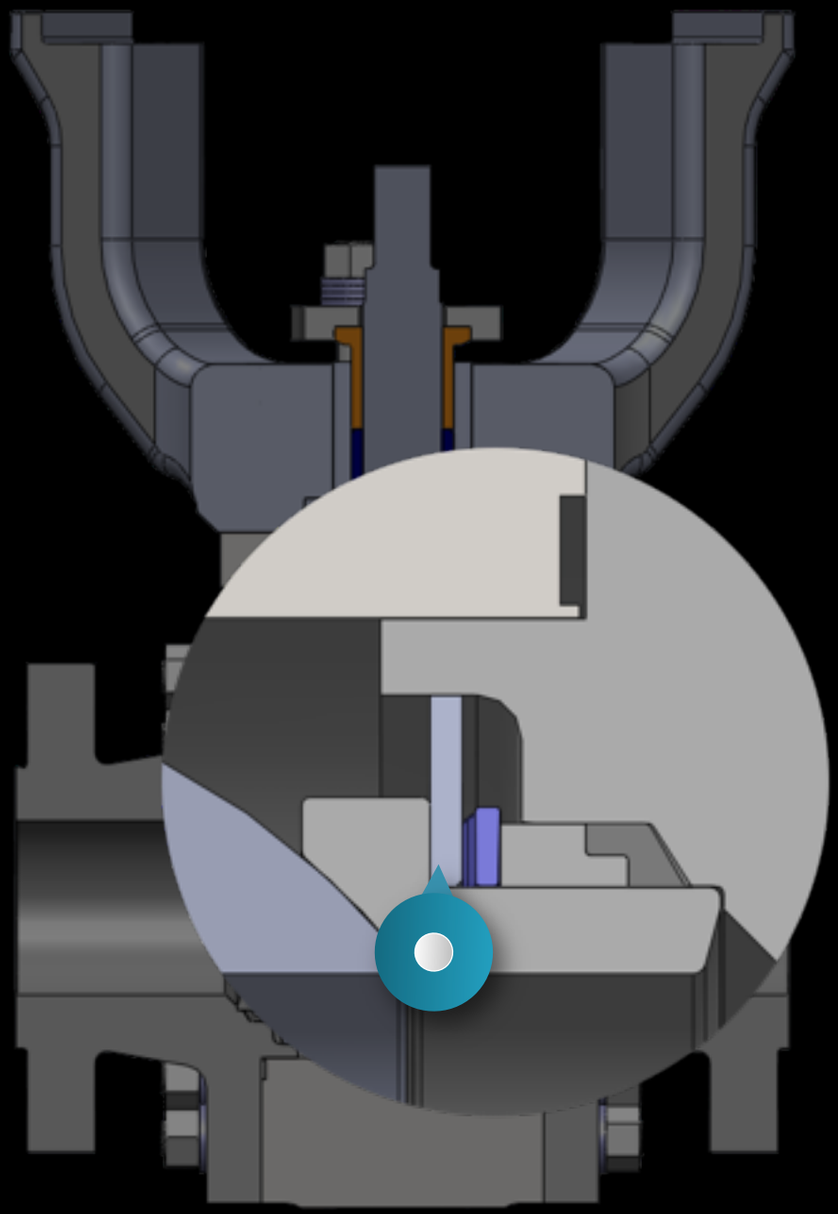
KEYSTONE

SEAL AND SPRING EVOLUTION



OLD DESIGN

Wedge seal

Compression ring

Scalloped ring

Wave spring

SEAL AND SPRING EVOLUTION

These four parts, are replaced by one, simplified component

Wedge seal

Compression ring

Scalloped ring

Wave spring

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KEYSTONE

SEAL AND SPRING EVOLUTION

These four parts, are replaced by one, simplified component

THE C-RING

AUTOCLAVE
METAL SEATED BALL VALVE

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KEYSTONE

AUTOCLAVE

METAL SEATED BALL VALVE

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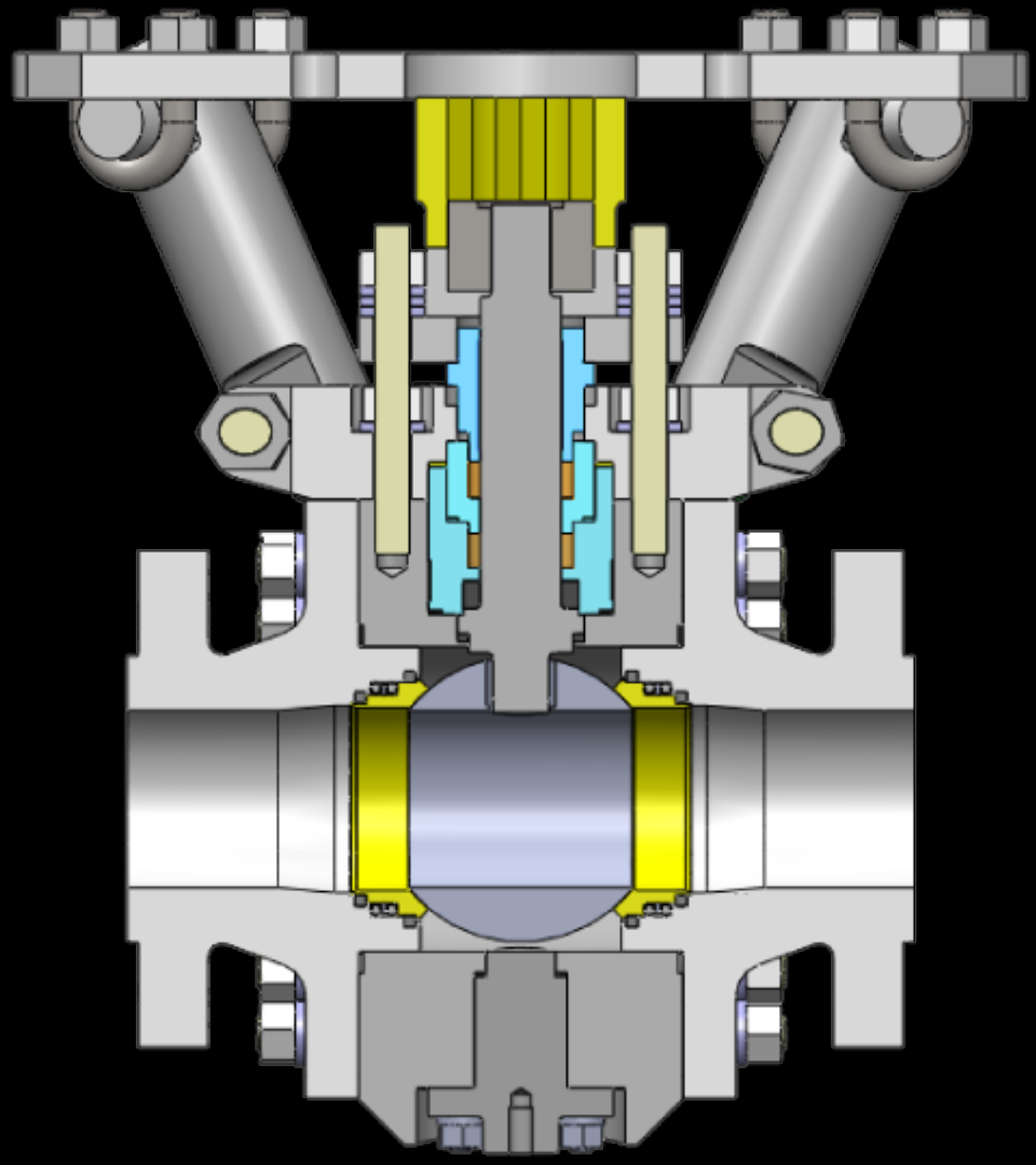
KEYSTONE

THE C-RING DESIGN



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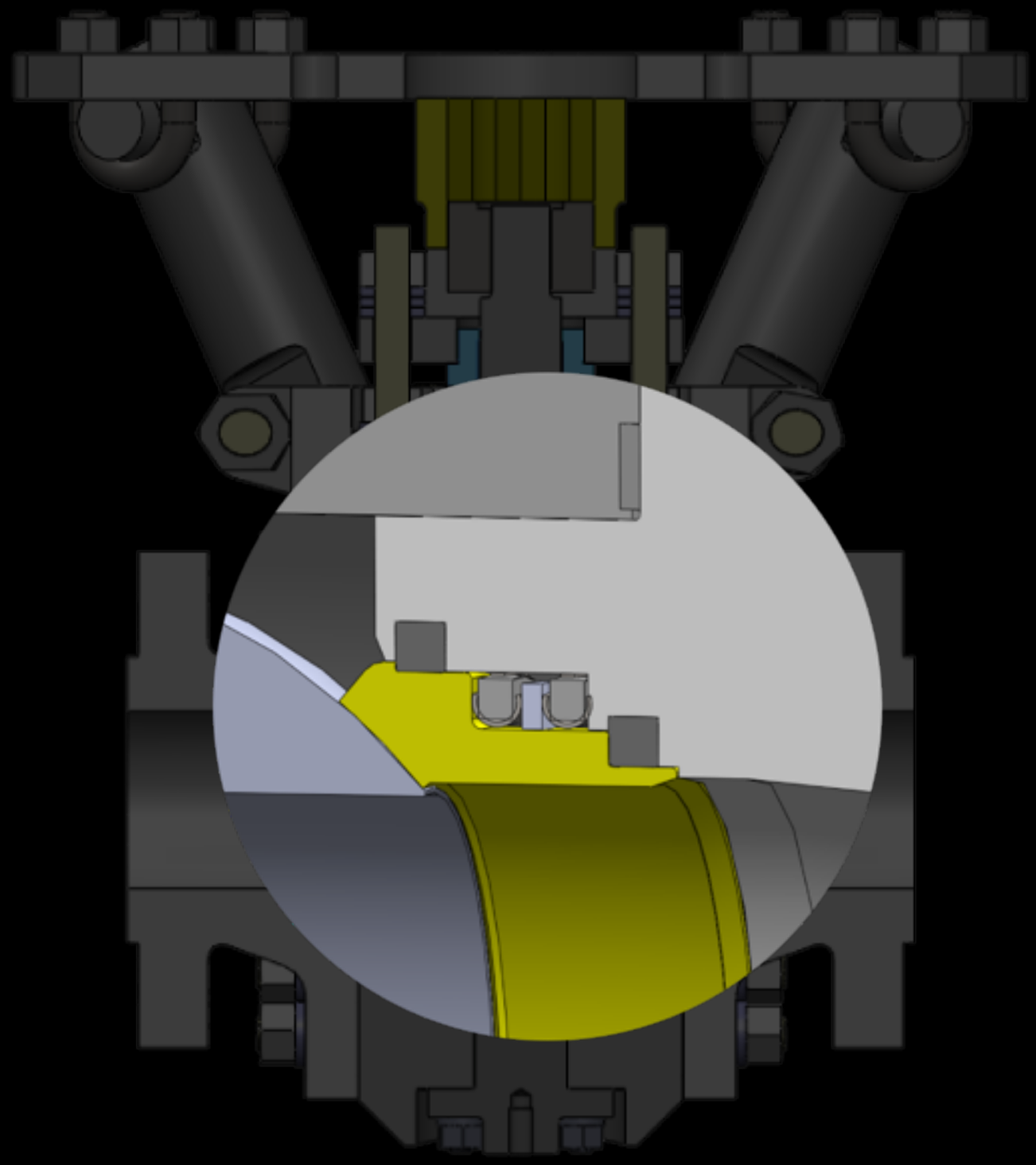
KEYSTONE

THE C-RING DESIGN



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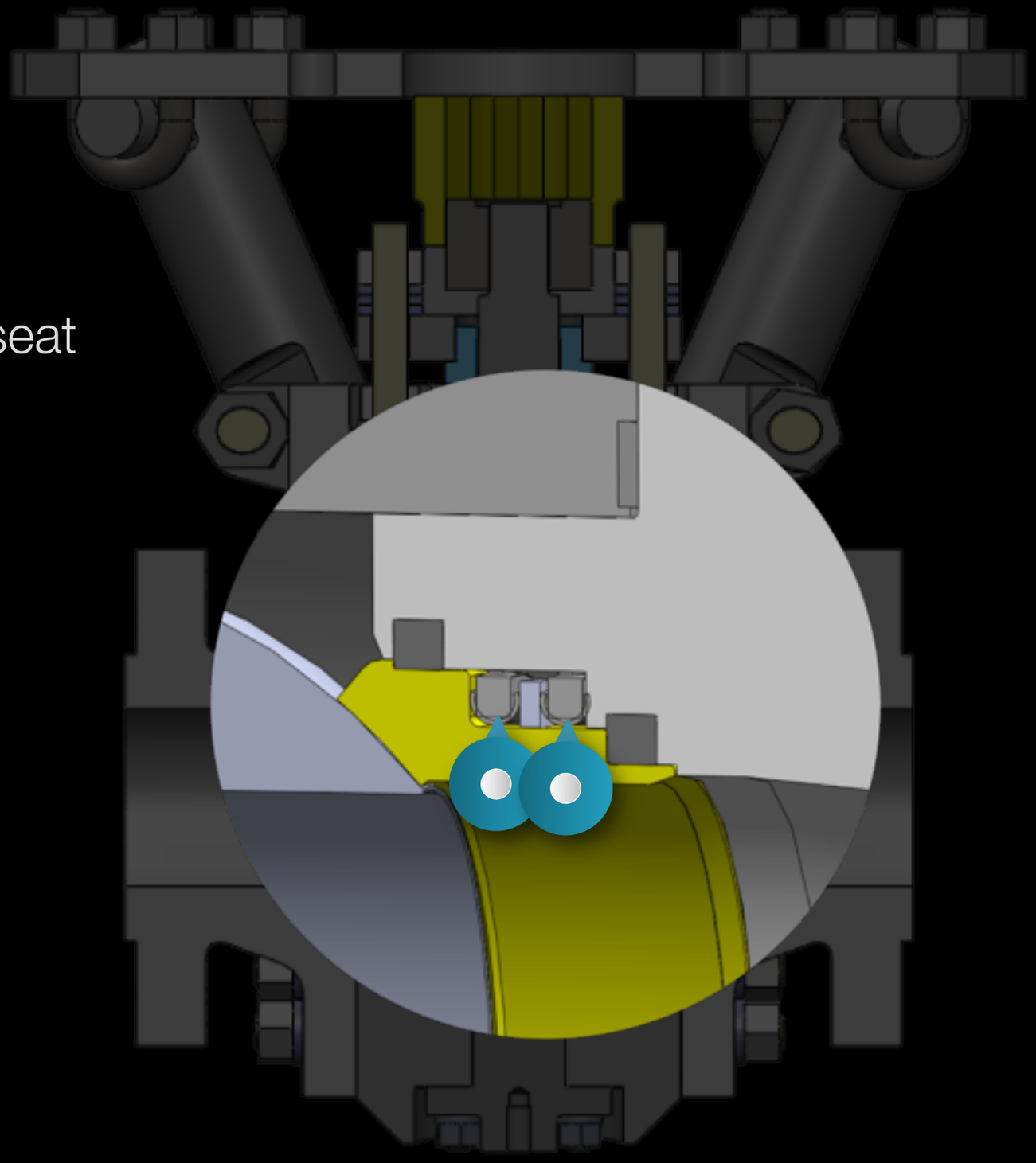
KEYSTONE

THE C-RING DESIGN

Two adjacent C-Rings encompass each seat



AUTOCLAVE

METAL SEATED BALL VALVE

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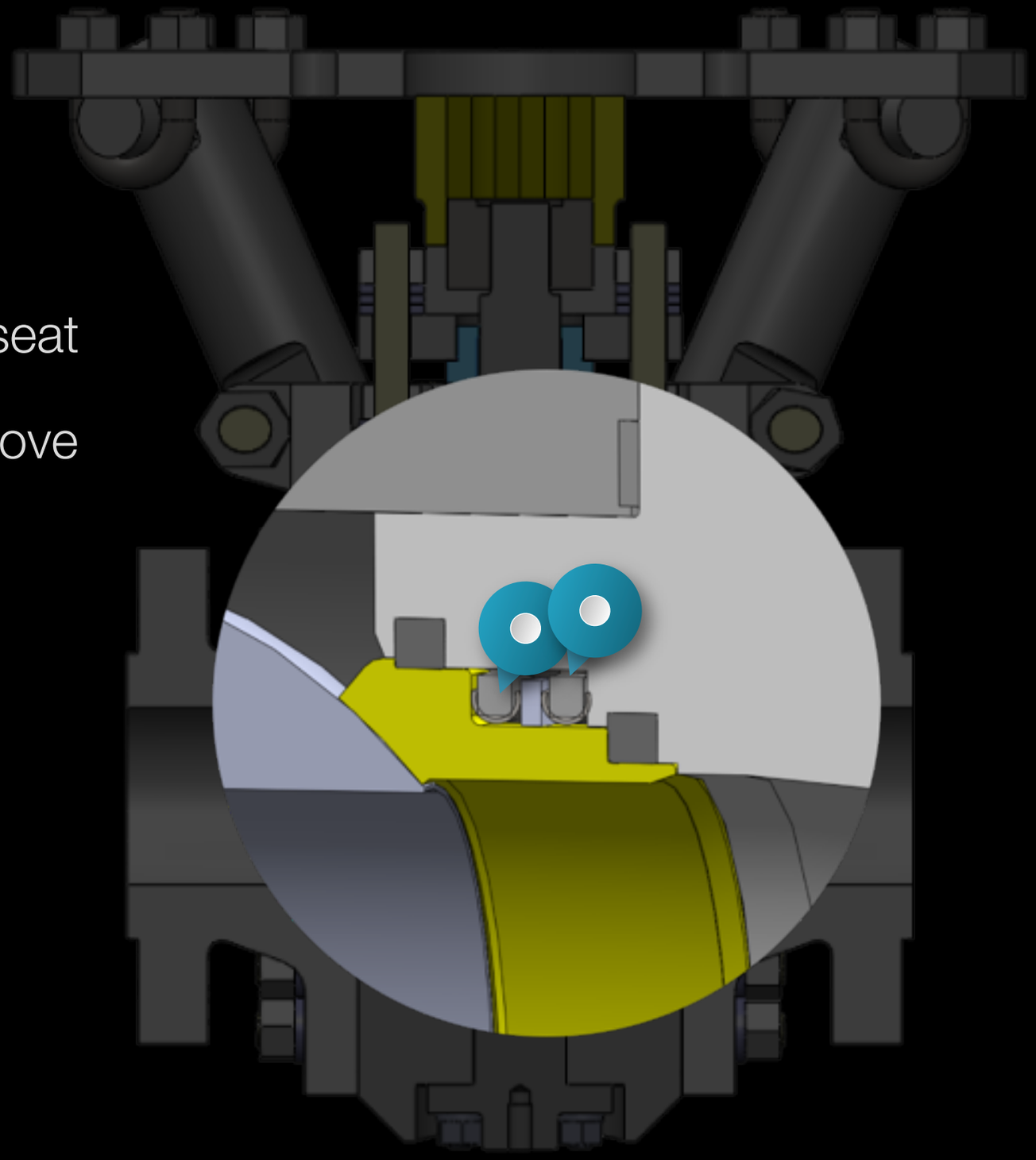
KEYSTONE

THE C-RING DESIGN

Two adjacent C-Rings encompass each seat

Braided graphite inserted into C-Ring groove



AUTOCLAVE

METAL SEATED BALL VALVE

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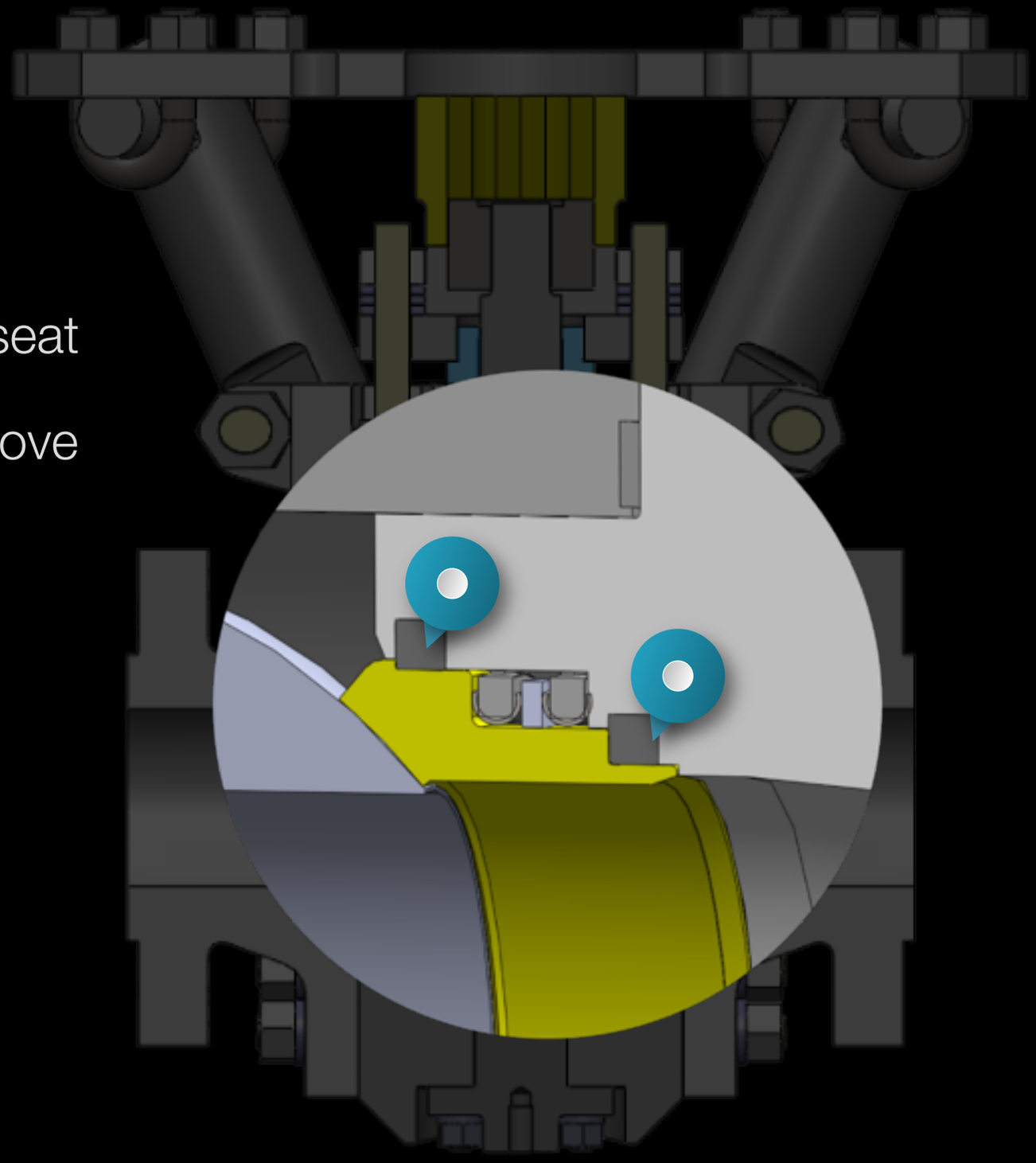
KEYSTONE

THE C-RING DESIGN

Two adjacent C-Rings encompass each seat

Braided graphite inserted into C-Ring groove

Wiper rings act as an additional barrier



AUTOCLAVE

METAL SEATED BALL VALVE

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KEYSTONE

AUTOCLAVE

METAL SEATED BALL VALVE

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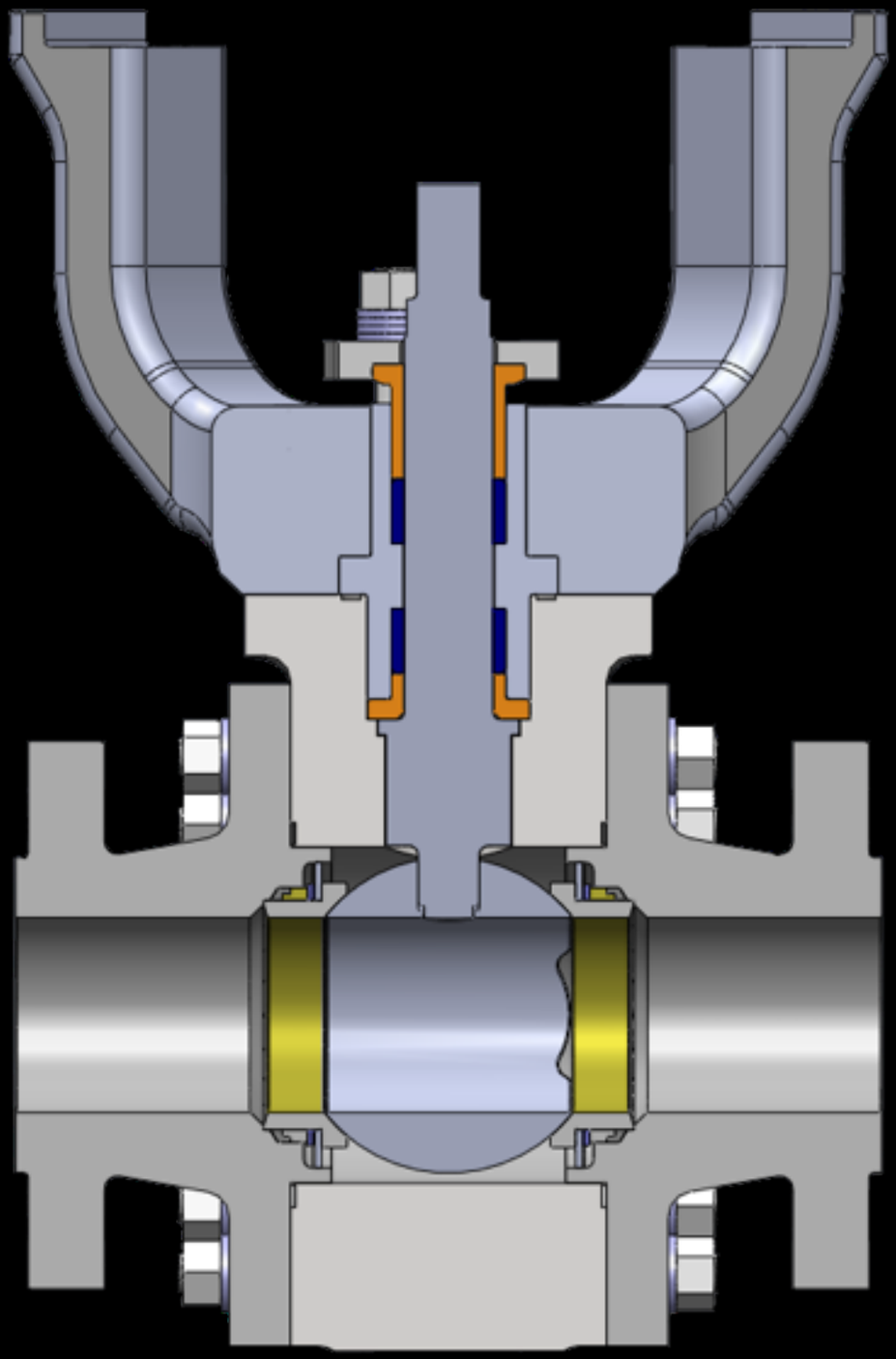
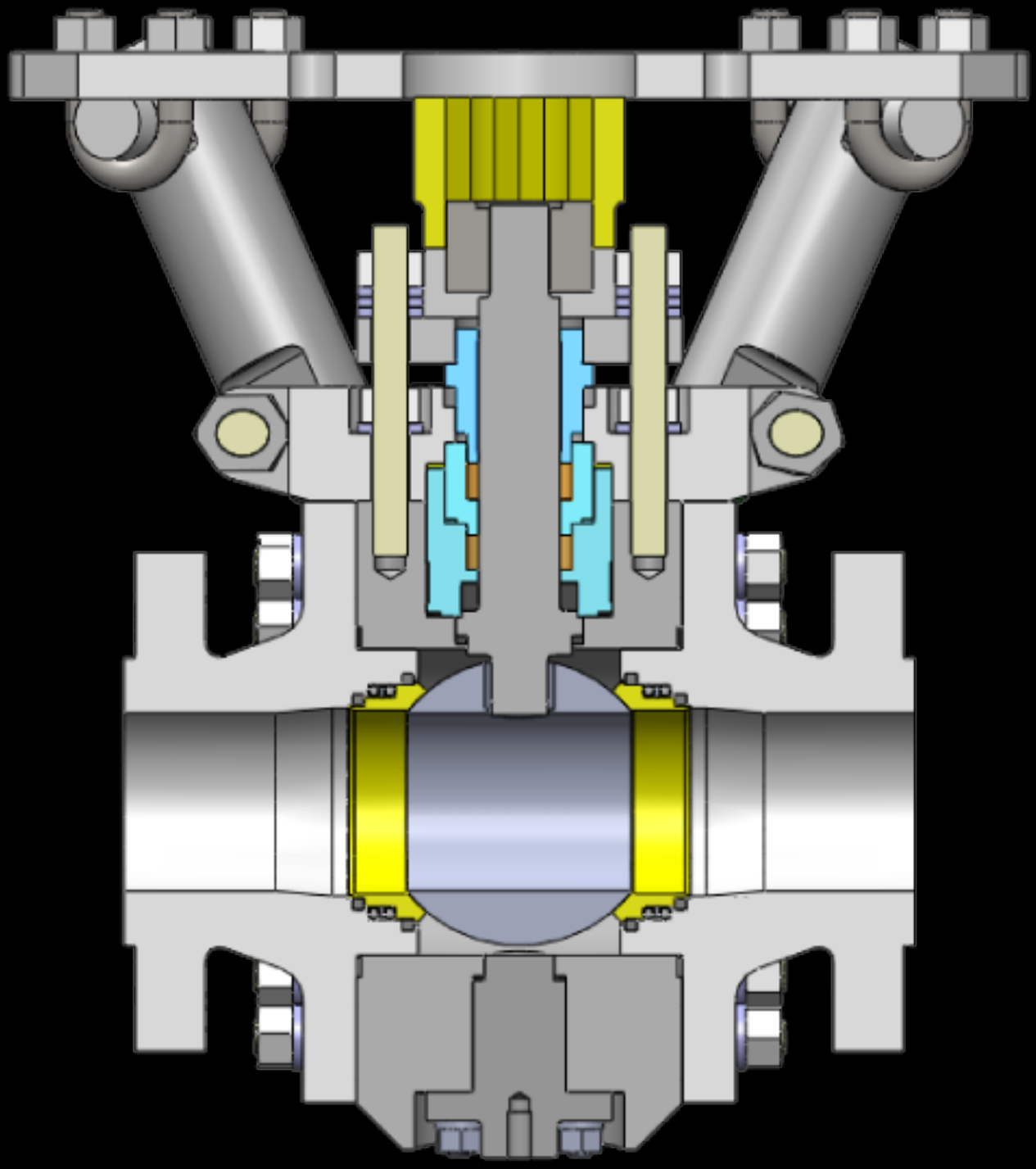
KEYSTONE





AUTOCLAVE

METAL SEATED BALL VALVE

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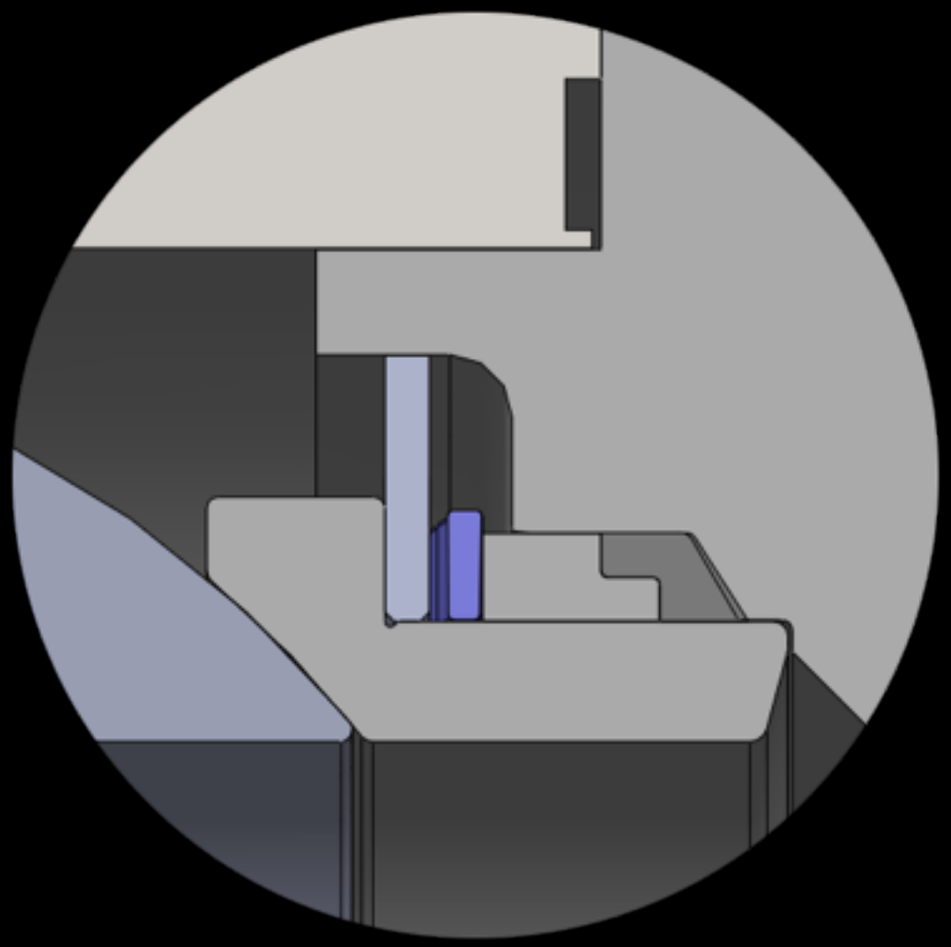
KEYSTONE



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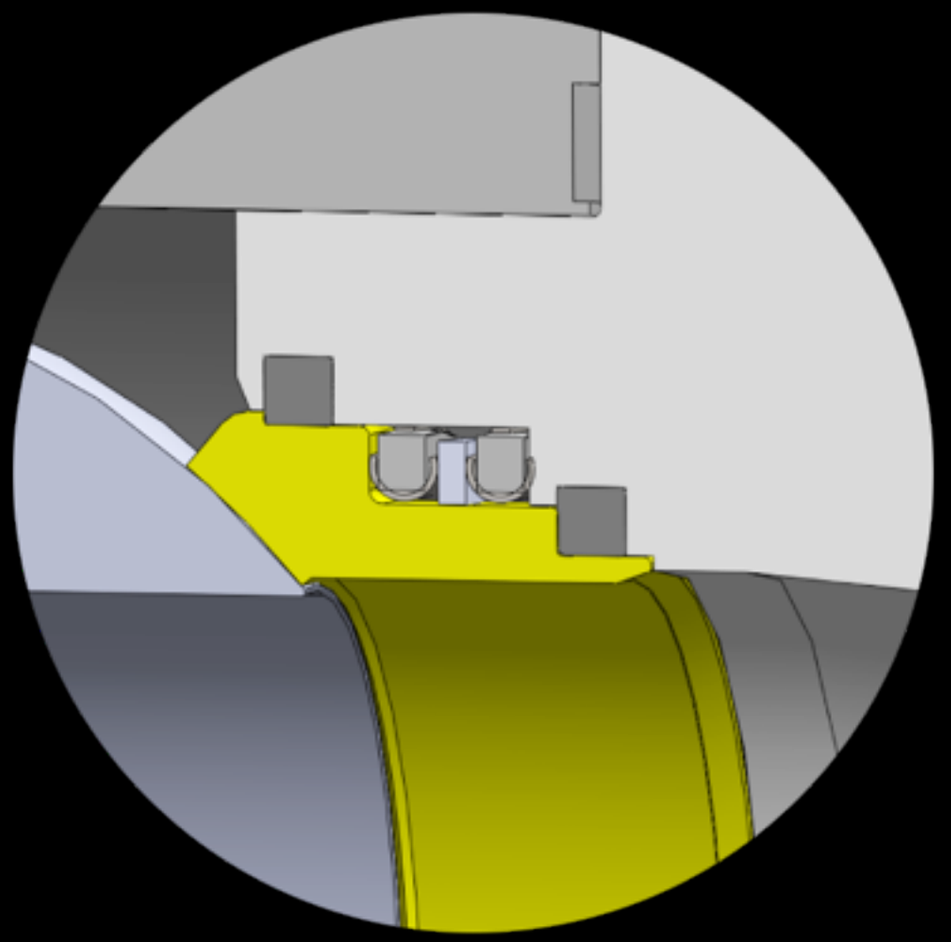

C-RING DESIGN

AUTOCLAVE

METAL SEATED BALL VALVE

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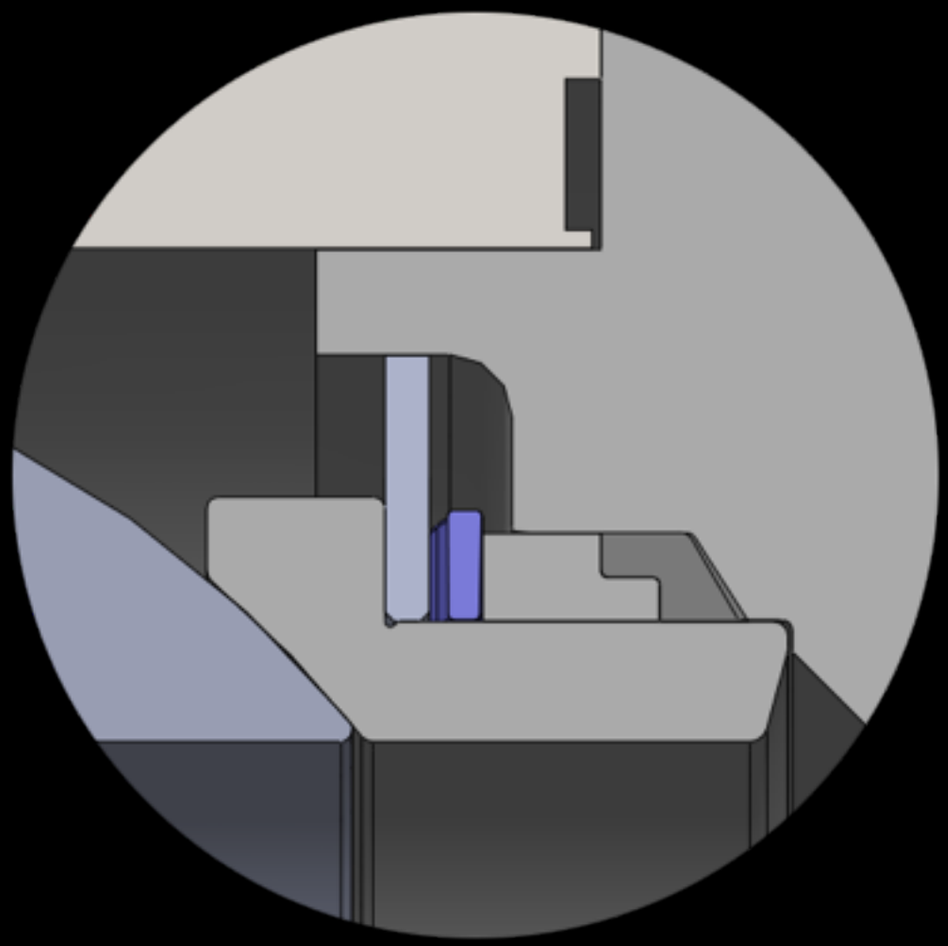
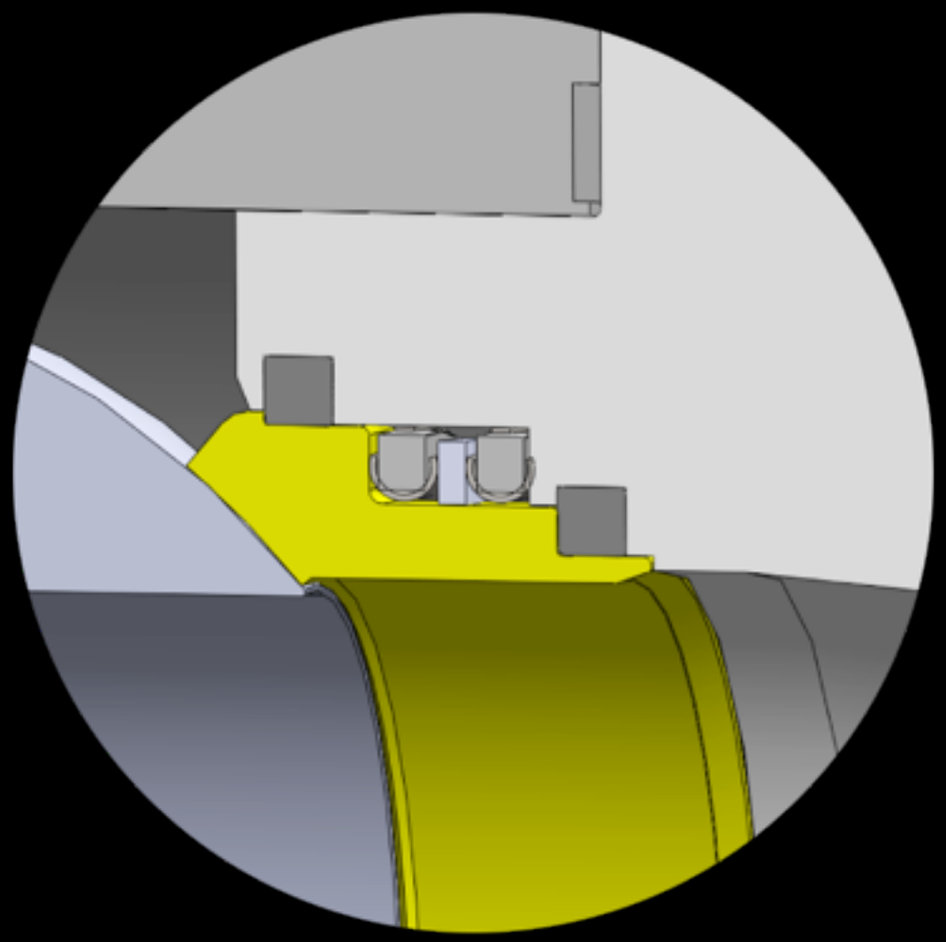
KEYSTONE

Seal and spring in one component.



OLD DESIGN



C-RING DESIGN

AUTOCLAVE
METAL SEATED BALL VALVE

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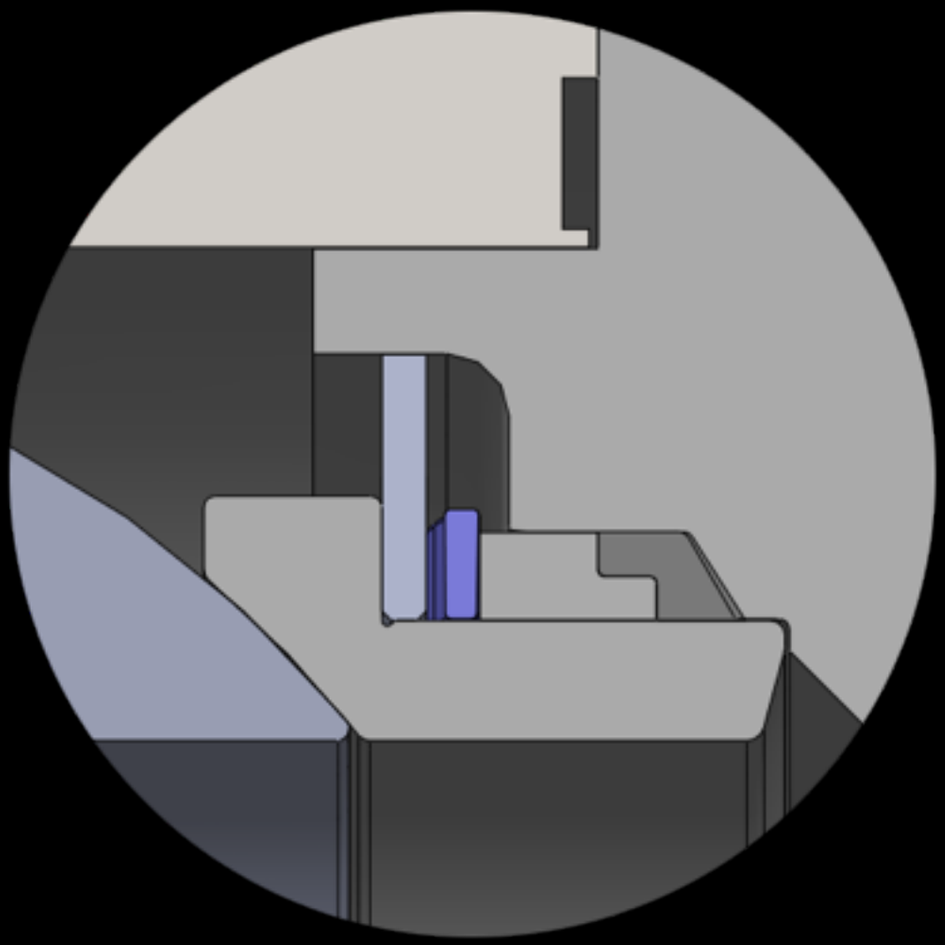
KEYSTONE

Seal and spring in one component.
Less susceptible to failure



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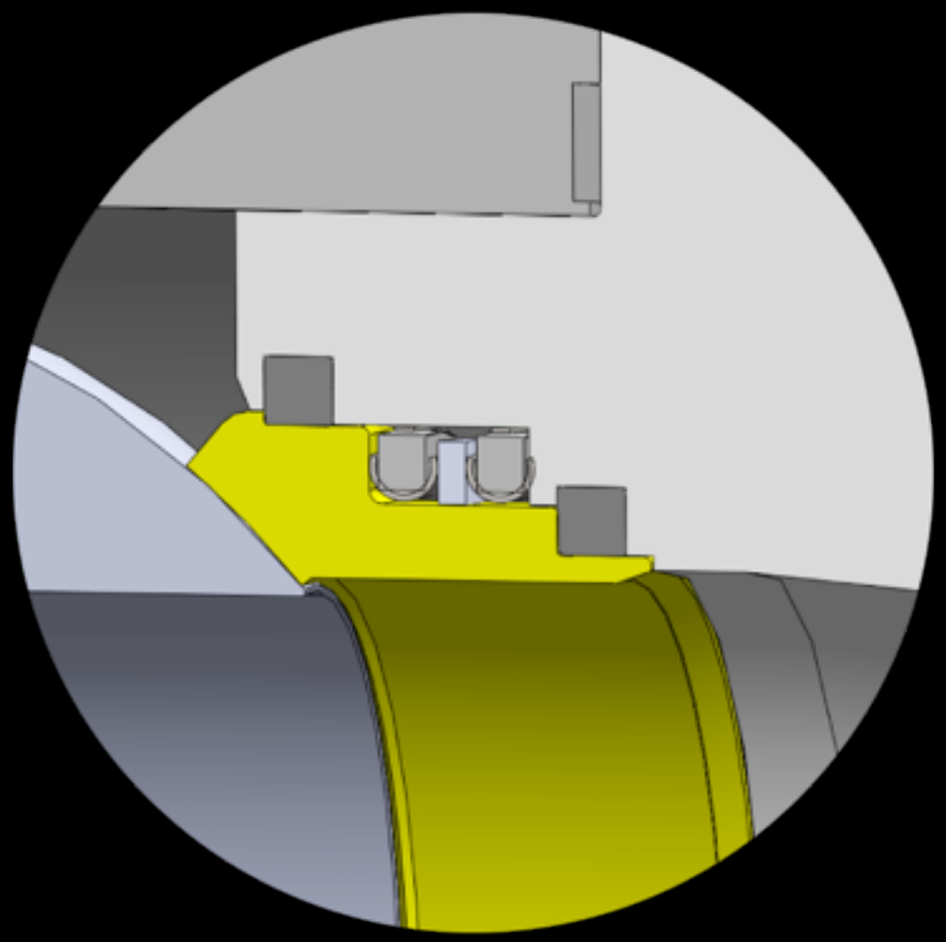

C-RING DESIGN

AUTOCLAVE

METAL SEATED BALL VALVE

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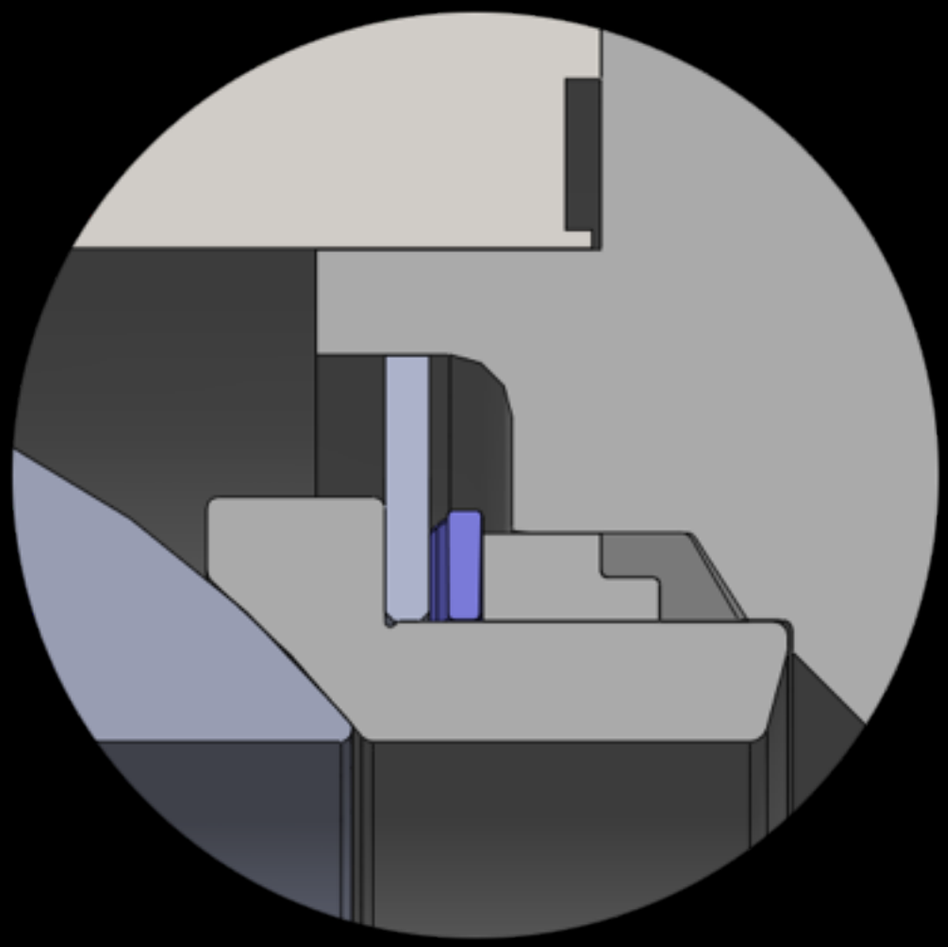
KEYSTONE

Seal and spring in one component.

Less susceptible to failure

Ball is loaded on seat.



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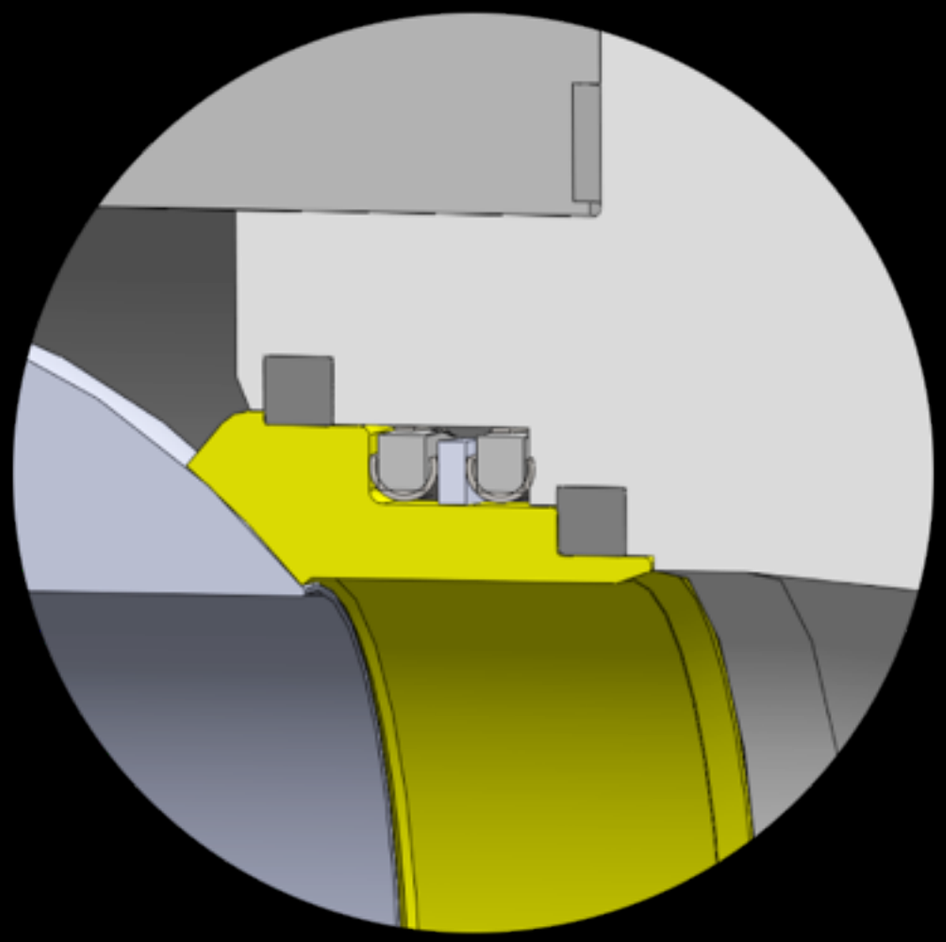

C-RING DESIGN

AUTOCLAVE

METAL SEATED BALL VALVE

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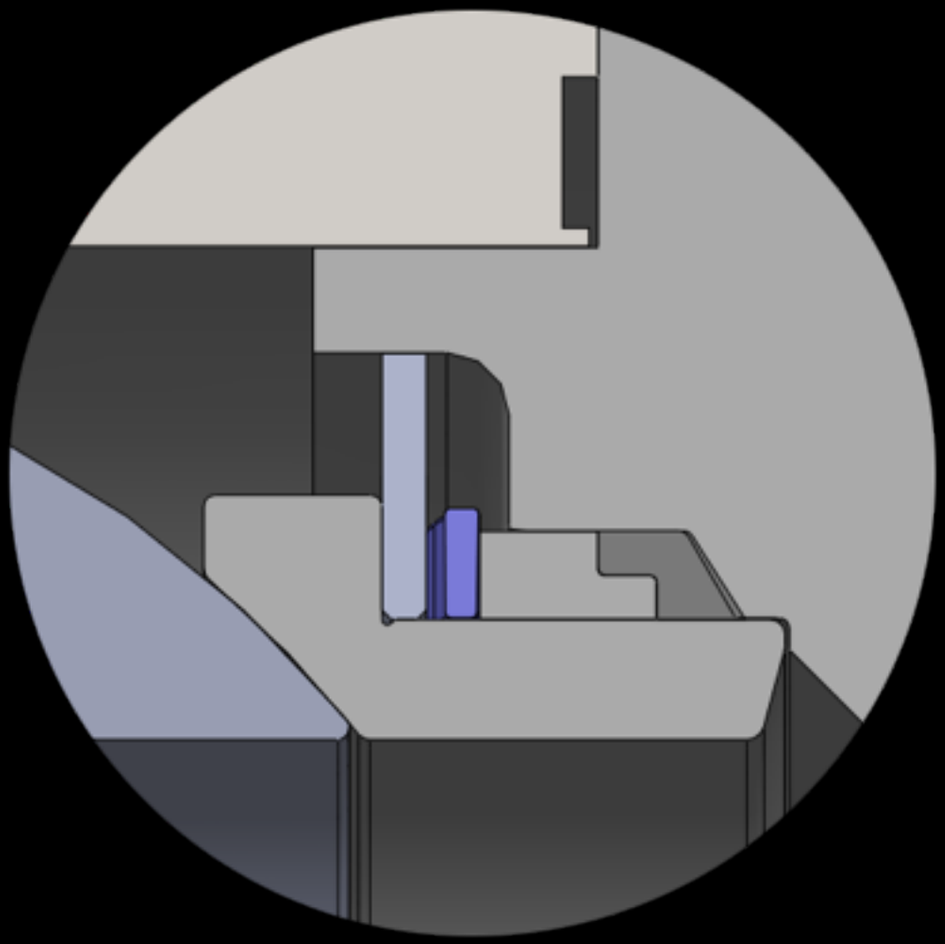
KEYSTONE

Seal and spring in one component.

Less susceptible to failure

Ball is loaded on seat.

Critical parts are protected from catalyst



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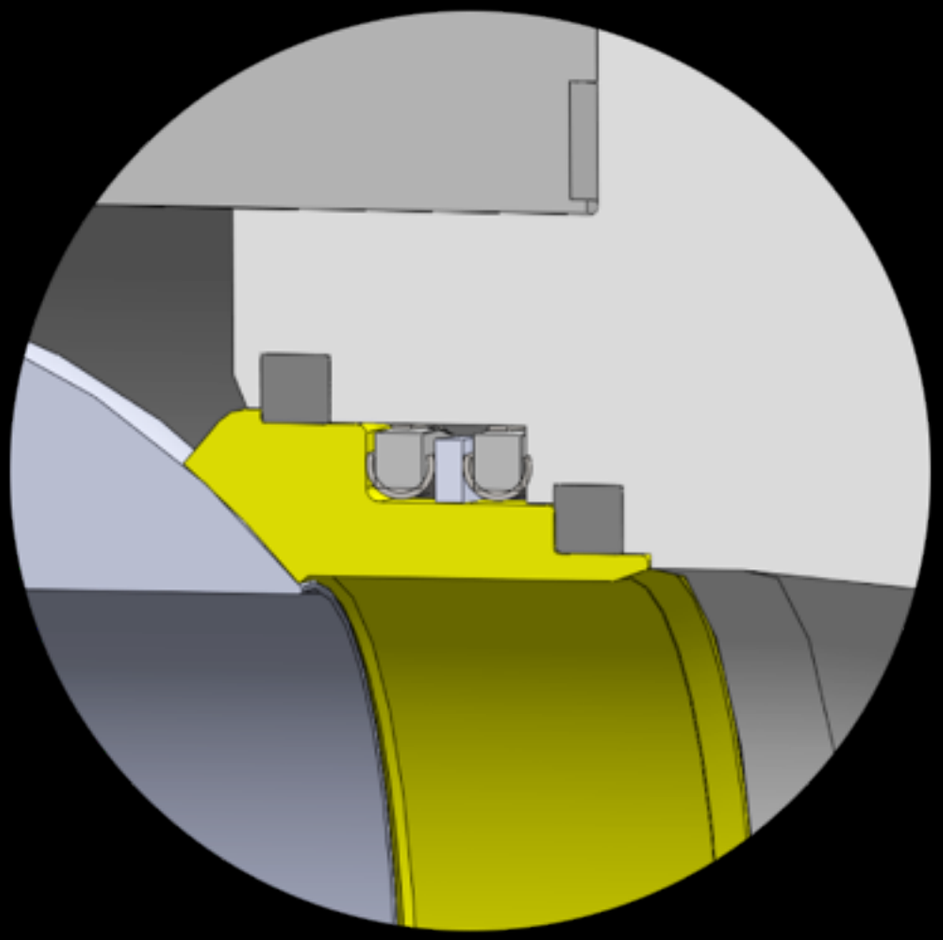

C-RING DESIGN

AUTOCLAVE

METAL SEATED BALL VALVE

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KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	C-Ring
SEAT LOADING	Belleville Washer	
SEAT DESIGN	Standard	Scraper
STEM SLOT	Standard	Scalloped
STEM SEALING	Single Packing	Dual Packing

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COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	C-Ring
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COMPETITION VS. KEYSTONE

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AUTOCLAVE

METAL SEATED BALL VALVE

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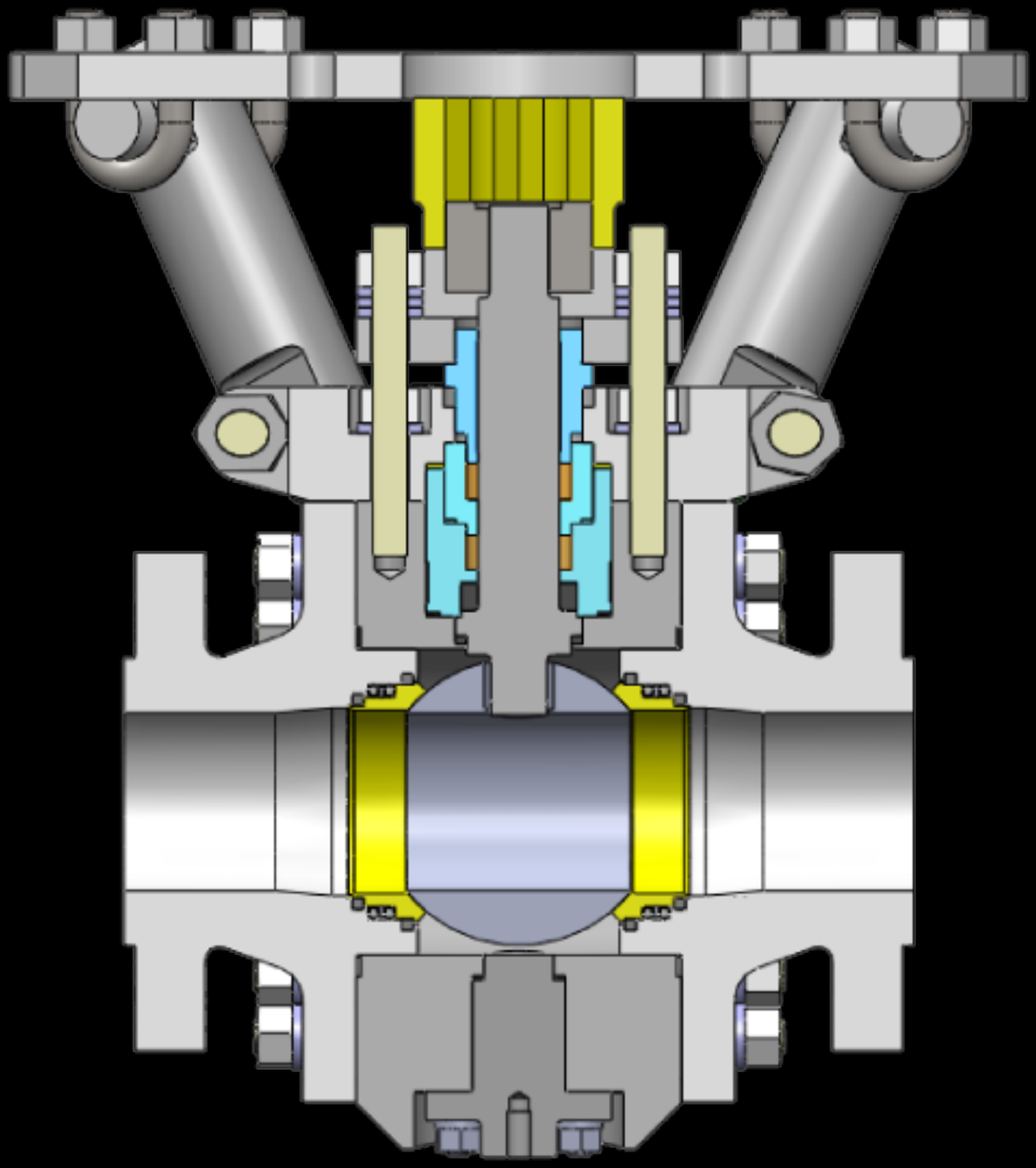
KEYSTONE



SCRAPER SEATS

AUTOCLAVE

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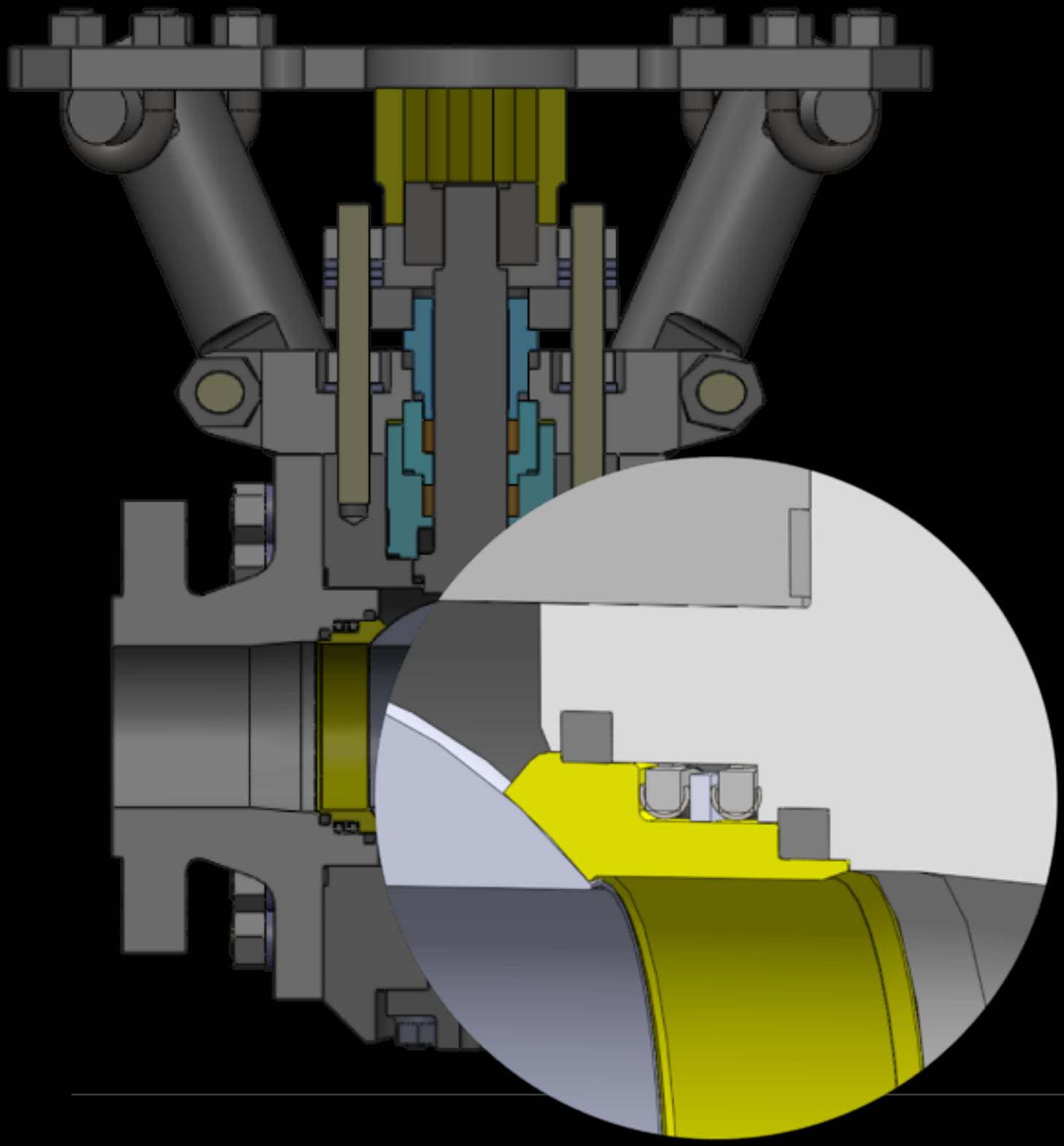
KEYSTONE



SCRAPER SEATS

AUTOCLAVE

METAL SEATED BALL VALVE

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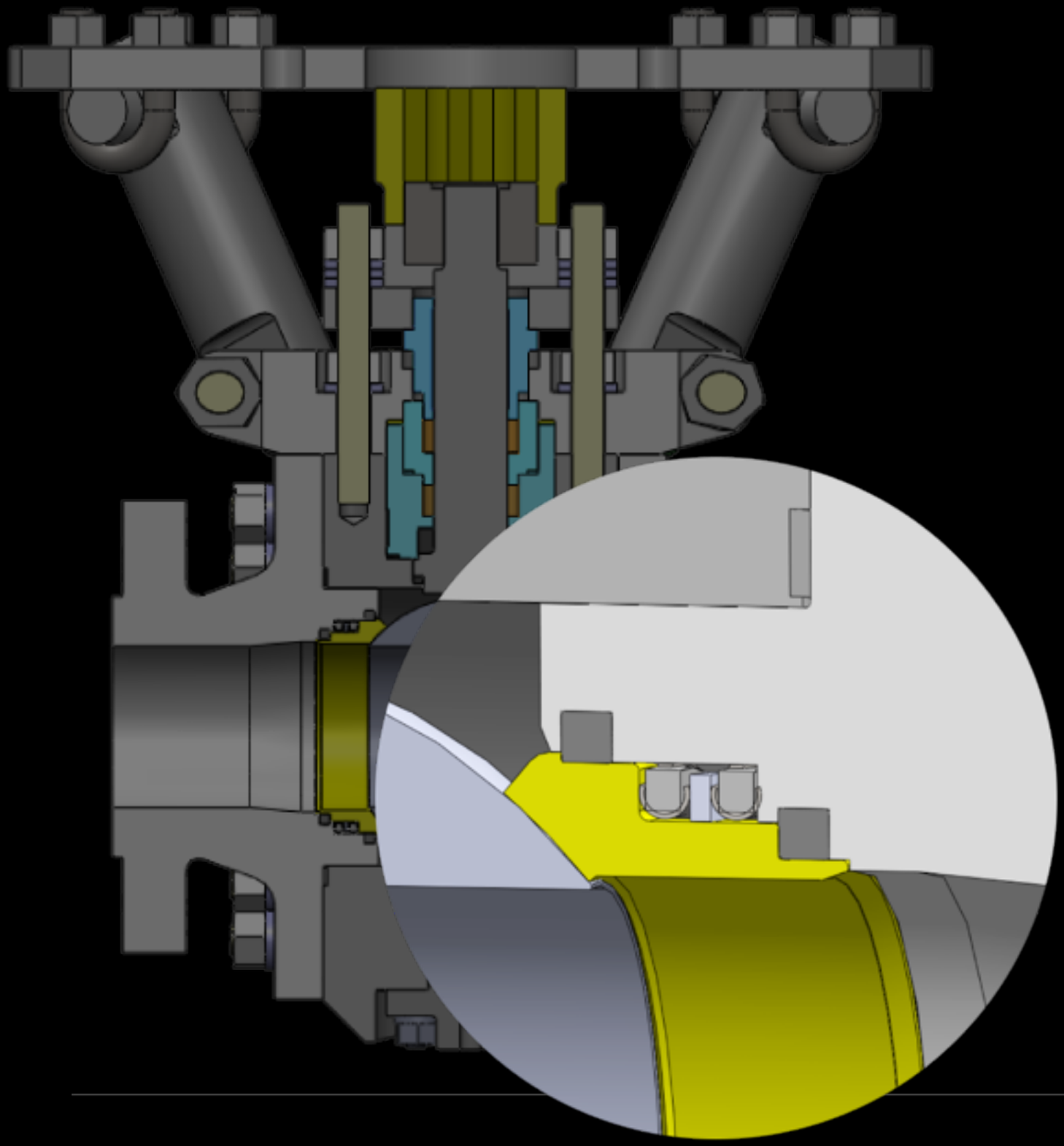
KEYSTONE



SCRAPER SEATS

Scraper edges on both sides

AUTOCLAVE

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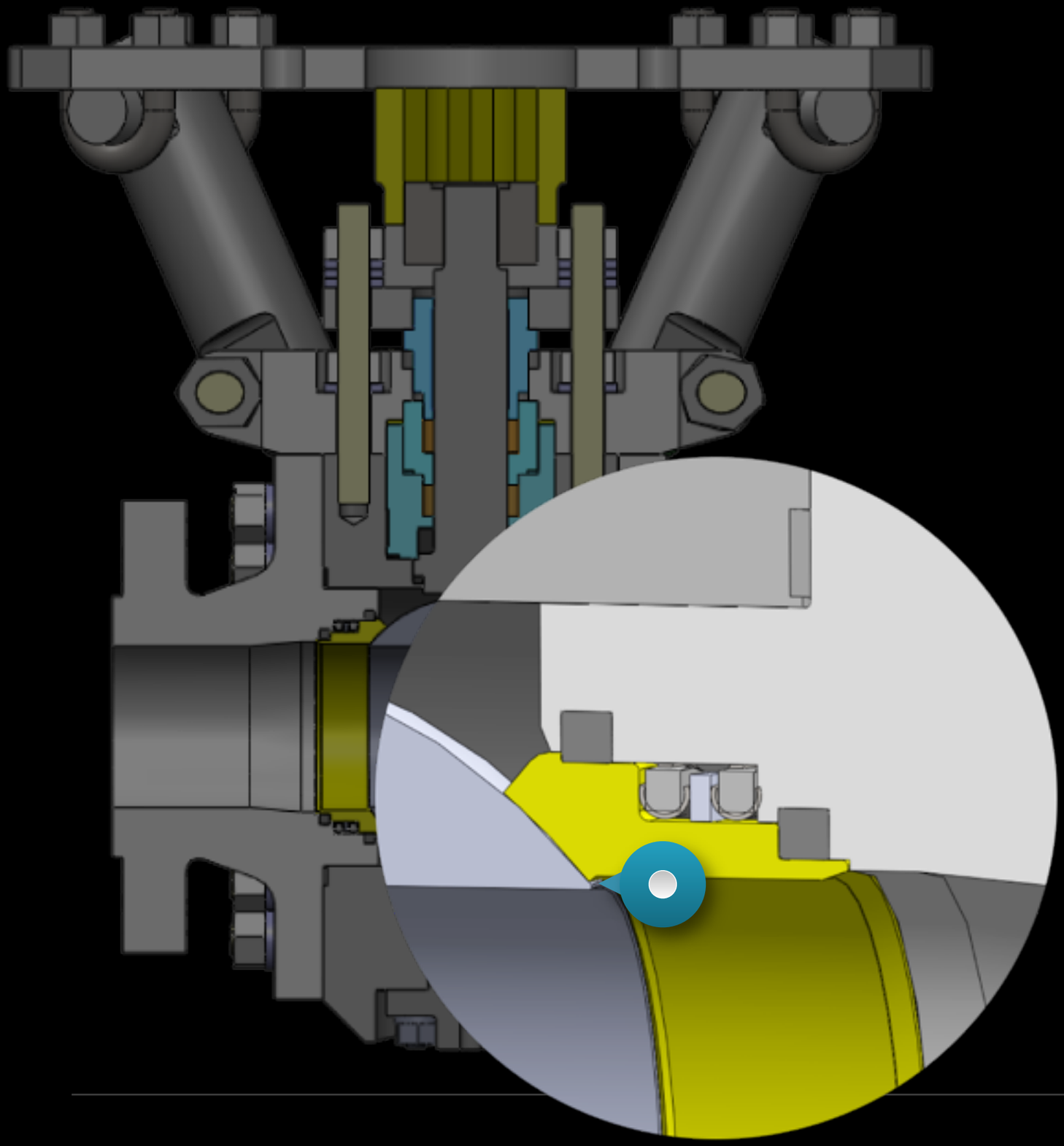
KEYSTONE



SCRAPER SEATS

Scraper edges on both sides

Ball scrapes seat

AUTOCLAVE

METAL SEATED BALL VALVE

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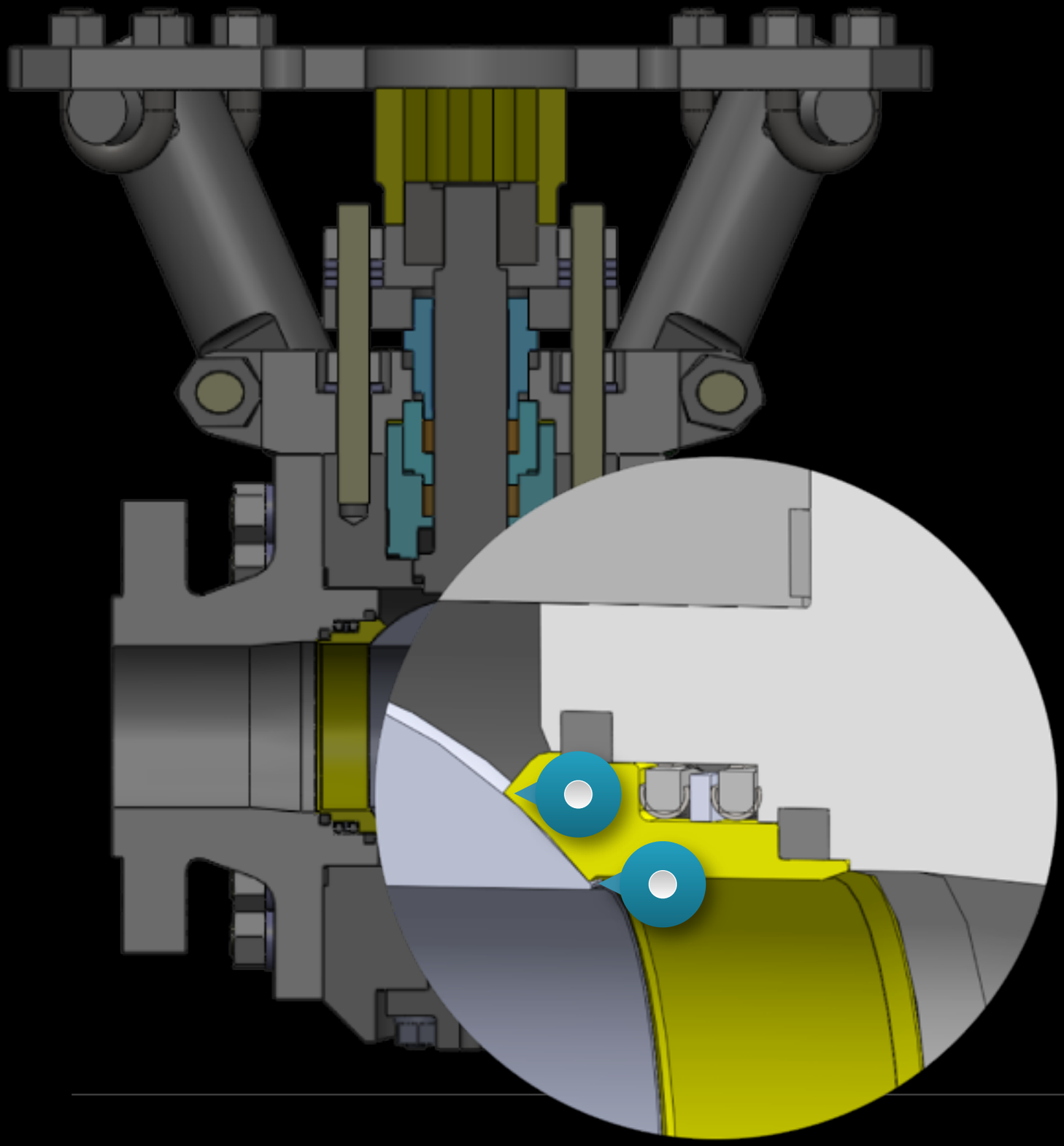
KEYSTONE



SCRAPER SEATS

Scraper edges on both sides

Ball scrapes seat

Seat scrapes ball

AUTOCLAVE

METAL SEATED BALL VALVE

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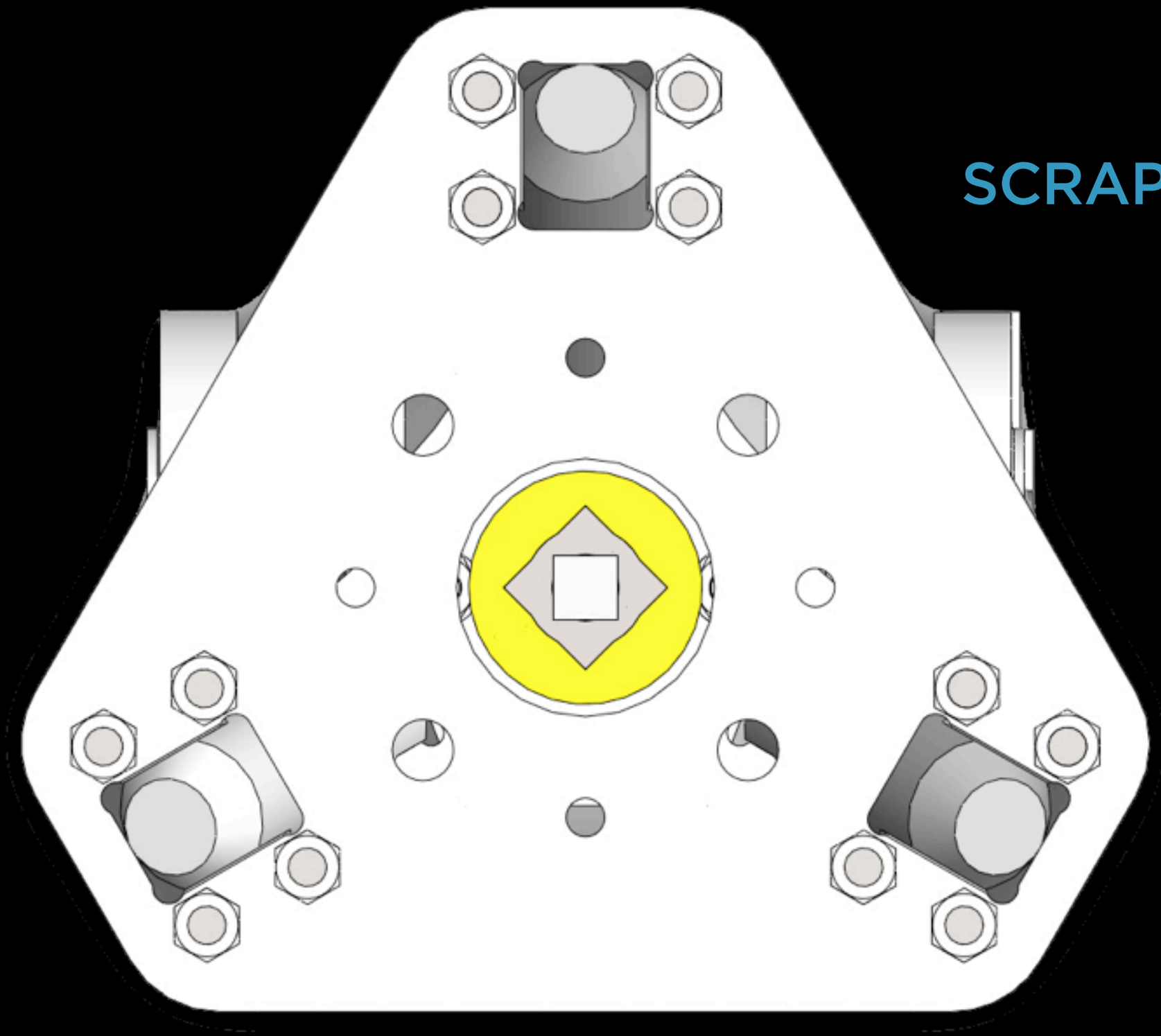
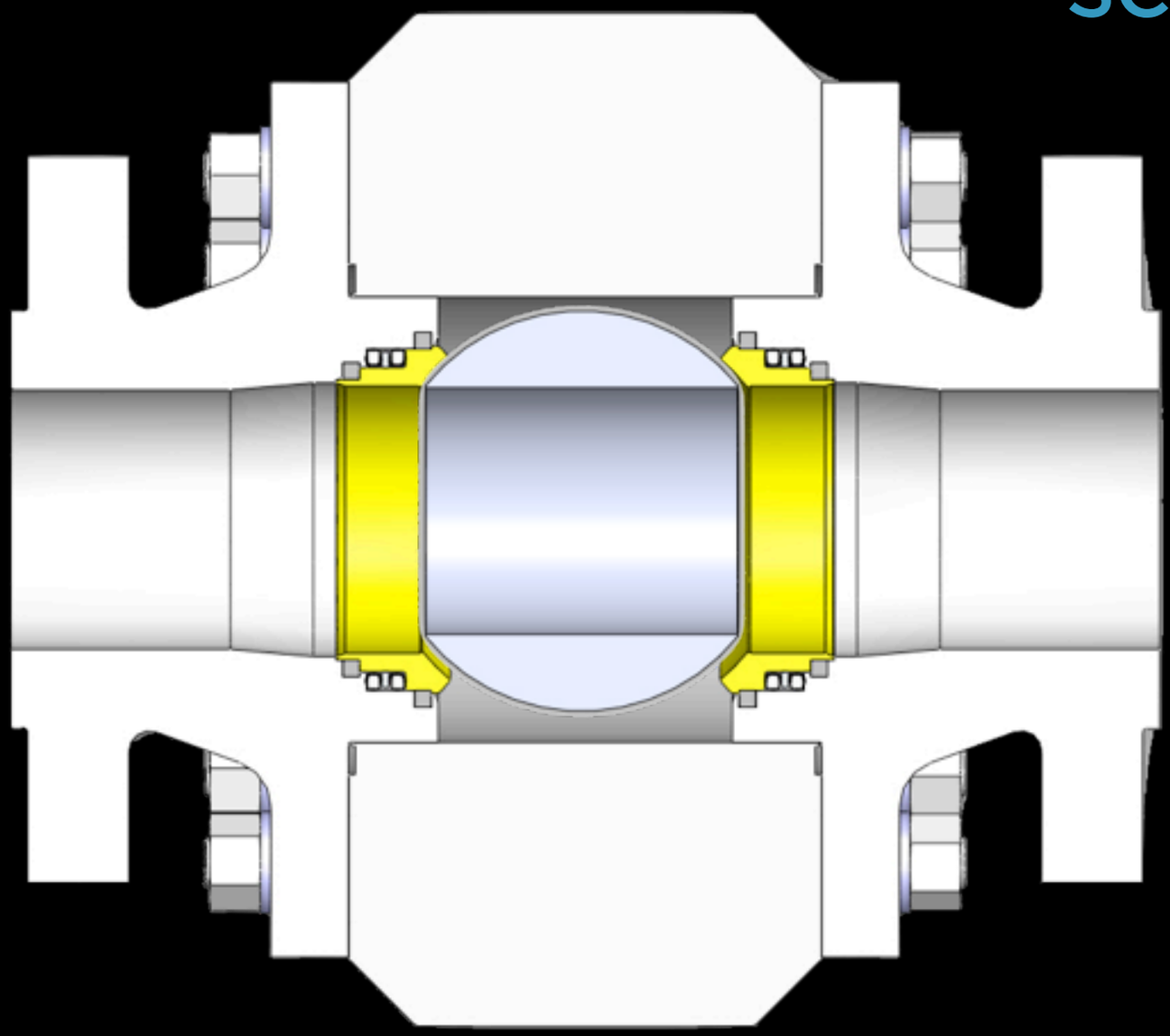
KEYSTONE

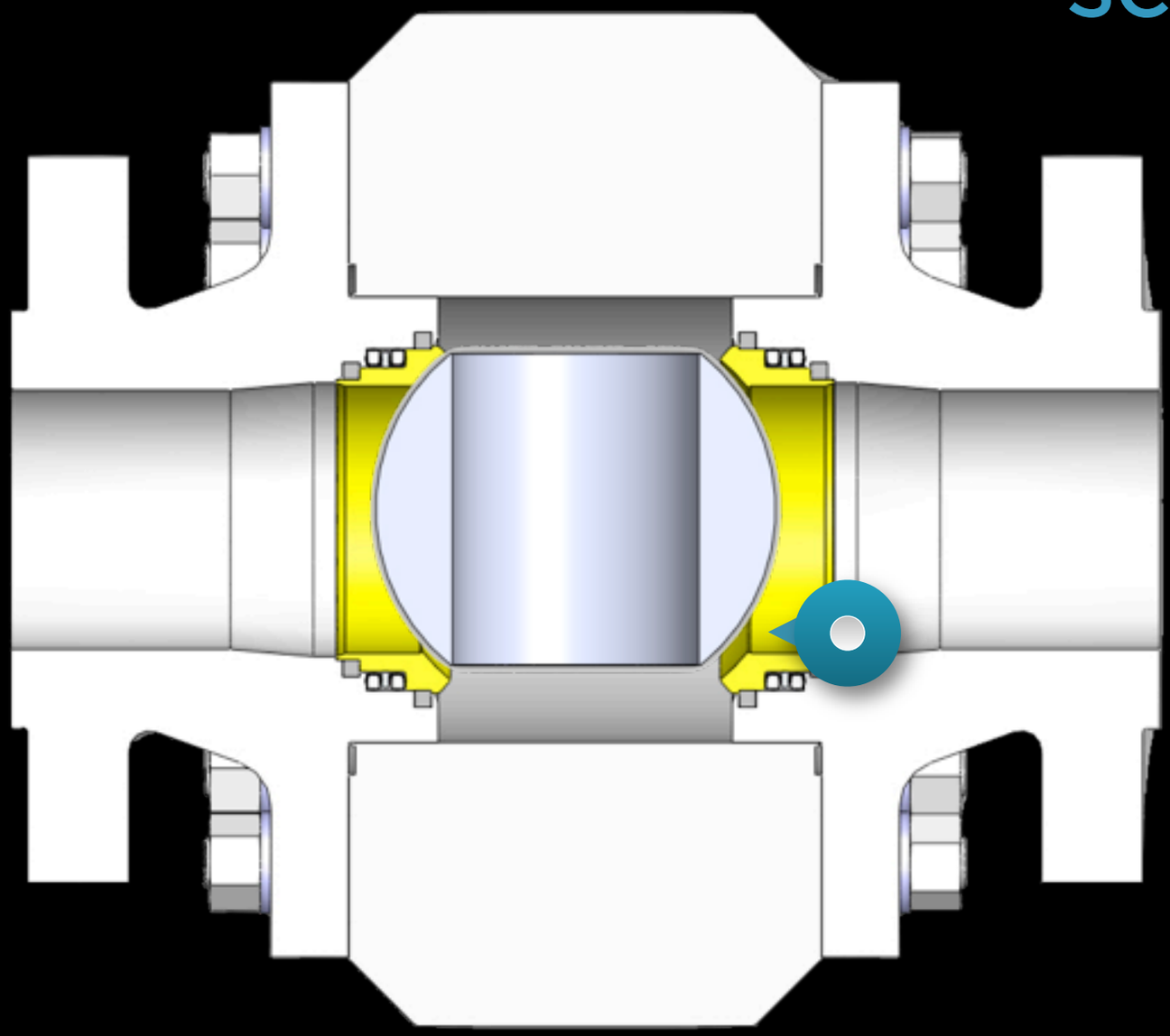
SCRAPER SEATS



SCRAPER SEATS

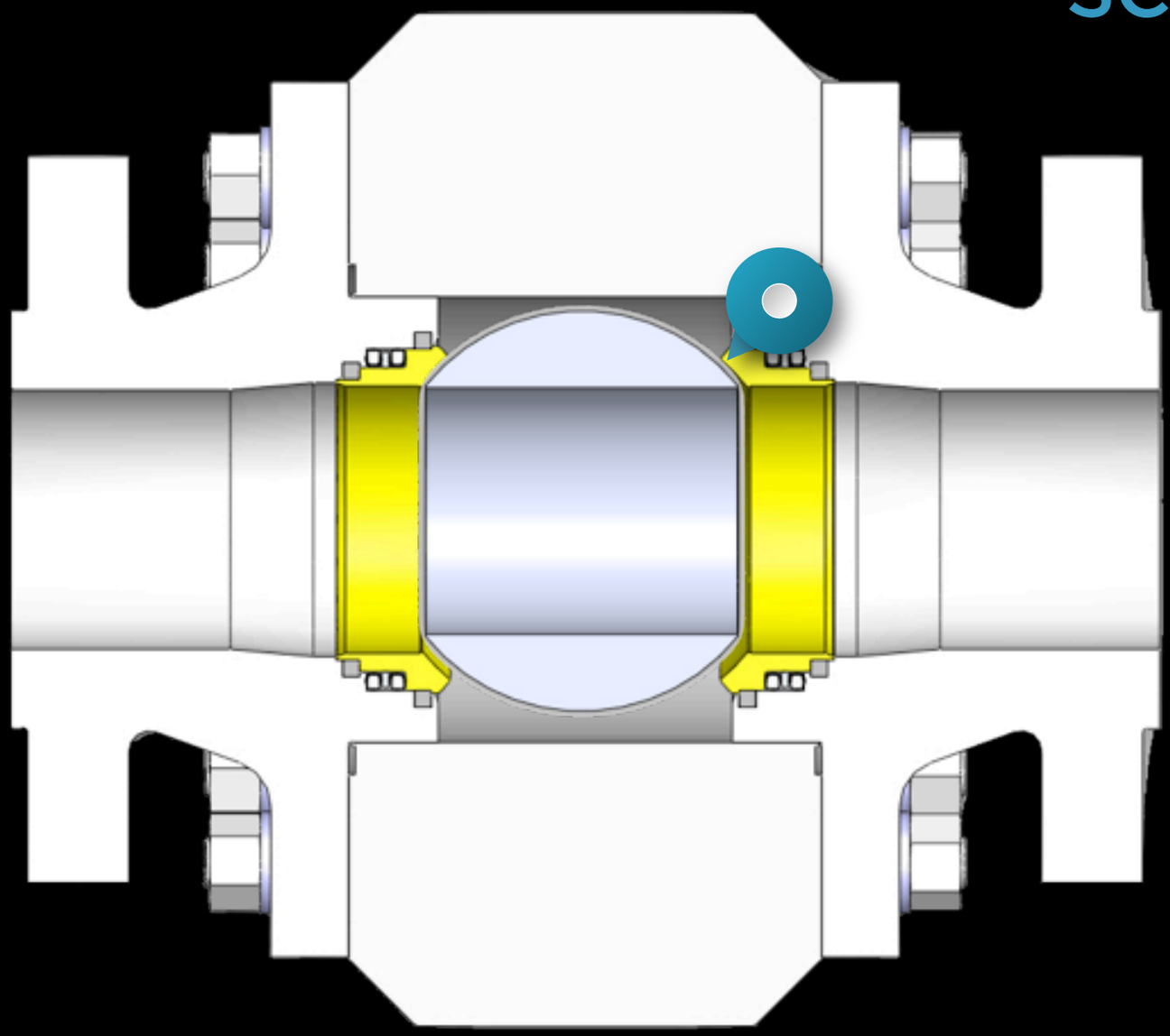


SCRAPER SEATS



SCRAPER SEATS

Seat scrapes ball



TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	Graphite wipers
SEAT LOADING	Belleville Washer	C-Ring
SEAT DESIGN	Standard	Scraper
STEM SLOT	Standard	Scalloped
STEM SEALING	Single Packing	Dual Packing

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COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	Graphite wipers
SEAT LOADING	Belleville Washer	C-Ring
SEAT DESIGN	Standard	Scraper
STEM SLOT	Standard	Scalloped
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COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing
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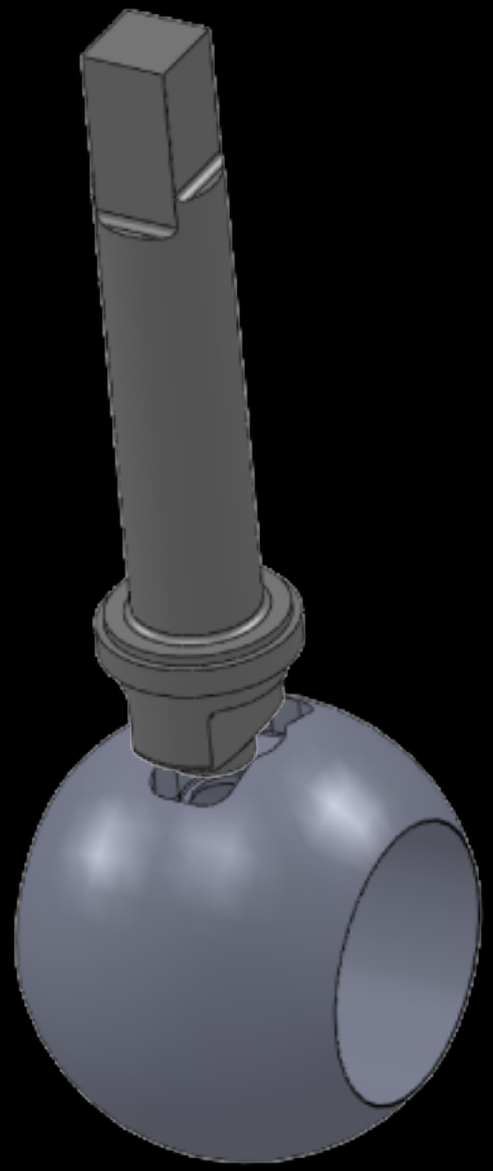
STEM SLOT	Standard	Scalloped



AUTOCLAVE

METAL SEATED BALL VALVE

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KEYSTONE

SCALLOPED BALL SLOT

AUTOCLAVE

METAL SEATED BALL VALVE

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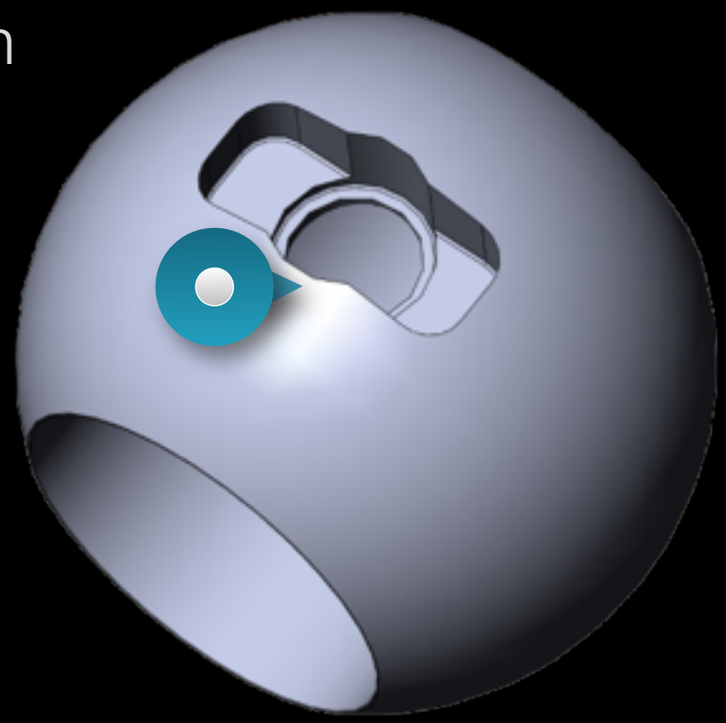
KEYSTONE

SCALLOPED BALL SLOT

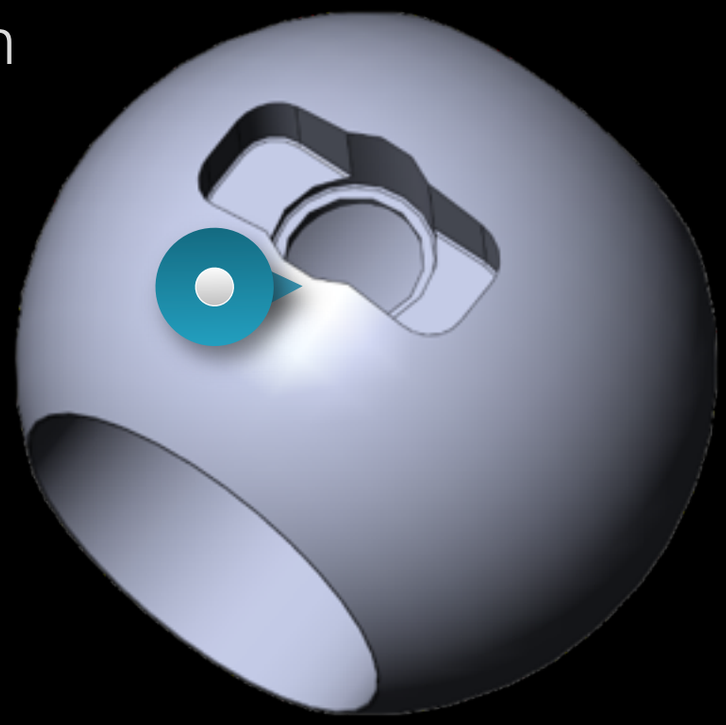
Scalloped ball slot allows catalyst to pass through



SCALLOPED BALL SLOT

Scalloped ball slot allows catalyst to pass through

Prevents severe build up



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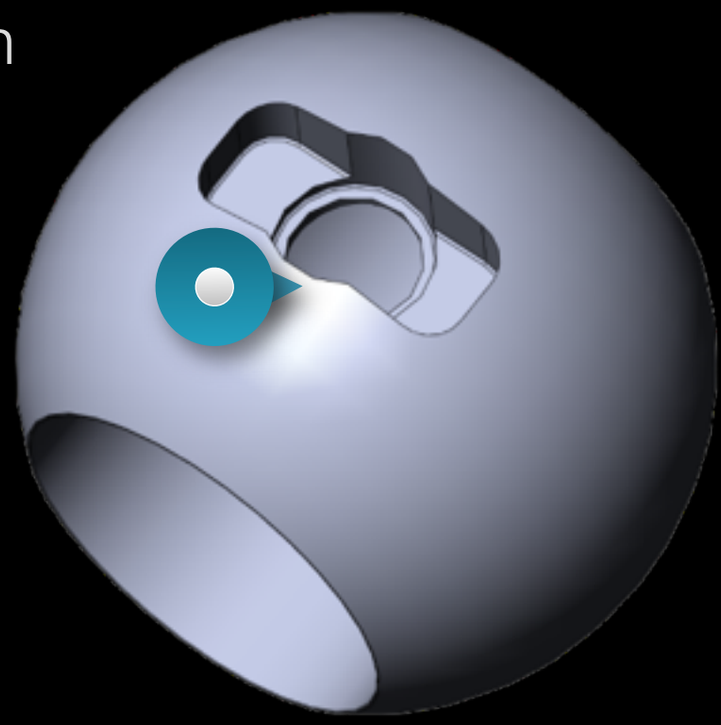
SCALLOPED BALL SLOT

Scalloped ball slot allows catalyst to pass through

Prevents severe build up

Catalyst can get in, but can also get out



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KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	Graphite wipers
SEAT LOADING	Belleville Washer	C-Ring
SEAT DESIGN	Standard	Scraper
STEM SLOT	Standard	Scalloped
STEM SEALING	Single Packing	Dual Packing

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COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing
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CATALYST BUILDUP	Sealed Seats	Graphite wipers
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COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing
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AUTOCLAVE

METAL SEATED BALL VALVE

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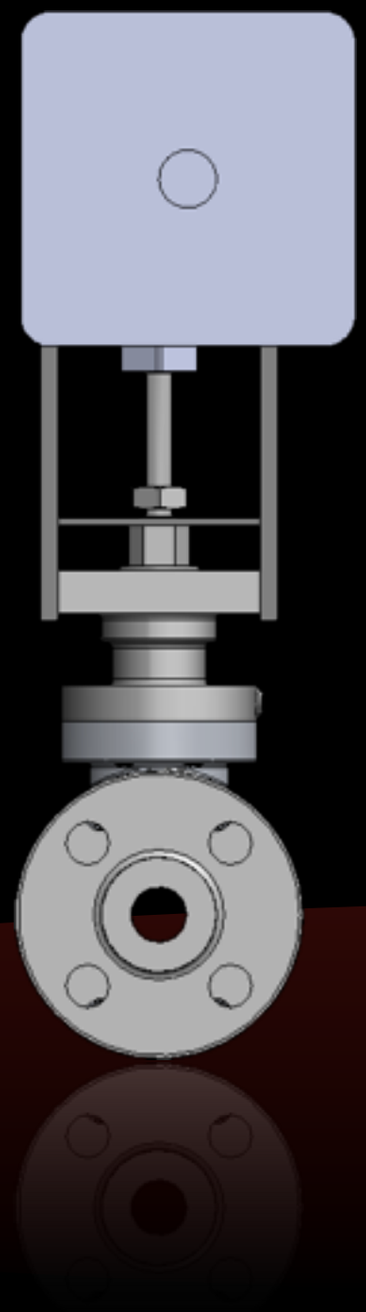
KEYSTONE



SINGLE PACKING

AUTOCLAVE

METAL SEATED BALL VALVE

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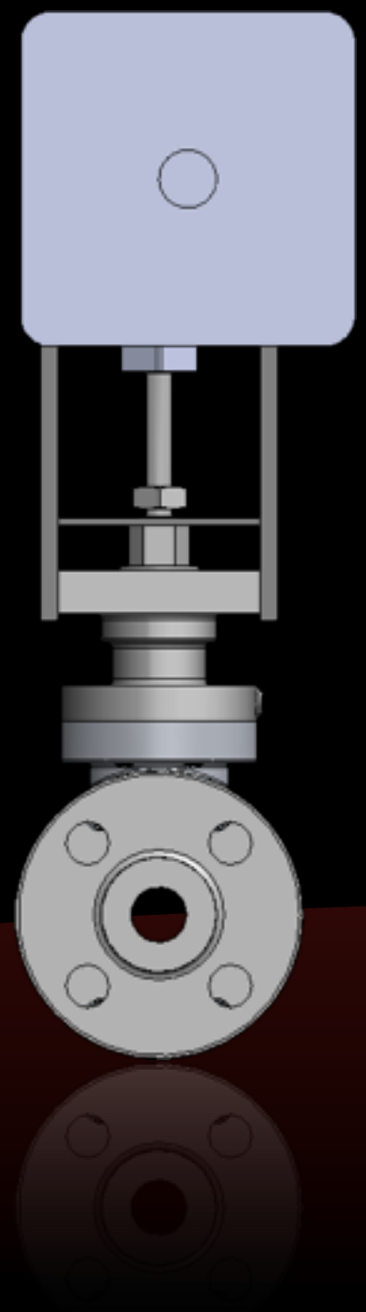
KEYSTONE



SINGLE PACKING

When packing leaks, there is risk of downtime, expense and injury

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KEYSTONE

AUTOCLAVE

METAL SEATED BALL VALVE

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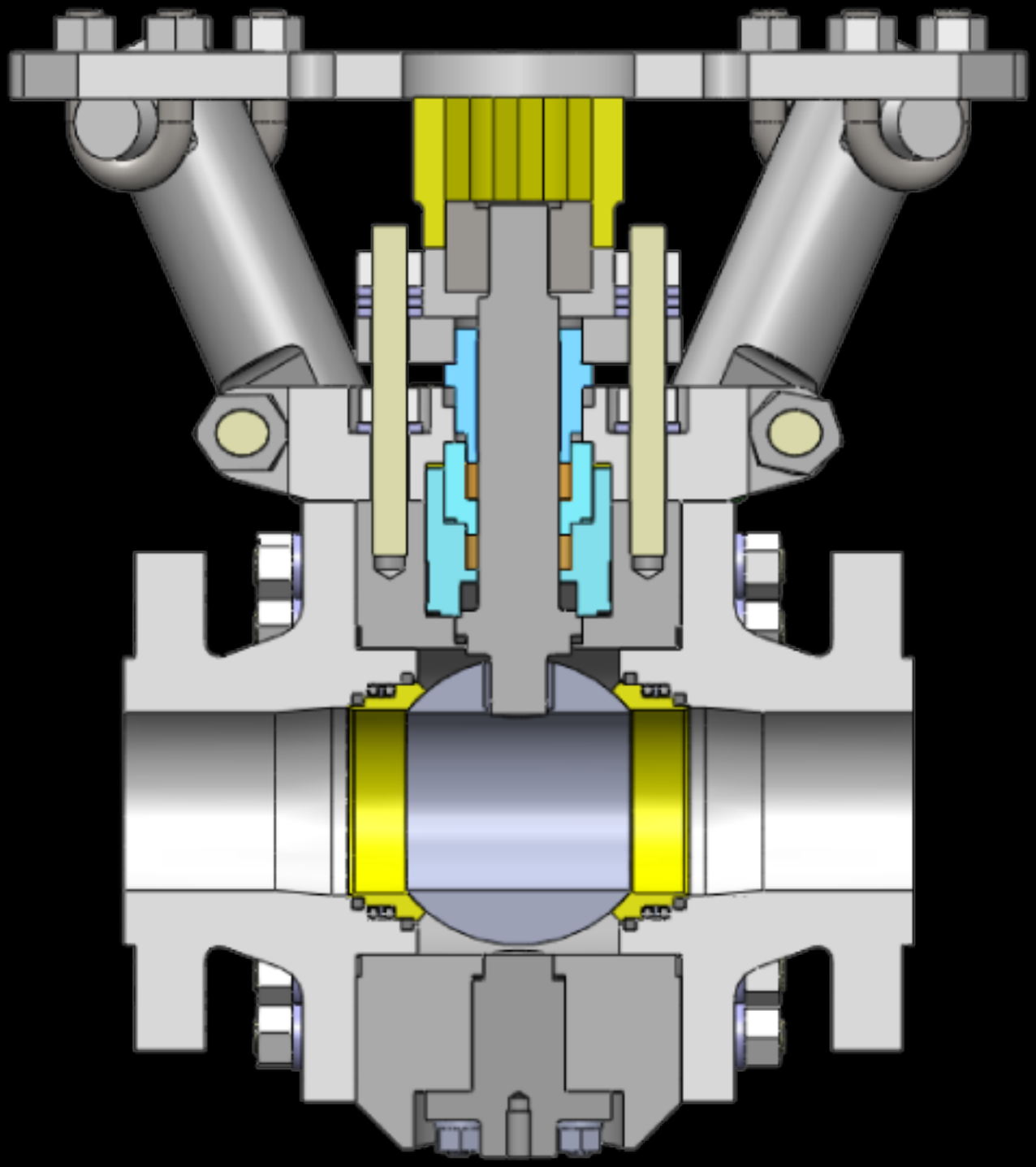
KEYSTONE



DUAL PACKING

AUTOCLAVE

METAL SEATED BALL VALVE

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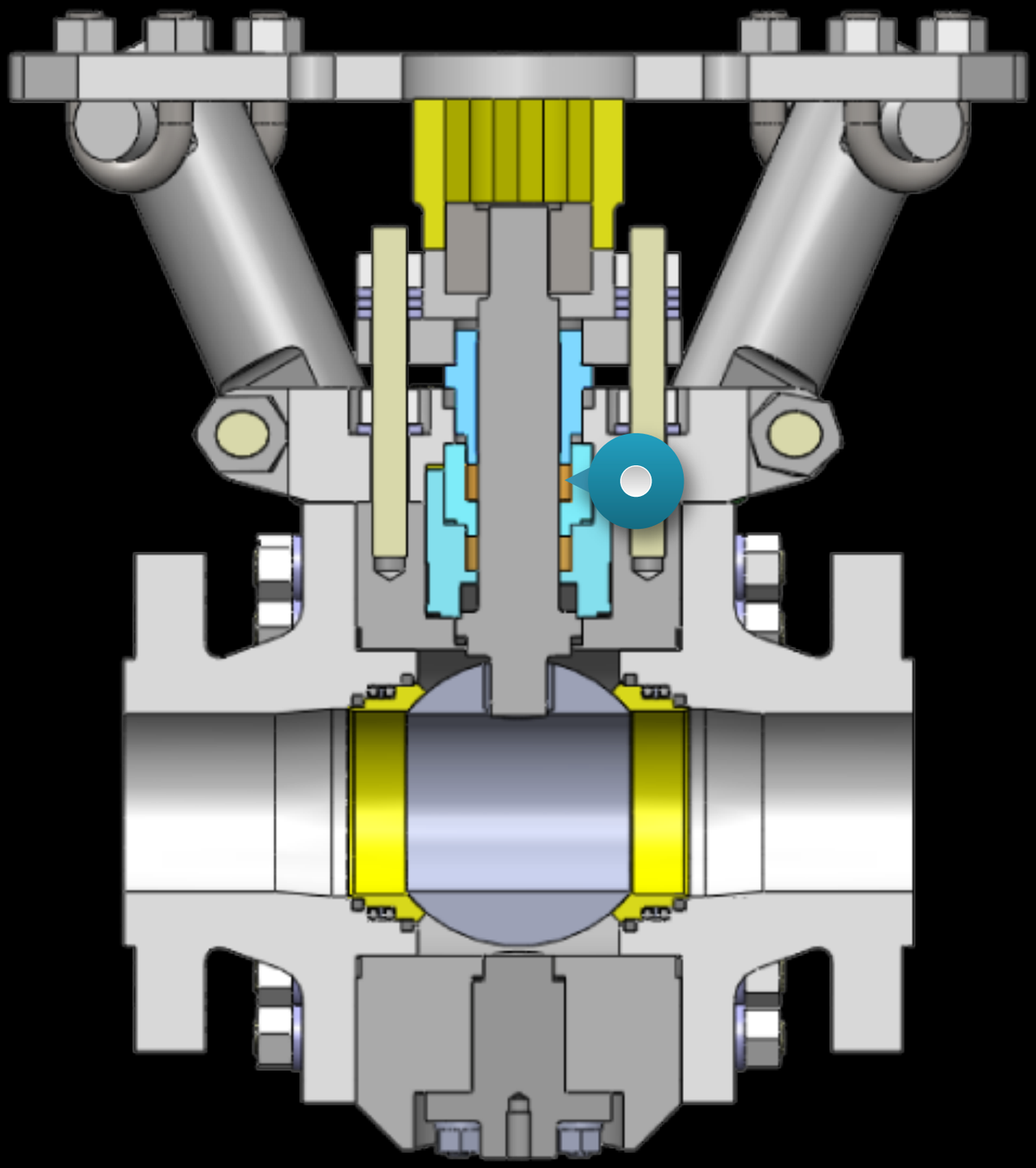
KEYSTONE



DUAL PACKING

Live loaded upper packing

AUTOCLAVE

METAL SEATED BALL VALVE

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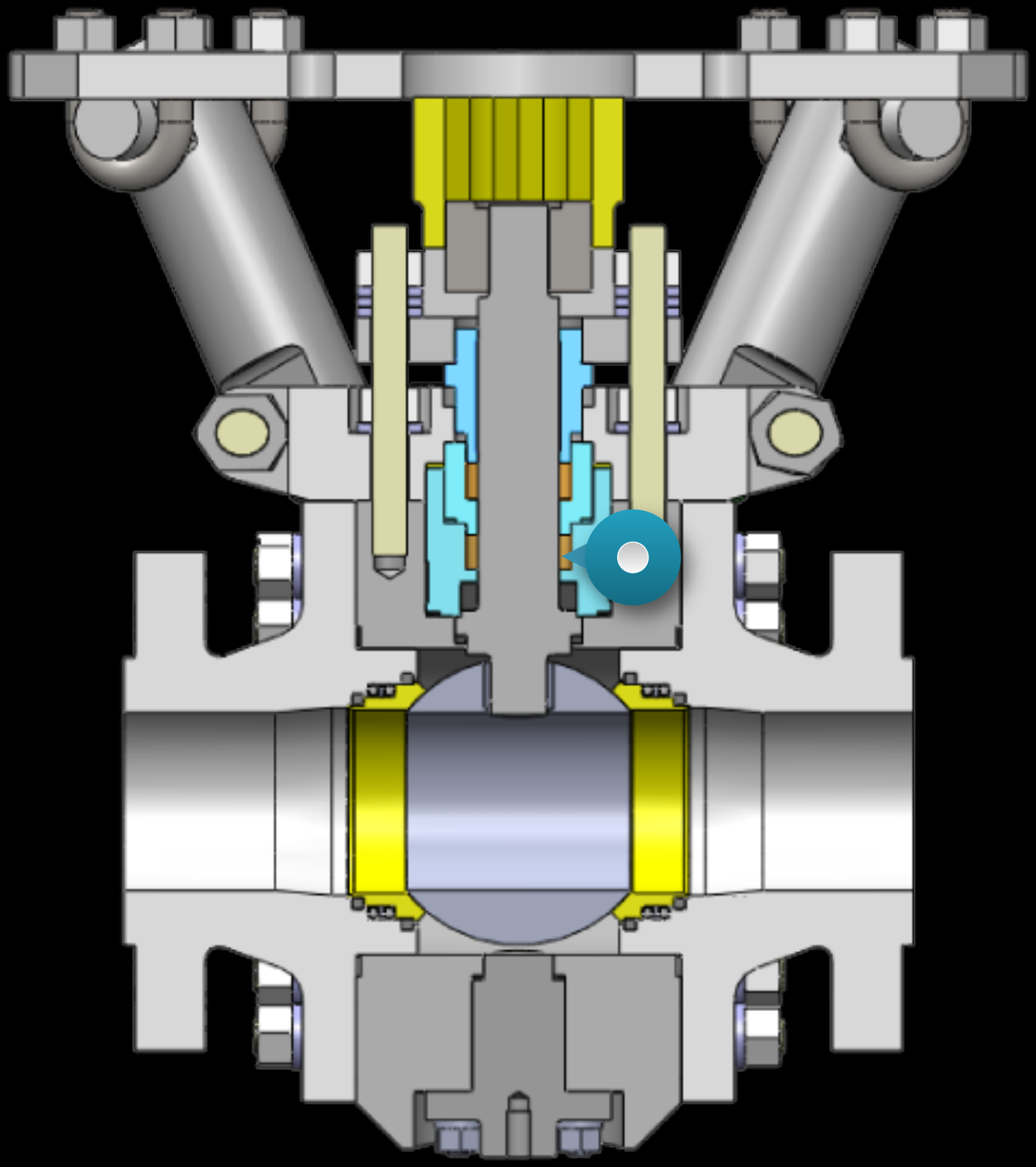
KEYSTONE



DUAL PACKING

Live loaded upper packing

Lower packing

AUTOCLAVE

METAL SEATED BALL VALVE

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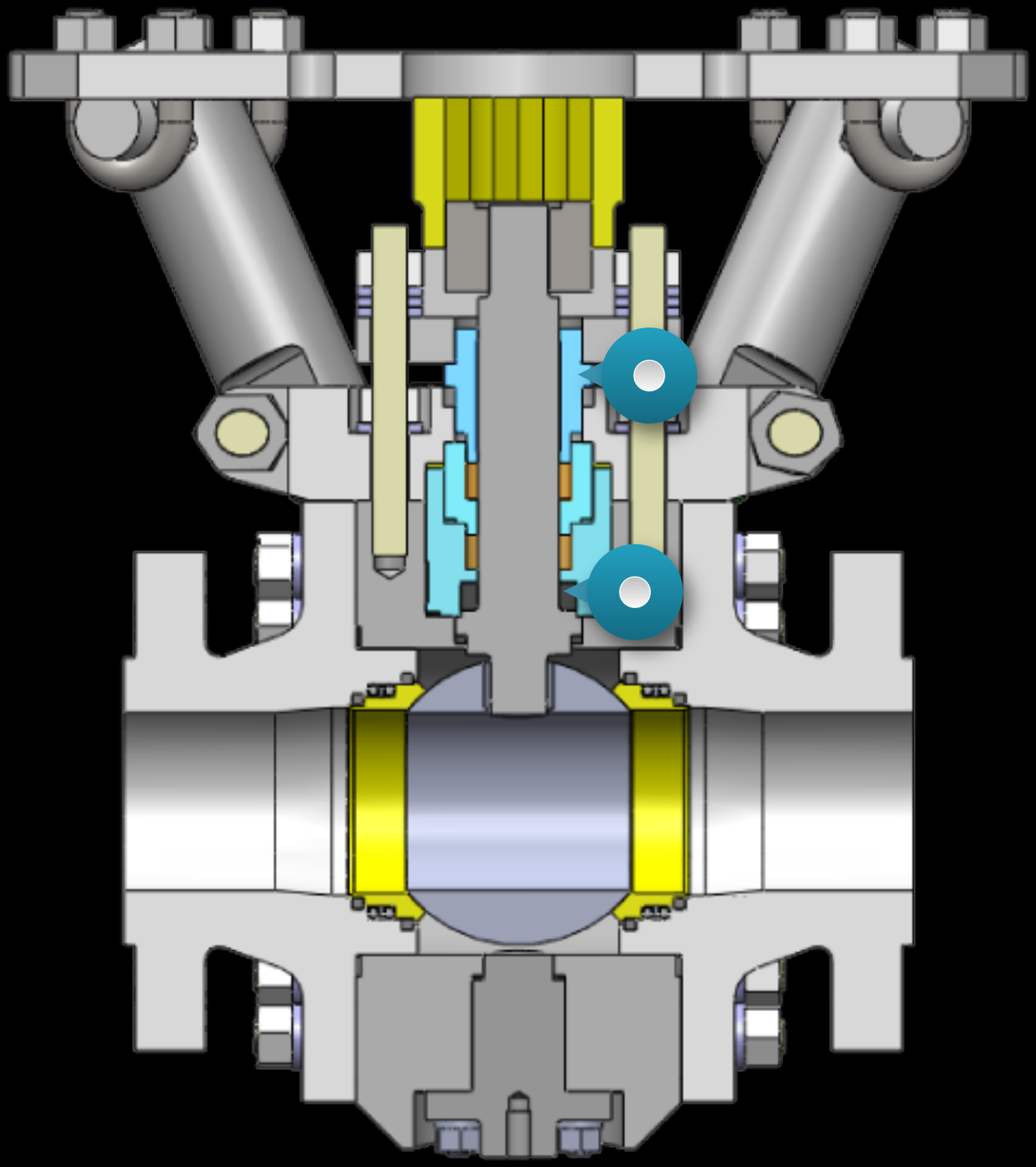
KEYSTONE



DUAL PACKING

Live loaded upper packing

Lower packing

Dual stem guides and graphite wipers

AUTOCLAVE

METAL SEATED BALL VALVE

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KEYSTONE

TRIM HARDENING	HVOF	Boronizing
ACTUATOR MOUNTING	Bent Bracket	Tripod Mount
CATALYST BUILDUP	Sealed Seats	Graphite wipers
SEAT LOADING	Belleville Washer	C-Ring
SEAT DESIGN	Standard	Scraper
STEM SLOT	Standard	Scalloped
STEM SEALING	Single Packing	Dual Packing
VERSATILITY	Limited	Trunnion plug

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COMPETITION VS. KEYSTONE

TRIM HARDENING	HVOF	Boronizing
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COMPETITION VS. KEYSTONE

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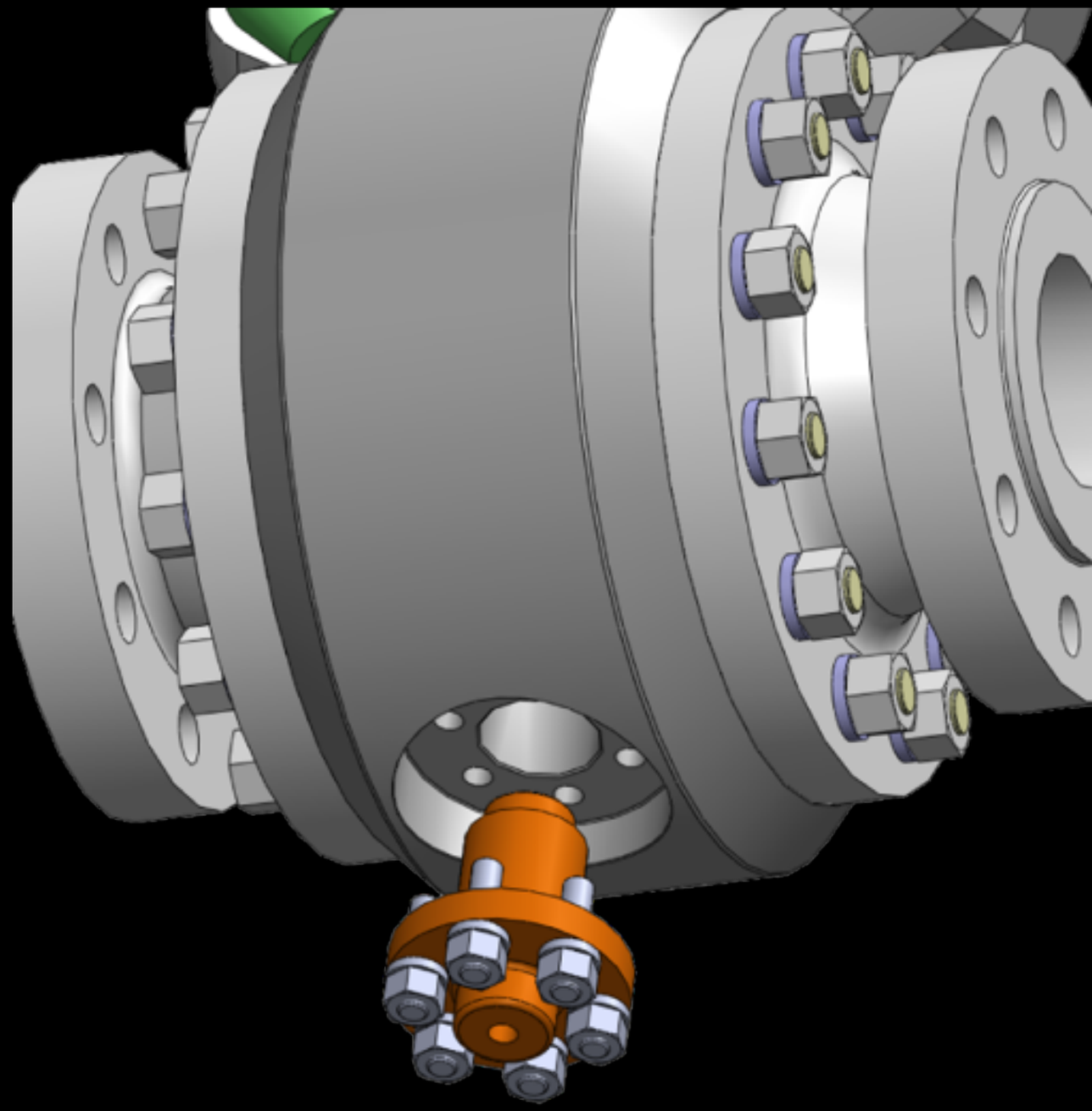

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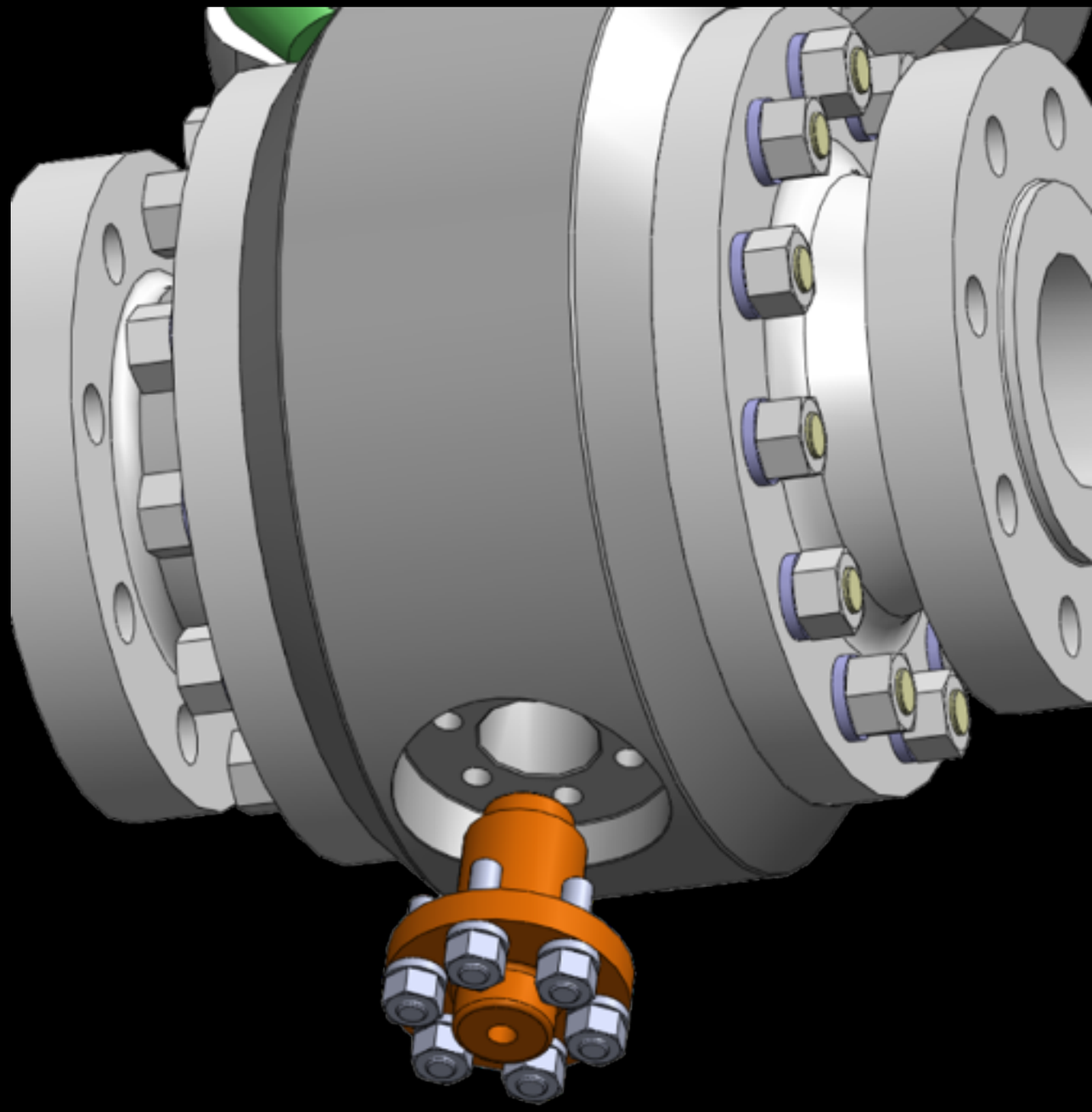
KEYSTONE

TRUNNION PLUG



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METAL SEATED BALL VALVE

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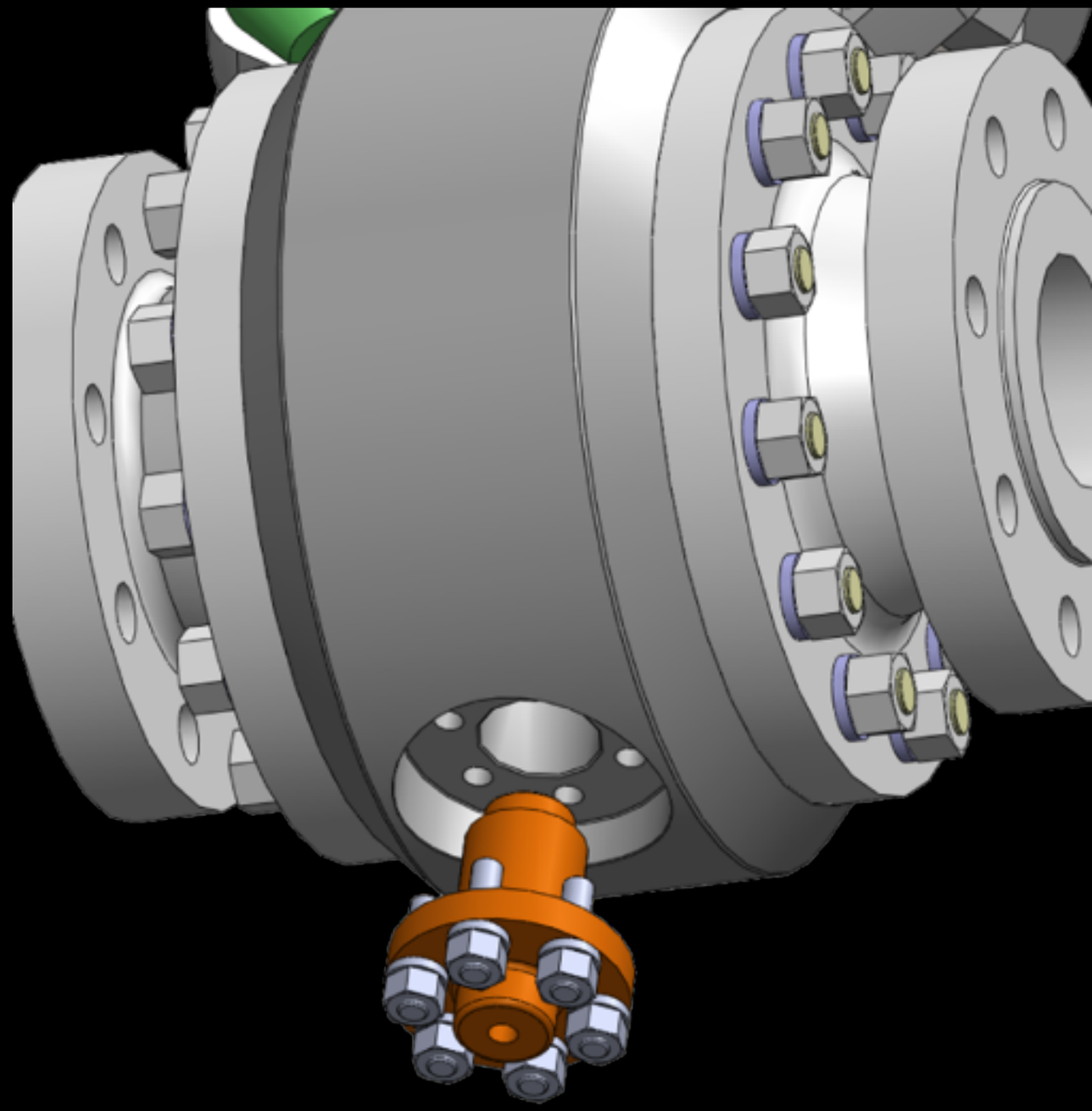
KEYSTONE

TRUNNION PLUG

Seat configurations are easily interchanged if needed



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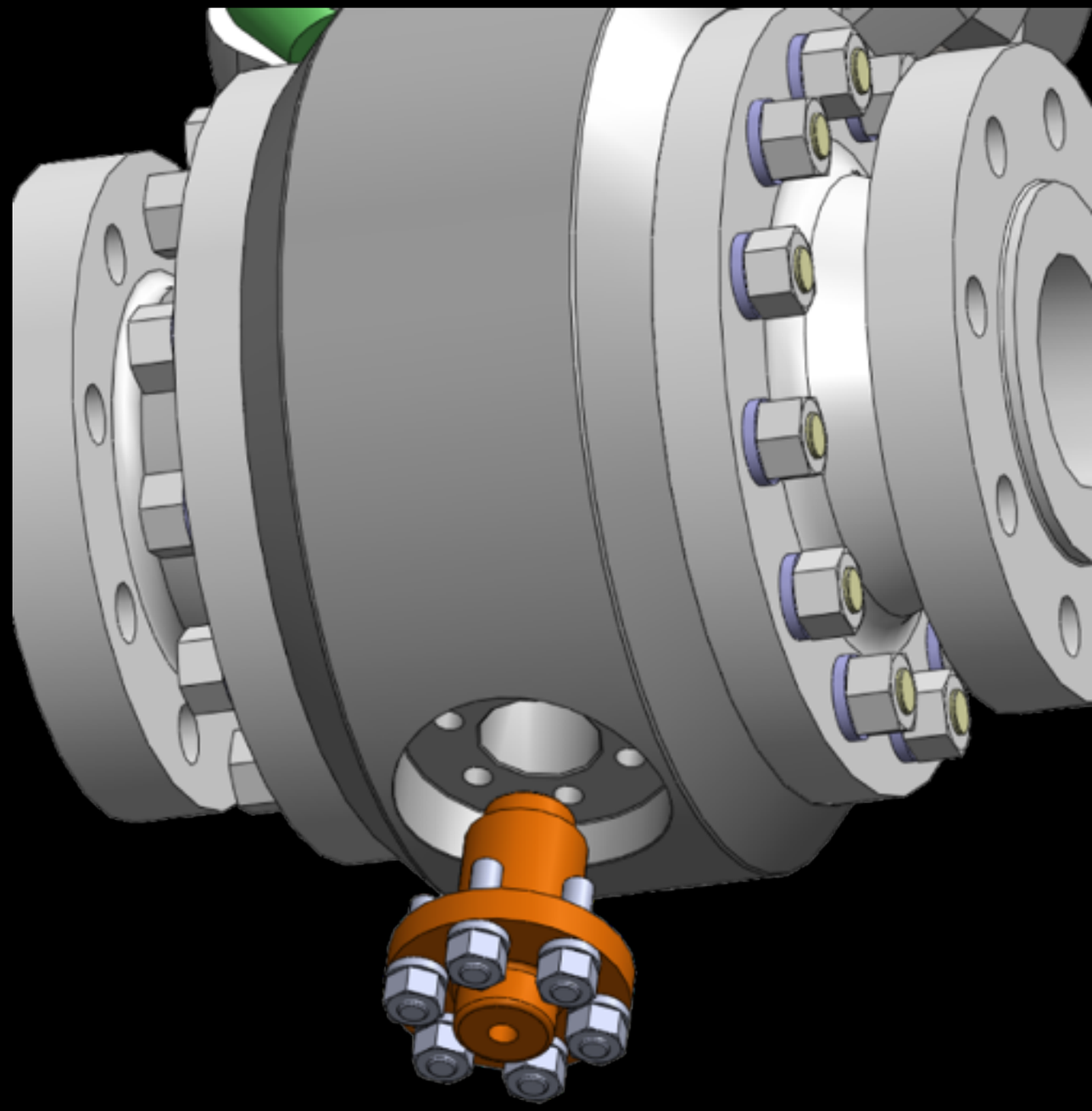
KEYSTONE

TRUNNION PLUG

Seat configurations are easily interchanged if needed

Current design is floating bidirectional



AUTOCLAVE

METAL SEATED BALL VALVE

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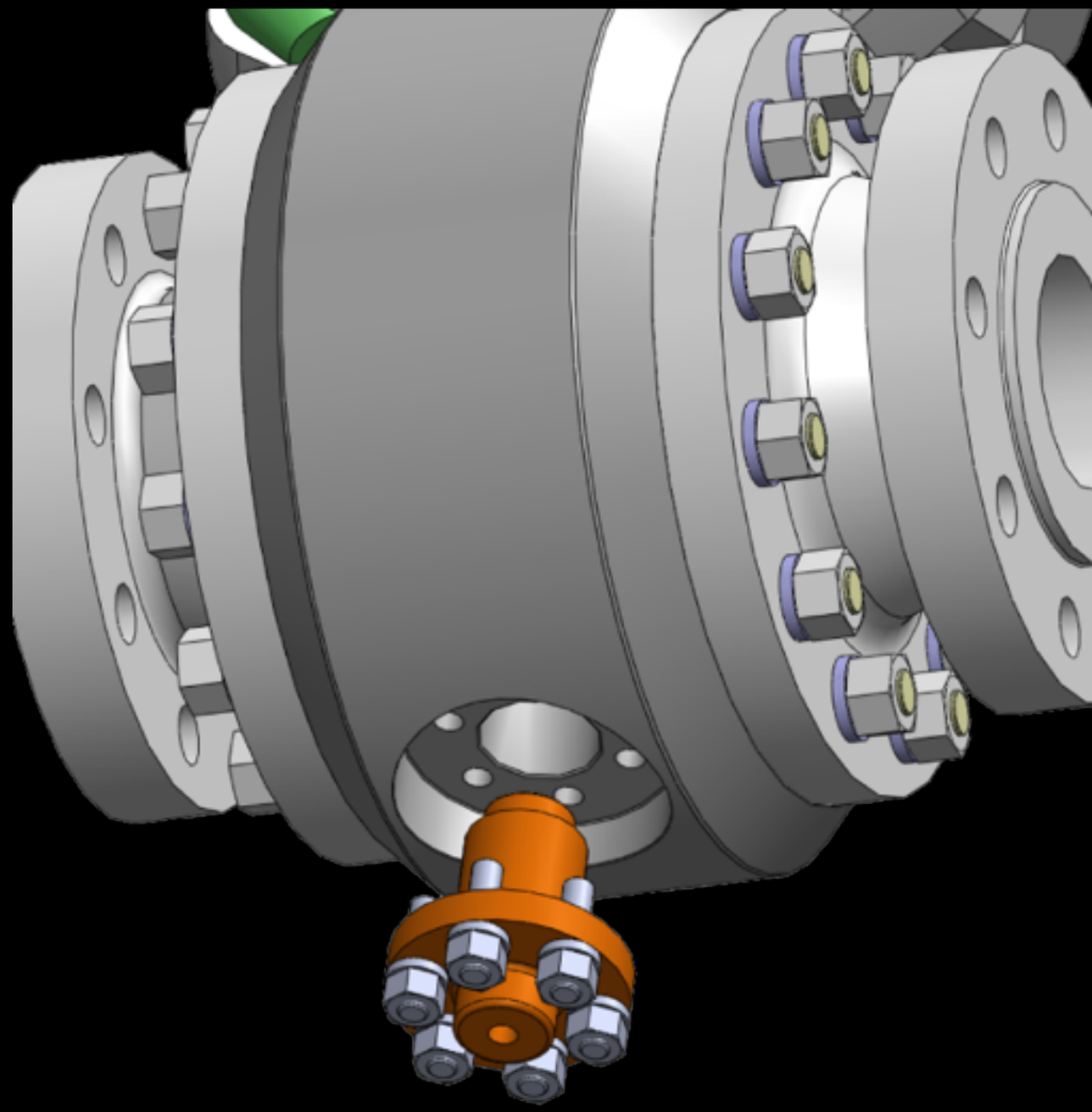
KEYSTONE

TRUNNION PLUG

Seat configurations are easily interchanged if needed

Current design is floating bidirectional

Trunnion mounted design or segmented ball design are possible



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DESIGN SPECIFICATIONS

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DESIGN SPECIFICATIONS

ASME B16.34, B16.5, B16.10, B16.11, B16.20

API 608, 598

MSS SP-25, SP-54, SP-55

ASTM A193/A 194M-96b, A194/A 194M-96

CRN 0911851.34567890YT

ISO 9001:2008

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FAST TRACK

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FAST TRACK

Expedited machining/assembly/shipping

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FAST TRACK

Expedited machining/assembly/shipping

Fee is based on costs incurred

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KEYSTONE

FAST TRACK

Expedited machining/assembly/shipping

Fee is based on costs incurred

Not on time? No Fast Track charge.

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M-CLASS CONFIGURATIONS

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M-CLASS CONFIGURATIONS

ON/OFF

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M-CLASS CONFIGURATIONS

ON/OFF

VARI-V CONTROL

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M-CLASS CONFIGURATIONS

ON/OFF

VARI-V CONTROL

CRYOGENIC

AUTOCLAVE

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KEYSTONE

M-CLASS CONFIGURATIONS

ON/OFF

VARI-V CONTROL

CRYOGENIC

3-WAY DIVERTER

M-CLASS CONFIGURATIONS

ON/OFF

VARI-V CONTROL

CRYOGENIC

3-WAY DIVERTER

BLOCK & BLEED

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SATISFIED KEYSTONE CUSTOMERS

SATISFIED KEYSTONE CUSTOMERS

SATISFIED KEYSTONE CUSTOMERS

EXXON

中国石化
SINOPEC

SATISFIED KEYSTONE CUSTOMERS

EXXON

中国石化
SINOPEC

GE

SATISFIED KEYSTONE CUSTOMERS

noranda

EXXON

SINOPEC

GE

SATISFIED KEYSTONE CUSTOMERS

noranda

BAYER

Bayer

EXXON

SINOPEC

GE

SATISFIED KEYSTONE CUSTOMERS

noranda

BAYER

Bayer

EXXON

NASA

中国石化 SINOPEC

GE

SATISFIED KEYSTONE CUSTOMERS

noranda

BAYER

Bayer

EXXON

NASA

SINOPEC

HUSKY

GE

SATISFIED KEYSTONE CUSTOMERS

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EXXON

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DUPONT®

The miracles of science™

HUSKY

GE

We have approximately 250 [Keystone] valves at Pasadena Refining. They are installed at various locations in the plant, including the S Zorb, Crude, Coker and Alky at this time.

[Keystone] Valves has provided us with exceptional after sales, service, faster delivery, and highquality product than any of our current valves supplier. They understand our processes and I ha confidence in any valve they specify.

- Christopher Owens, TAR Planning and Execution Procurement/ Contracts Coordinator, Pasadena Refining

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METAL SEATED BALL VALVE

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KEYSTONE

I would recommend [Keystone] Valves to any prospective customer and again, I tell you the services, quality of this [Keystone] valve is above 1st rate."

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KEYSTONE

Our conclusion was that [Keystone] was the 'A' rated valve for this service..., Mogas was rated 'C', VTI was rated 'F'..."

[Keystone] has excellent after sales support. At Wood River and PRSI, any issue with their valves received immediate attention, as seen when some [Keystone] valves were installed incorrectly.

[Keystone] immediately traveled to the site and did not charge for this service.

- Bill Gerrie, Lead Instrument and Control Engineer
ConocoPhillips, Ferndale Washington

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KEYSTONE

I recommend [Keystone] not as a matter of brand preference but as the end result of a thorough engineering evaluation.

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OTHER M-CLASS VALVES

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KEYSTONE

OTHER M-CLASS VALVES

Made-to-order metal seated valves

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OTHER M-CLASS VALVES

Made-to-order metal seated valves

½” to 16” full port, Up to 4500# class

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OTHER M-CLASS VALVES

Made-to-order metal seated valves

½” to 16” full port, Up to 4500# class

-328 °F/-200 °C to 1292 °F/700 °C

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KEYSTONE

OTHER M-CLASS VALVES

Made-to-order metal seated valves

½” to 16” full port, Up to 4500# class

-328 °F/-200 °C to 1292 °F/700 °C

Shortest lead times in the industry

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KEYSTONE

OTHER M-CLASS VALVES

Made-to-order metal seated valves

½” to 16” full port, Up to 4500# class

-328 °F/-200 °C to 1292 °F/700 °C

Shortest lead times in the industry

Most extreme applications

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OTHER KEYSTONE PRODUCTS

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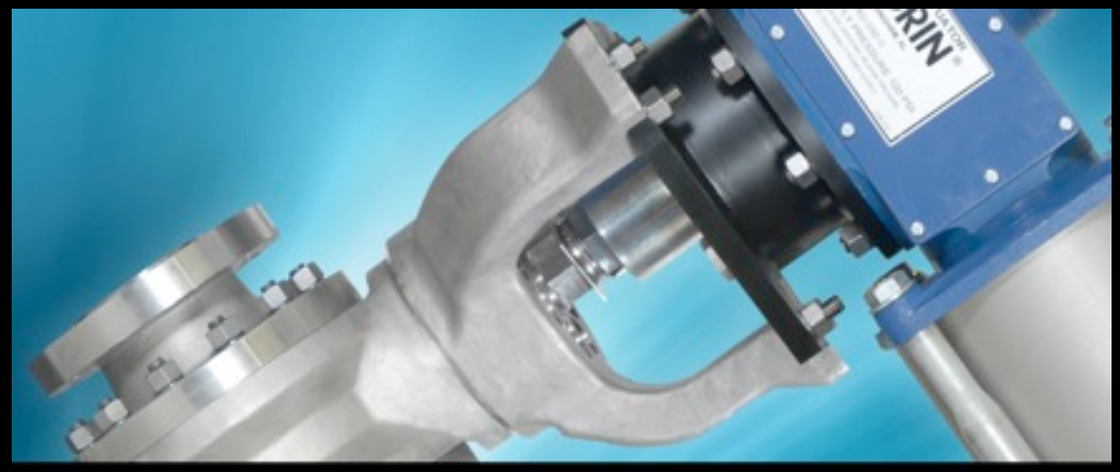
KEYSTONE

OTHER KEYSTONE PRODUCTS

S-CLASS

SOFT SEATED BALL VALVES

KEYSTONE



M-CLASS

METAL SEATED BALL VALVES

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