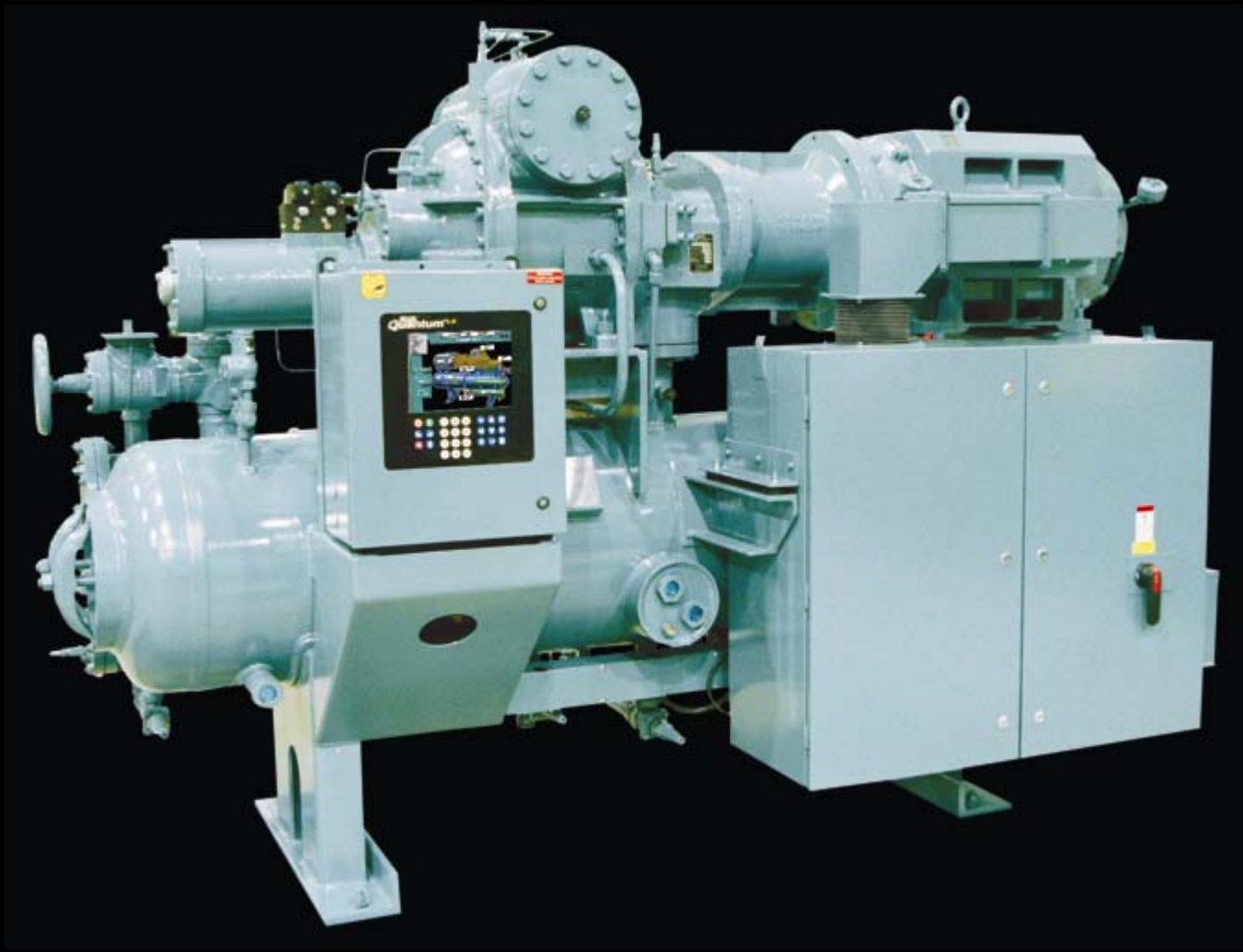
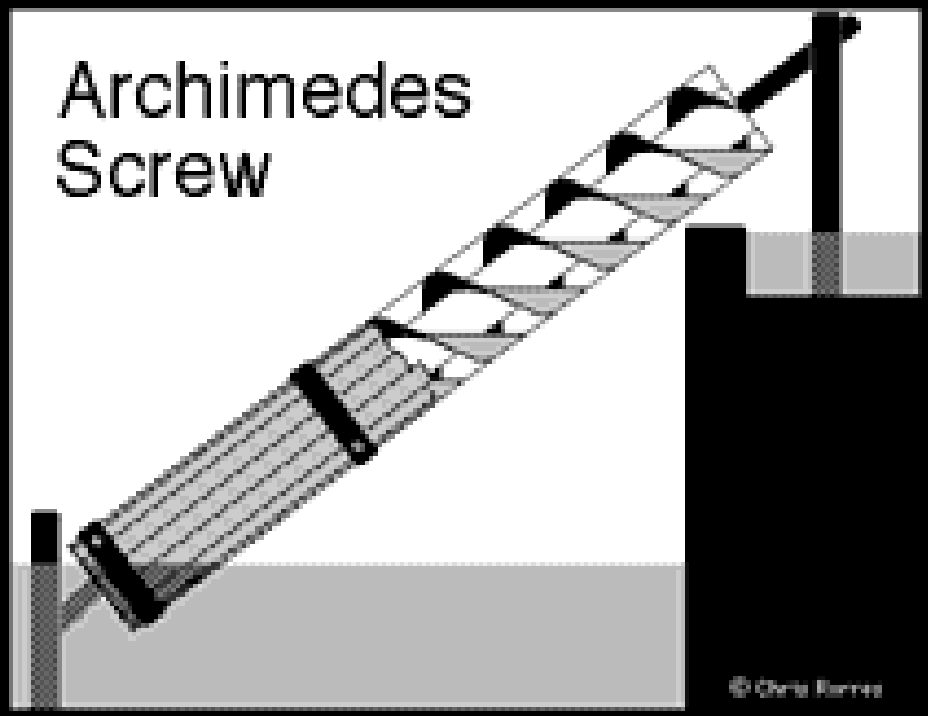
Frick
BY JOHNSON CONTROLS

ROTARY SCREW COMPRESSORS

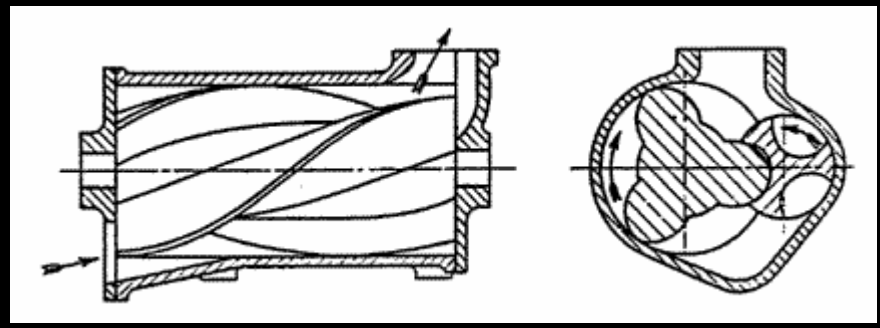


HISTORY

The concept of using a screw shape to perform work goes all the way back to Archimedes and the ancient Greeks.

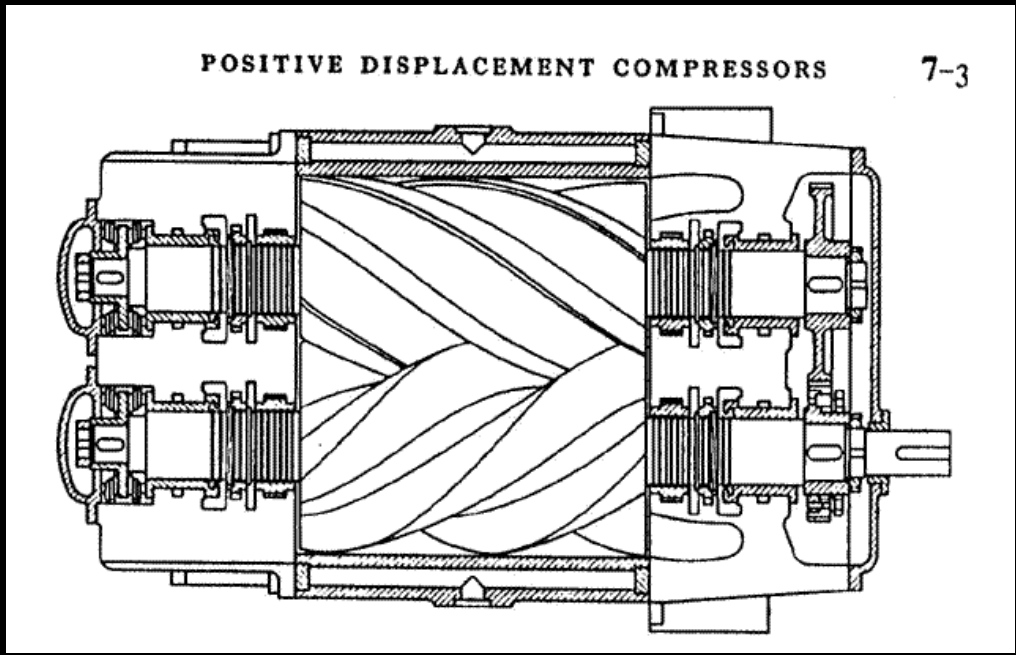


The first patents relating to the rotary screw compressor were entered in Germany in 1878 by Heinrich Krigar. The rotor design proposed by Krigar was similar to the Roots design but incorporated a 180 degree twist in the rotor lobes. The technology was not available at this time, however, to manufacture the rotors.



Fifty years later a Swedish steam turbine manufacturer named Ljungstroms Angturbin AB appointed a new chief engineer named Alf Lysholm. Lysholm was responsible not only for the design of a usable twin screw but he also patented the method to precisely manufacture the screws. Ljungstroms Angturbin AB later became SRM, Svenska Rotor Maskiner. SRM has licensed this technology to every major screw compressor manufacturer today.

The first prototype of a rotary screw was built in 1943. Early rotary screw compressors were typically air compressors designed to operate oil free. Rotors were initially geared to prevent the rotors from wearing excessively and evidenced excessive blow-by making the machines too inefficient to be used as refrigeration compressors.



In 1955, SRM, in association with Holroyd Company, the first economically useful screws were built using symmetrical rotors.

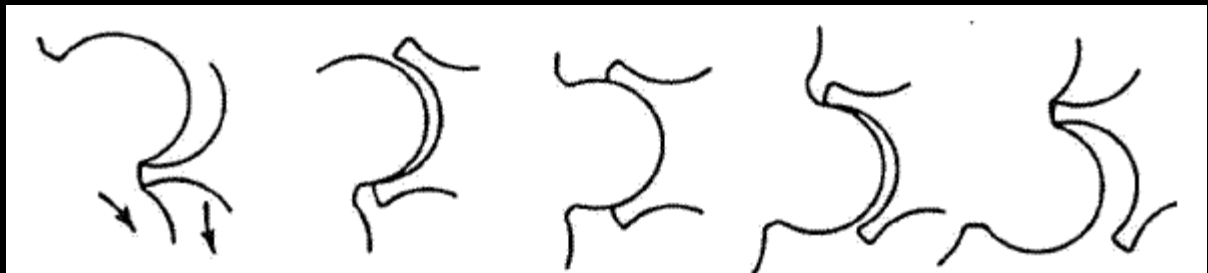


FIG. 7-12.—MESHING PROCESS OF OLD LOBE SHAPE

In 1960, the first oil injected screw was built with asymmetrical rotors and it was now possible to remove the gears and allow the male rotor to drive the female rotor directly, cushioned by the oil film between them.

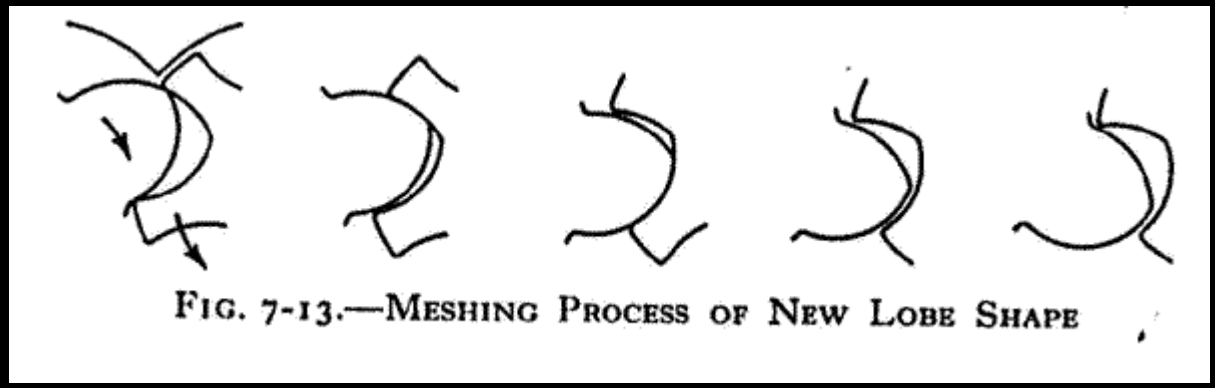


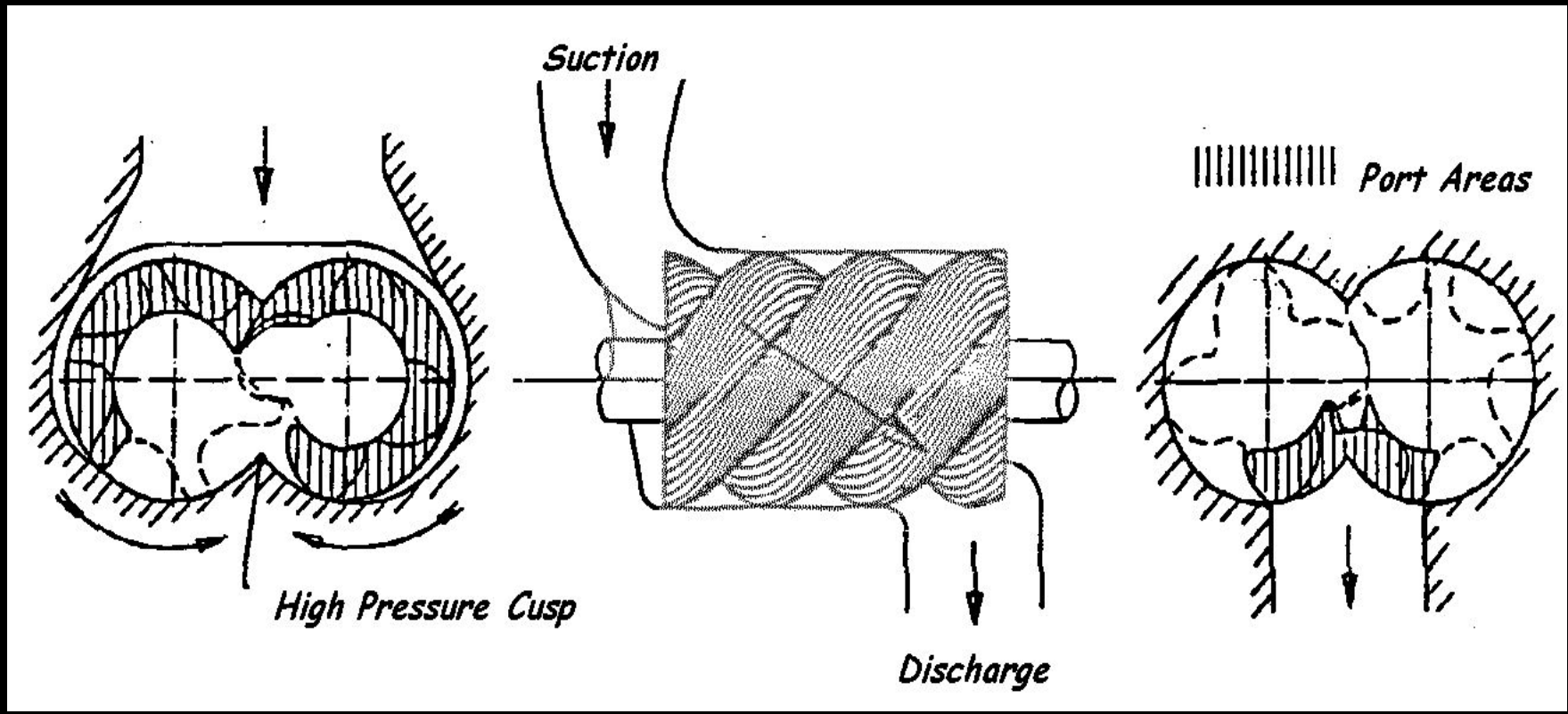
FIG. 7-13.—MESHING PROCESS OF NEW LOBE SHAPE

Screw compressors were now efficient enough that they could now be applied to refrigeration applications.

Fundamentals of Compression

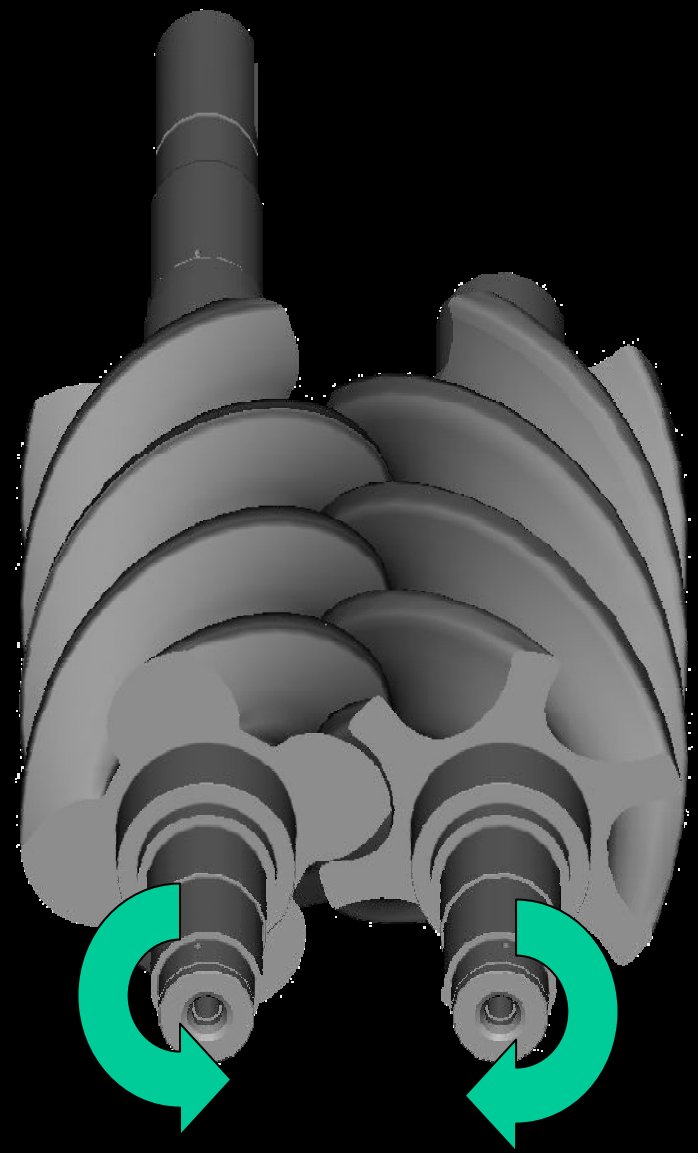
- Screw compressors are positive displacement volume reduction devices.
- The process is similar to a reciprocating compressor more than other compressor type.

Screw Compressor Basic Geometry



Construction

- Male and Female Rotors Mounted on Radial and Axial Bearings.
- Fitted in close tolerance intersecting bores.
- Lobe Combinations M+F, 4+6, 5+7, 5+6

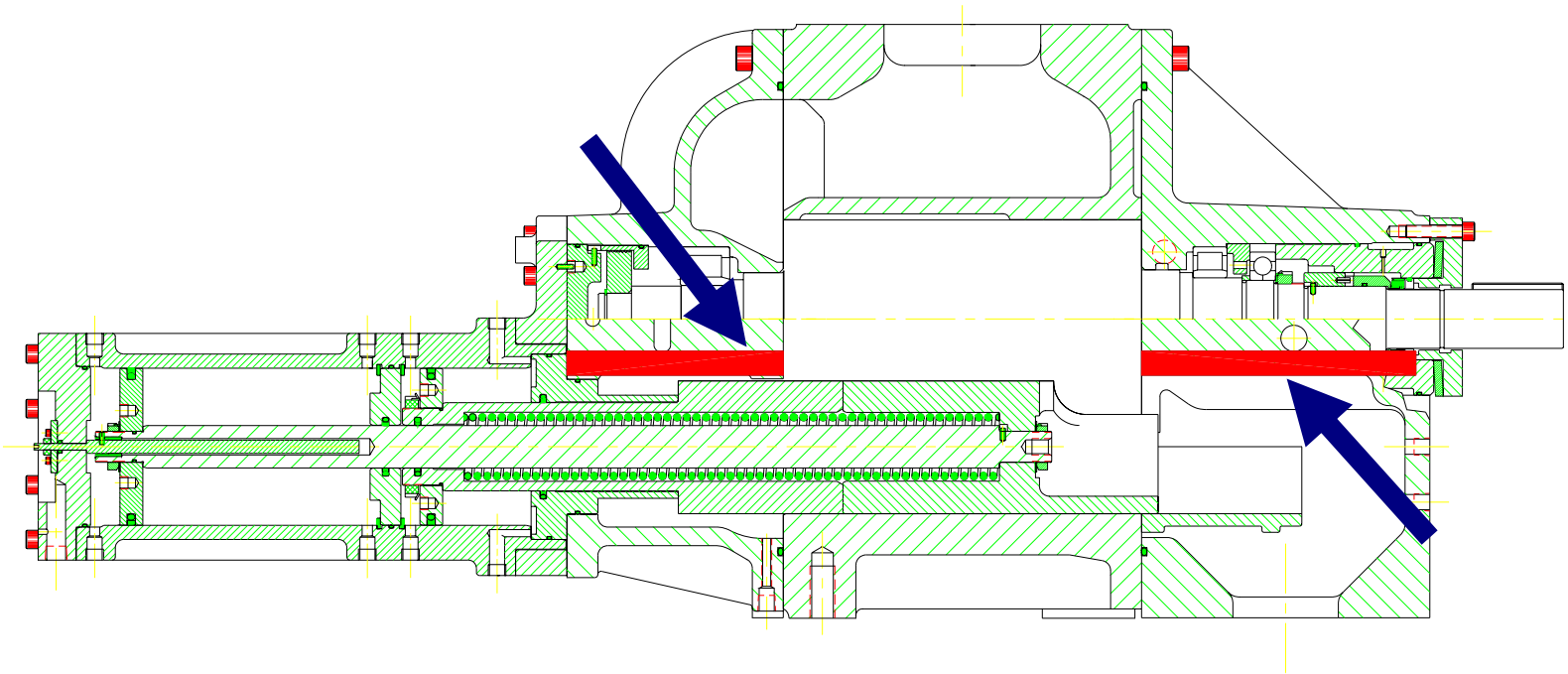


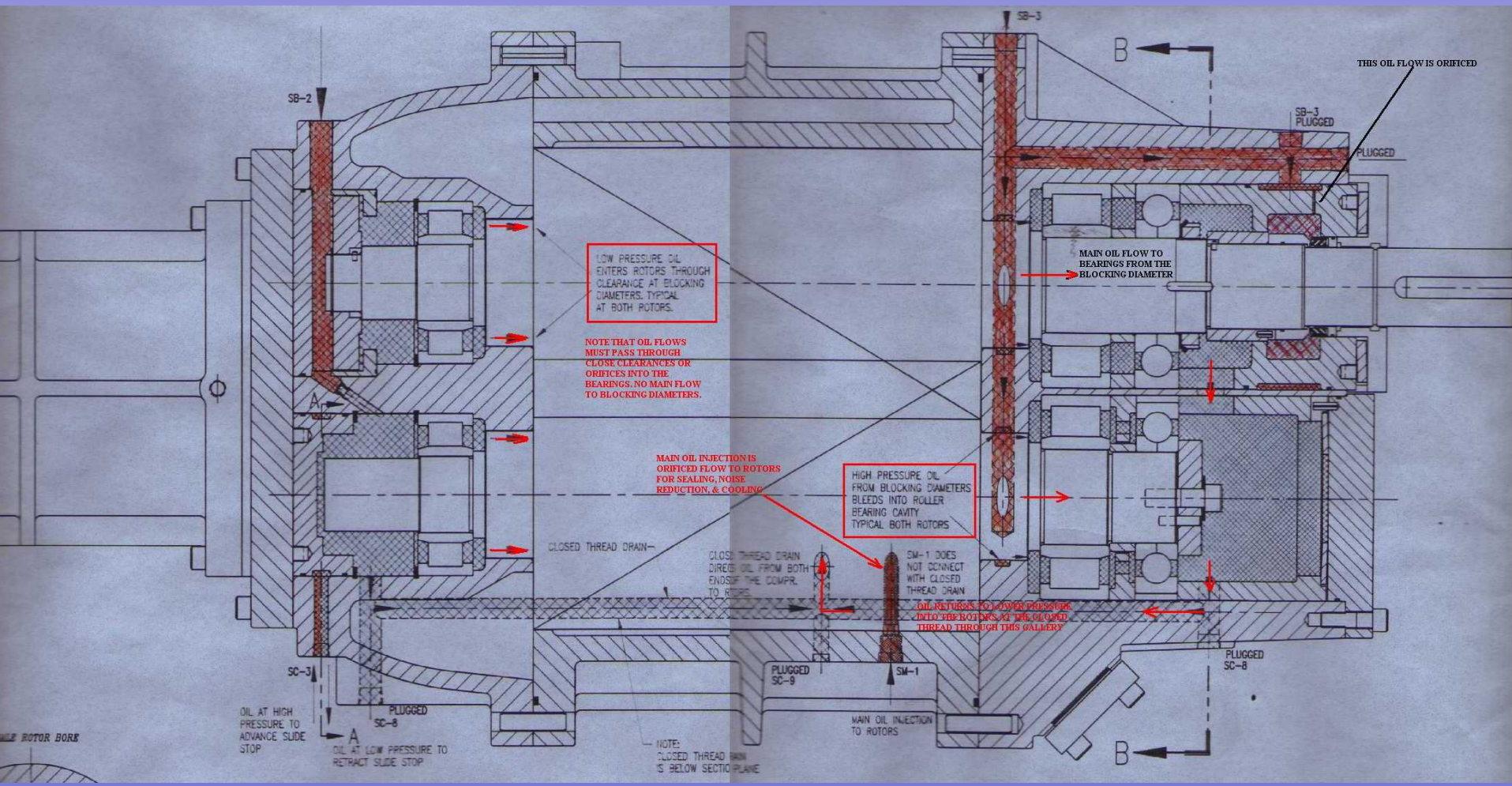
Male Rotor 3600rpm
Female Rotor 2400 rpm

Oil Injection

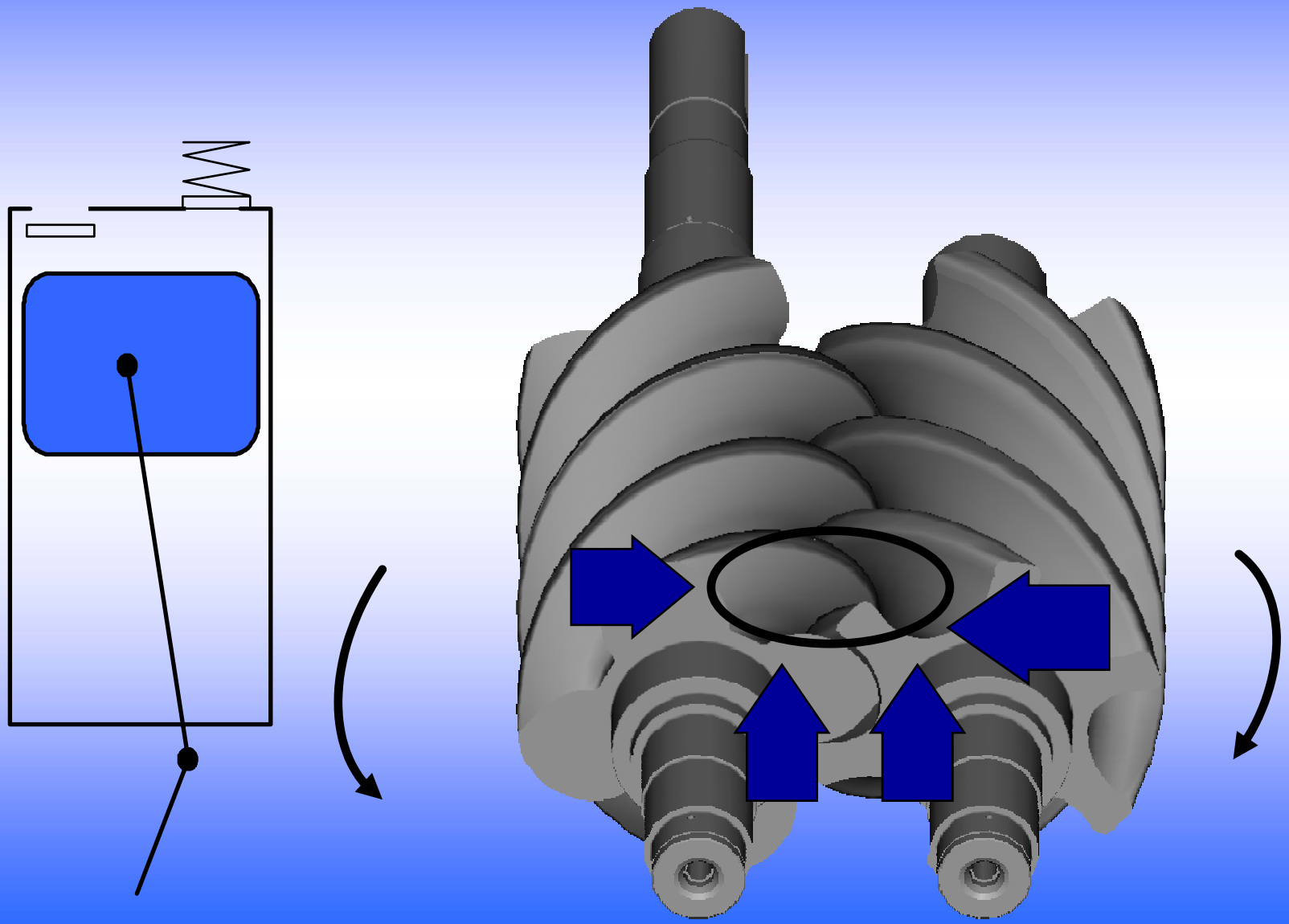
- Oil is used for lubrication, sealing, cooling, and to dampen vibration.
- 10-20 GPM injected per 100 horsepower
- Transfers heat of compression to the oil
- Maintains low discharge temperatures even at very high compression ratios.
- Makes simple systems possible at high Compression Ratios

Oil Reservoirs

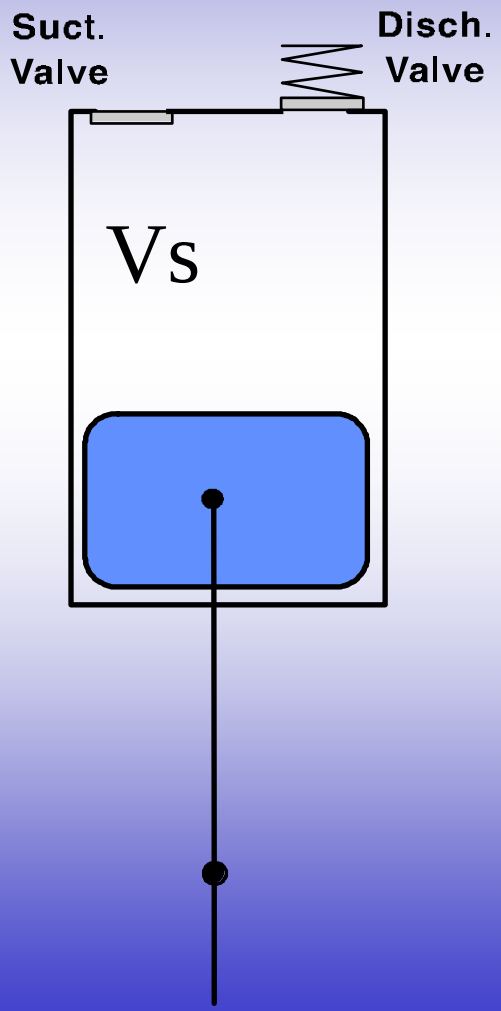


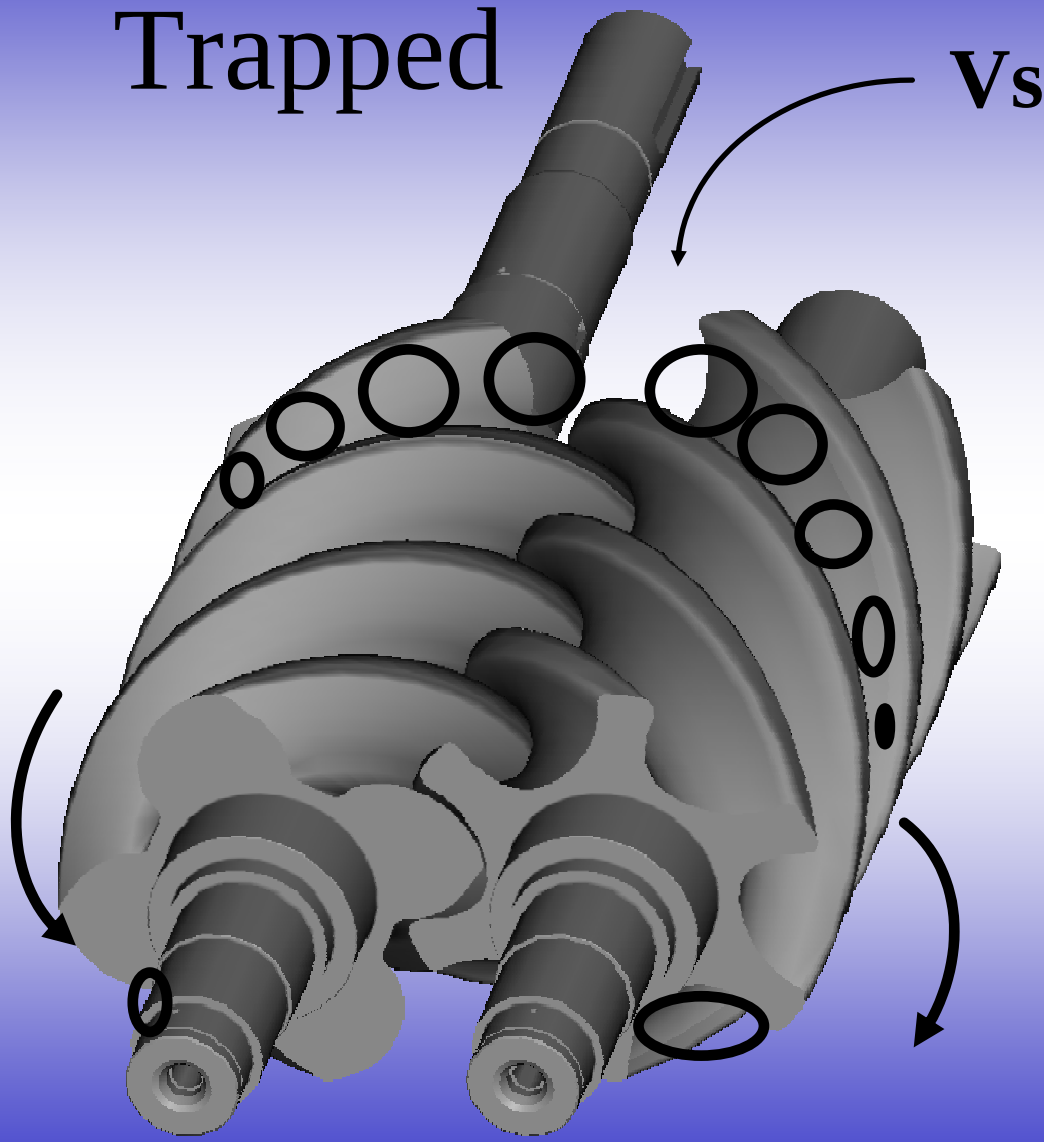

SB-2
SB-3
B
THIS OIL FLOW IS ORIFICED
SB-3 PLUGGED
PLUGGED
MAIN OIL FLOW TO BEARINGS FROM THE BLOCKING DIAMETER
LOW PRESSURE OIL ENTERS ROTORS THROUGH CLEARANCE AT BLOCKING DIAMETERS. TYPICAL AT BOTH ROTORS.
NOTE THAT OIL FLOWS MUST PASS THROUGH CLOSE CLEARANCES OR ORIFICES INTO THE BEARINGS. NO MAIN FLOW TO BLOCKING DIAMETERS.
A
MAIN OIL INJECTION IS ORIFICED FLOW TO ROTORS FOR SEALING, NOISE REDUCTION, & COOLING
HIGH PRESSURE OIL FROM BLOCKING DIAMETERS BLEEDS INTO ROLLER BEARING CAVITY TYPICAL BOTH ROTORS
CLOSED THREAD DRAIN
CLOSED THREAD DRAIN DIRECTS OIL FROM BOTH ENDS OF THE COMPR. TO RTORS
SM-1 DOES NOT CONNECT WITH CLOSED THREAD DRAIN
OIL RETURNS TO LOWER PRESSURE INTO THE ROTORS AT THE CLOSED THREAD THROUGH THIS GALLERY
SC-3
PLUGGED SC-9
SM-1
PLUGGED SC-8
OIL AT HIGH PRESSURE TO ADVANCE SLIDE STOP
PLUGGED SC-8
A
OIL AT LOW PRESSURE TO RETRACT SLIDE STOP
MAIN OIL INJECTION TO ROTORS
NOTE: CLOSED THREAD DRAIN IS BELOW SECTION PLANE
B

Suction process

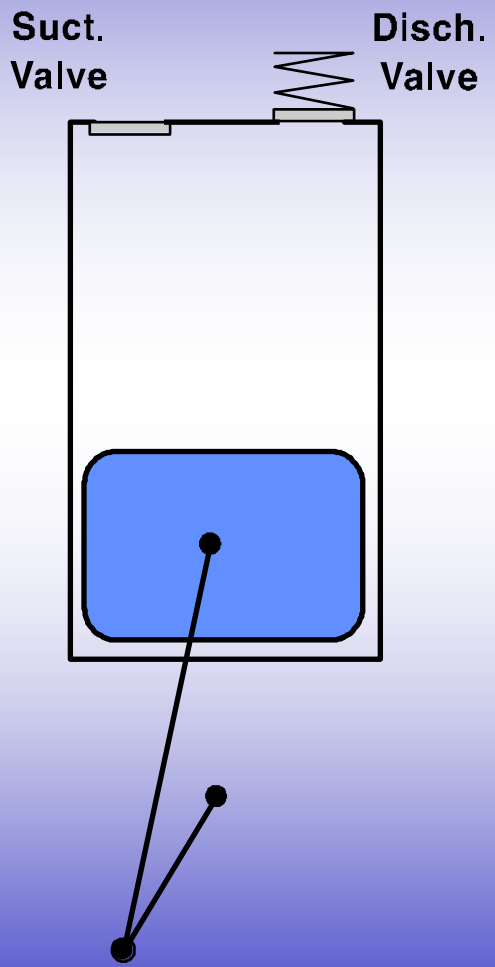


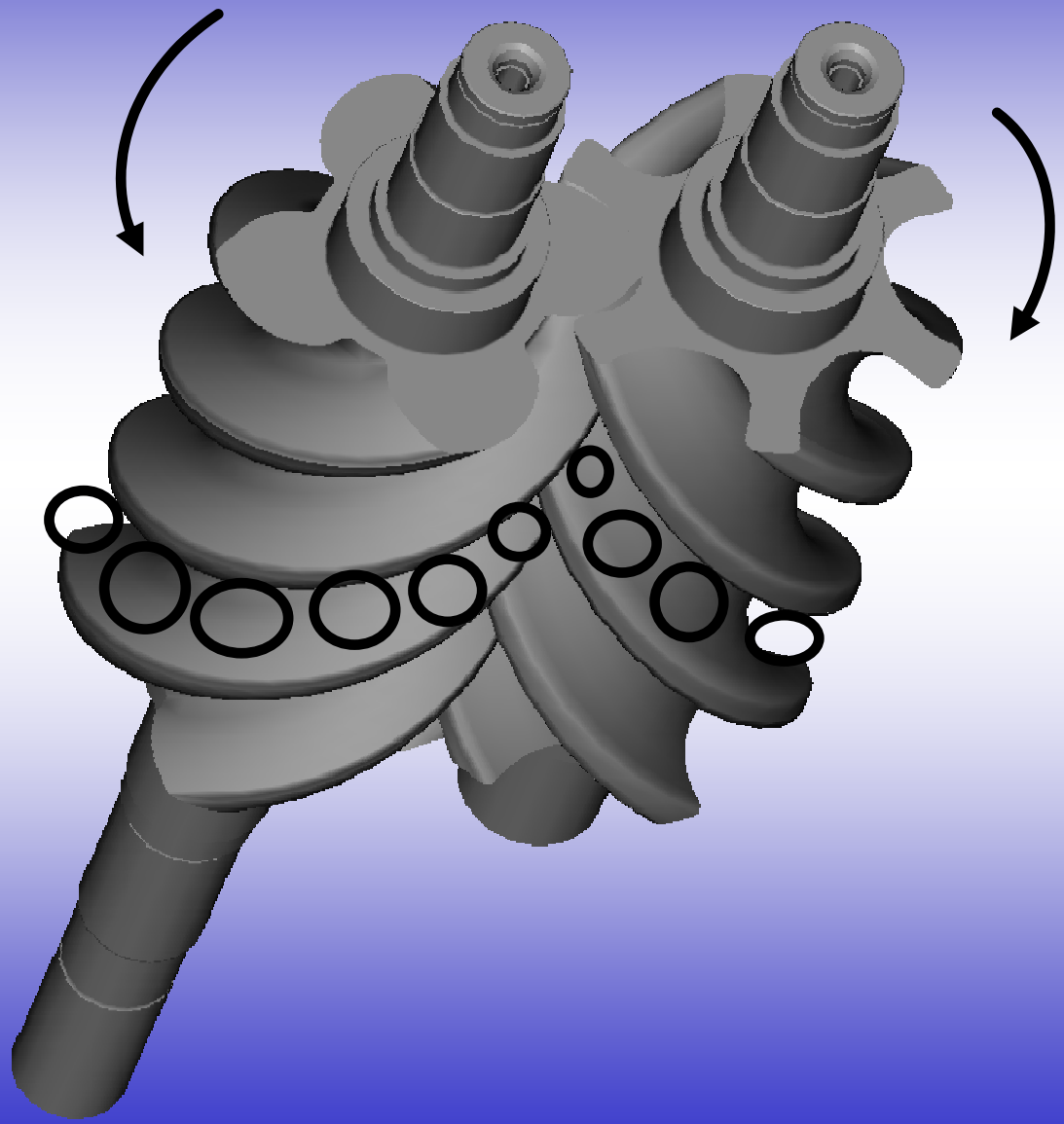
Maximum Suction Volume Trapped



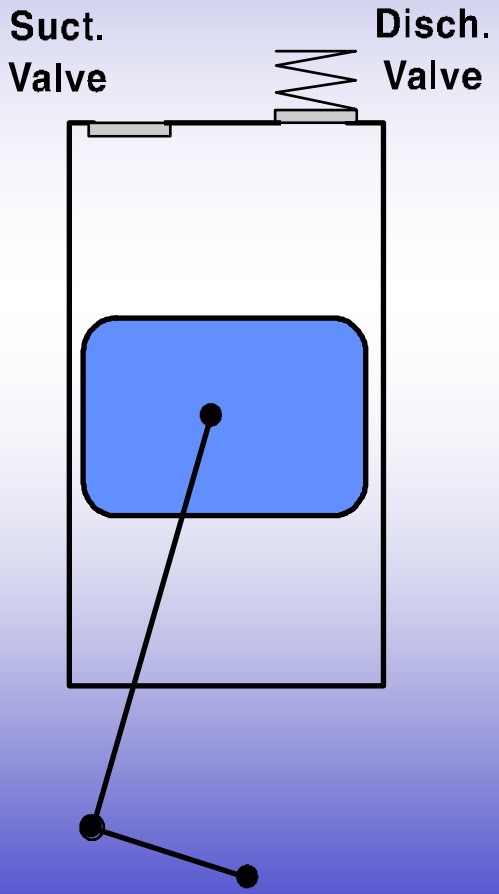


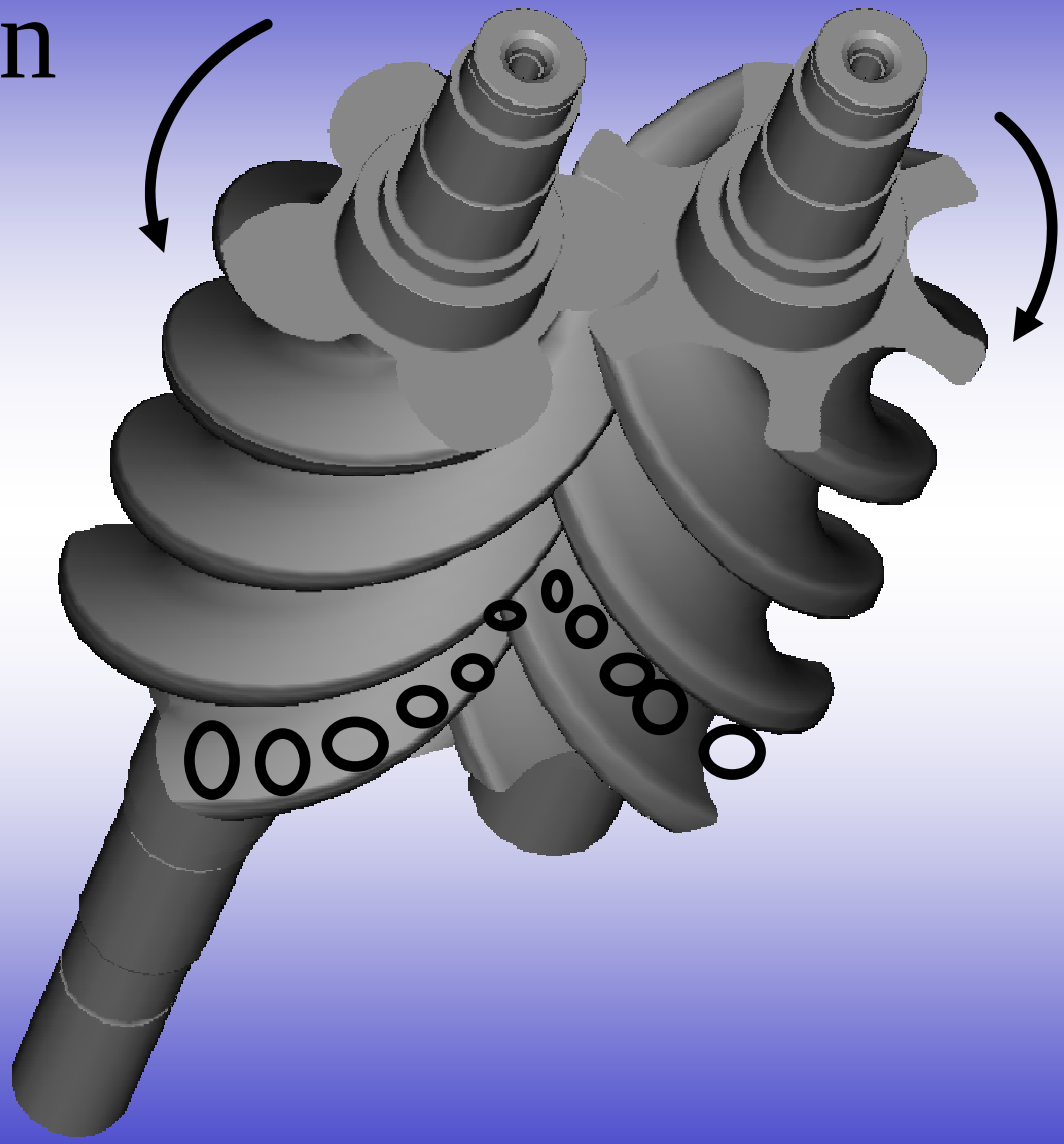
Transfer



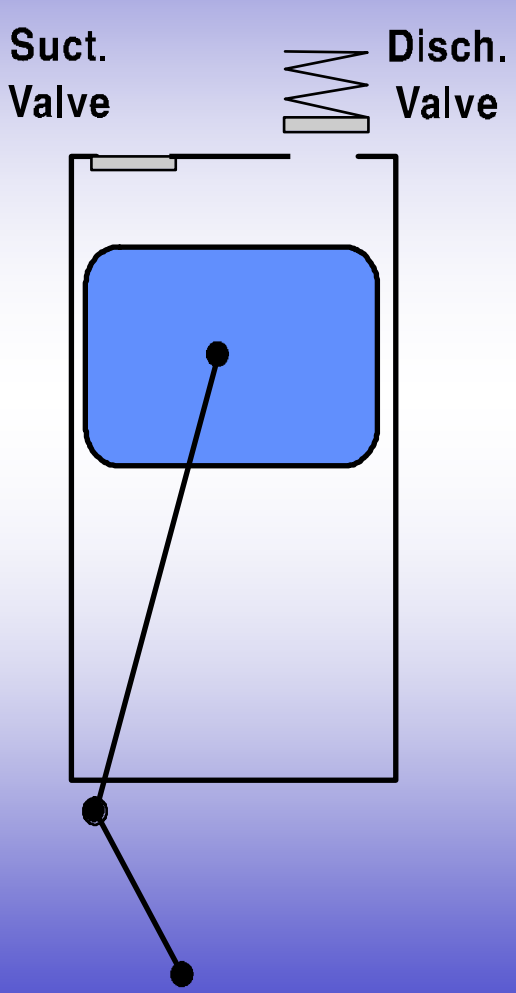


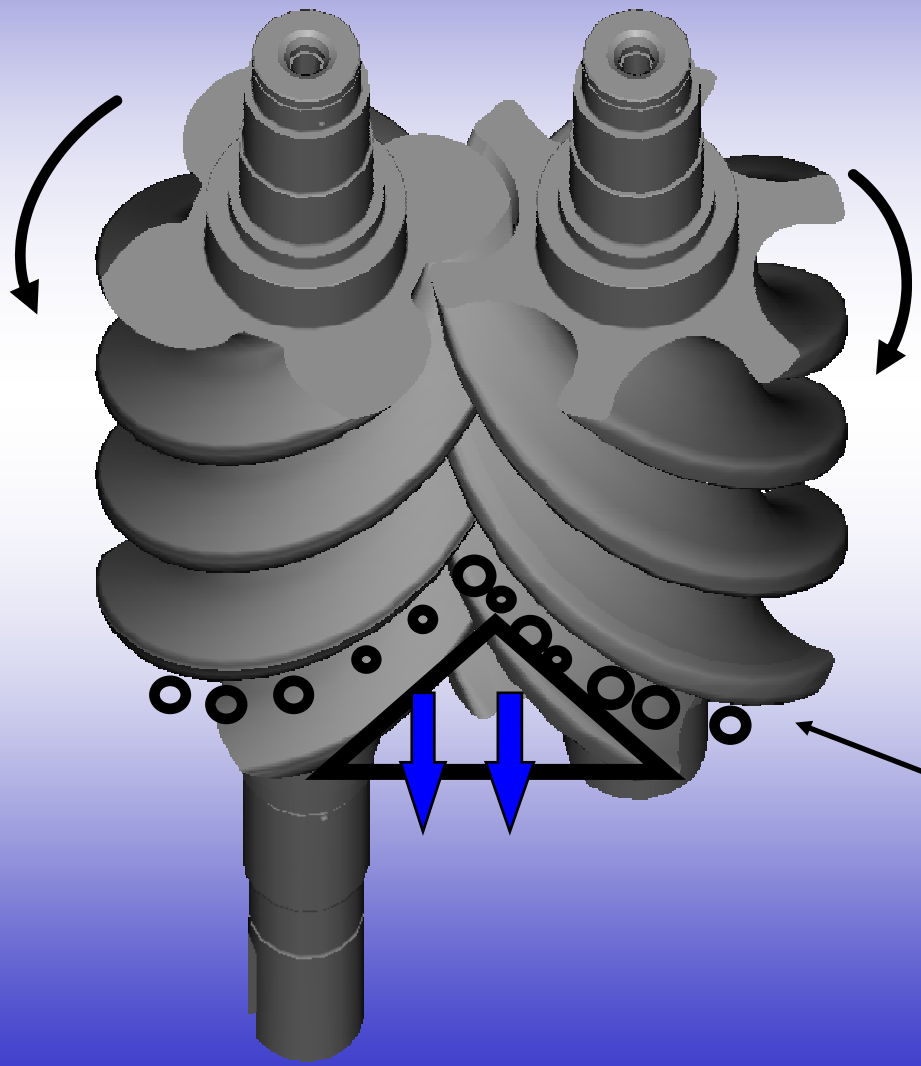
Compression



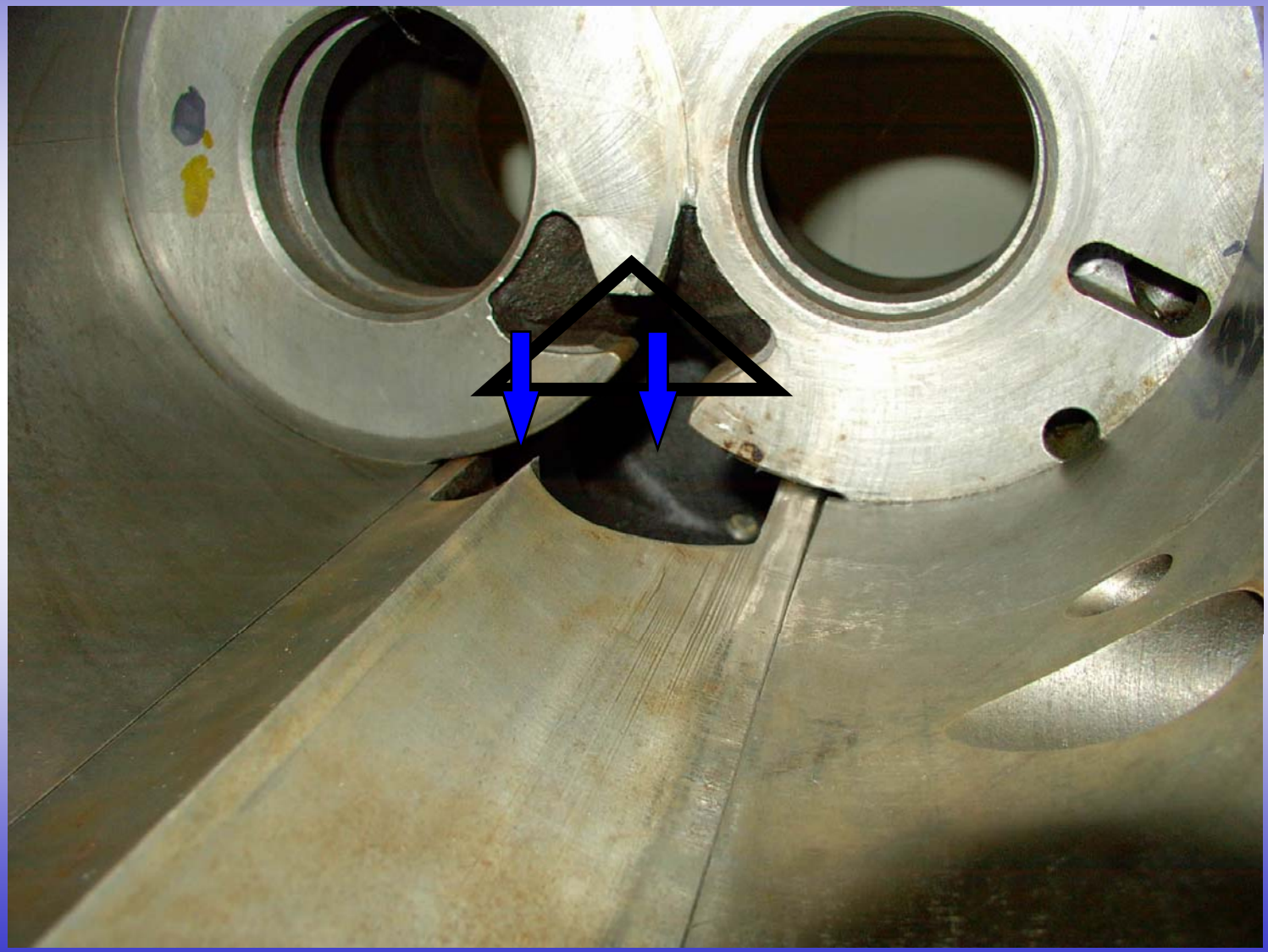


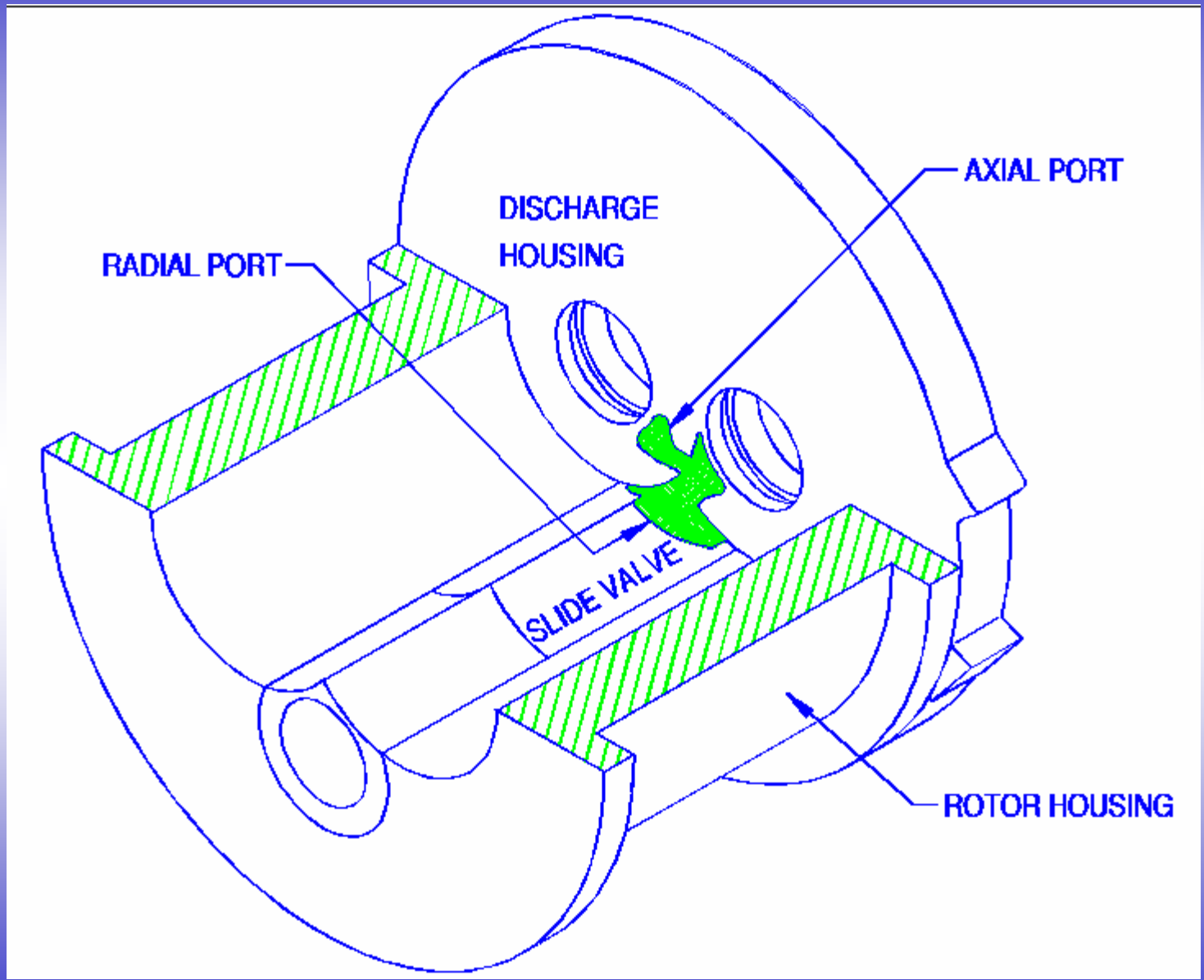
Beginning of Discharge



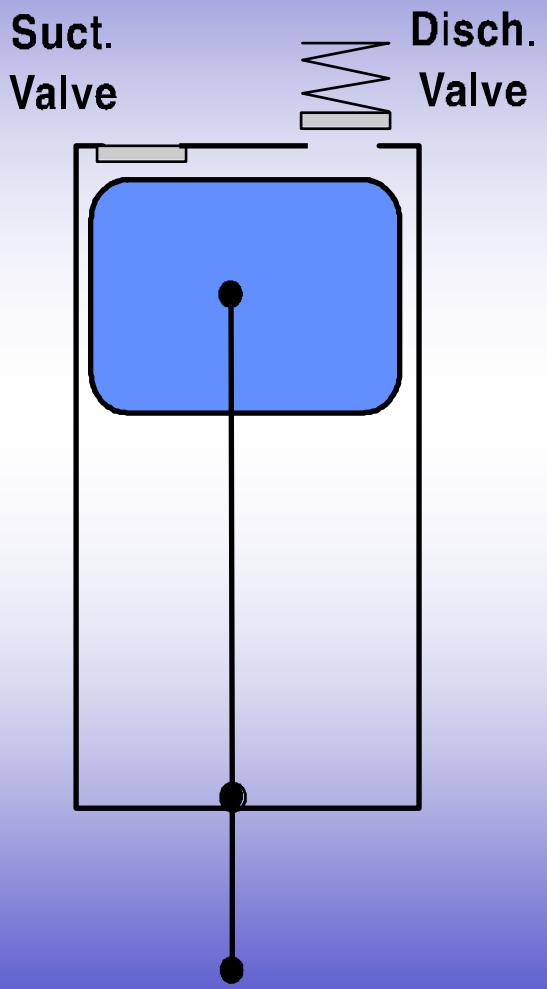


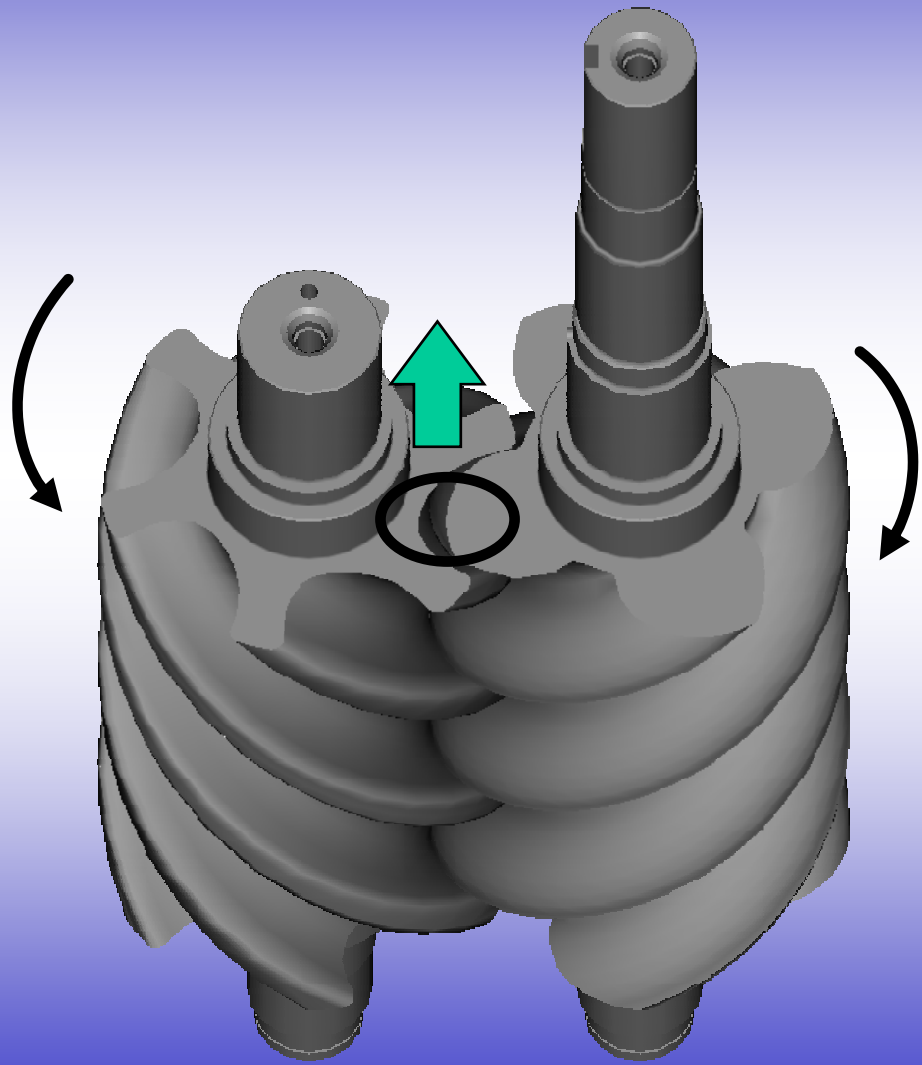
Beginning of Discharge

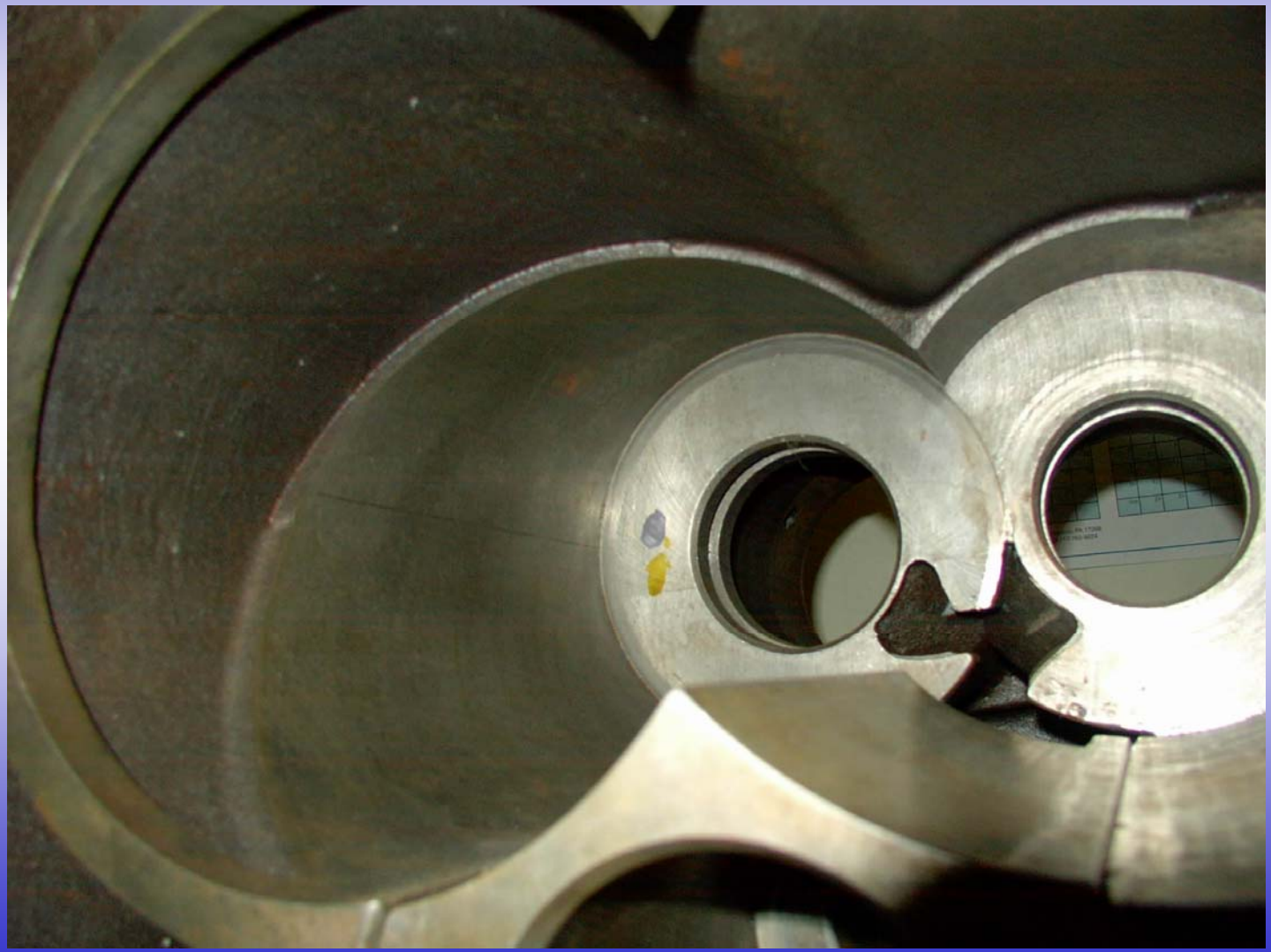


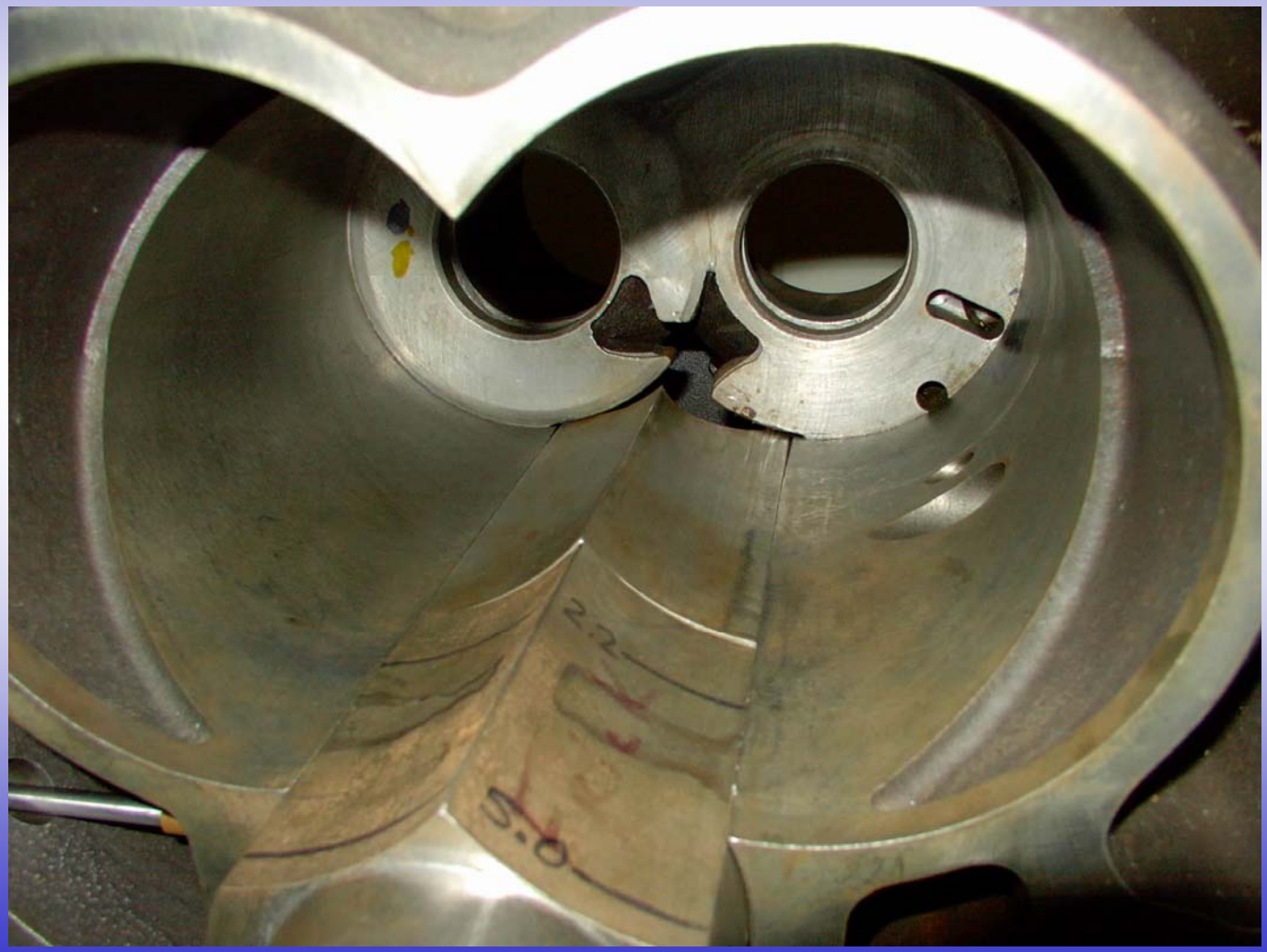

AXIAL PORT
DISCHARGE
HOUSING
RADIAL PORT
SLIDE VALVE
ROTOR HOUSING

End of Discharge





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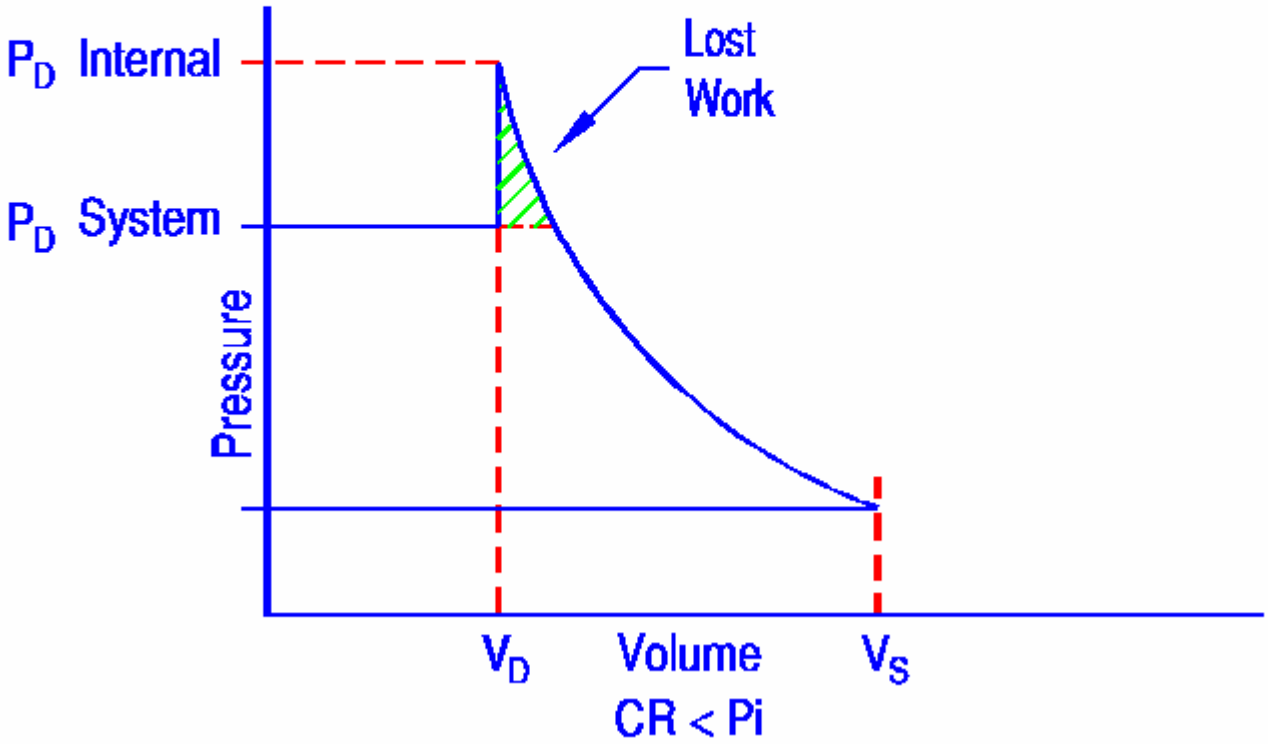
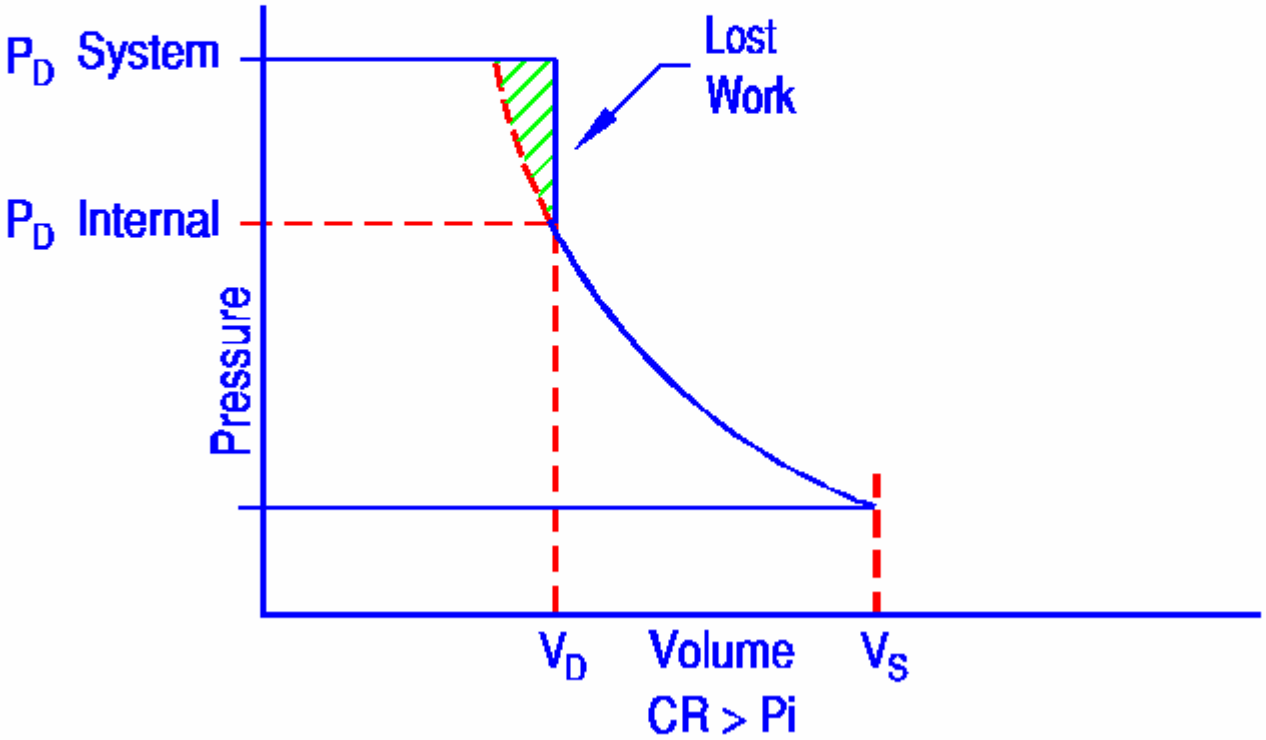
Volume Ratio

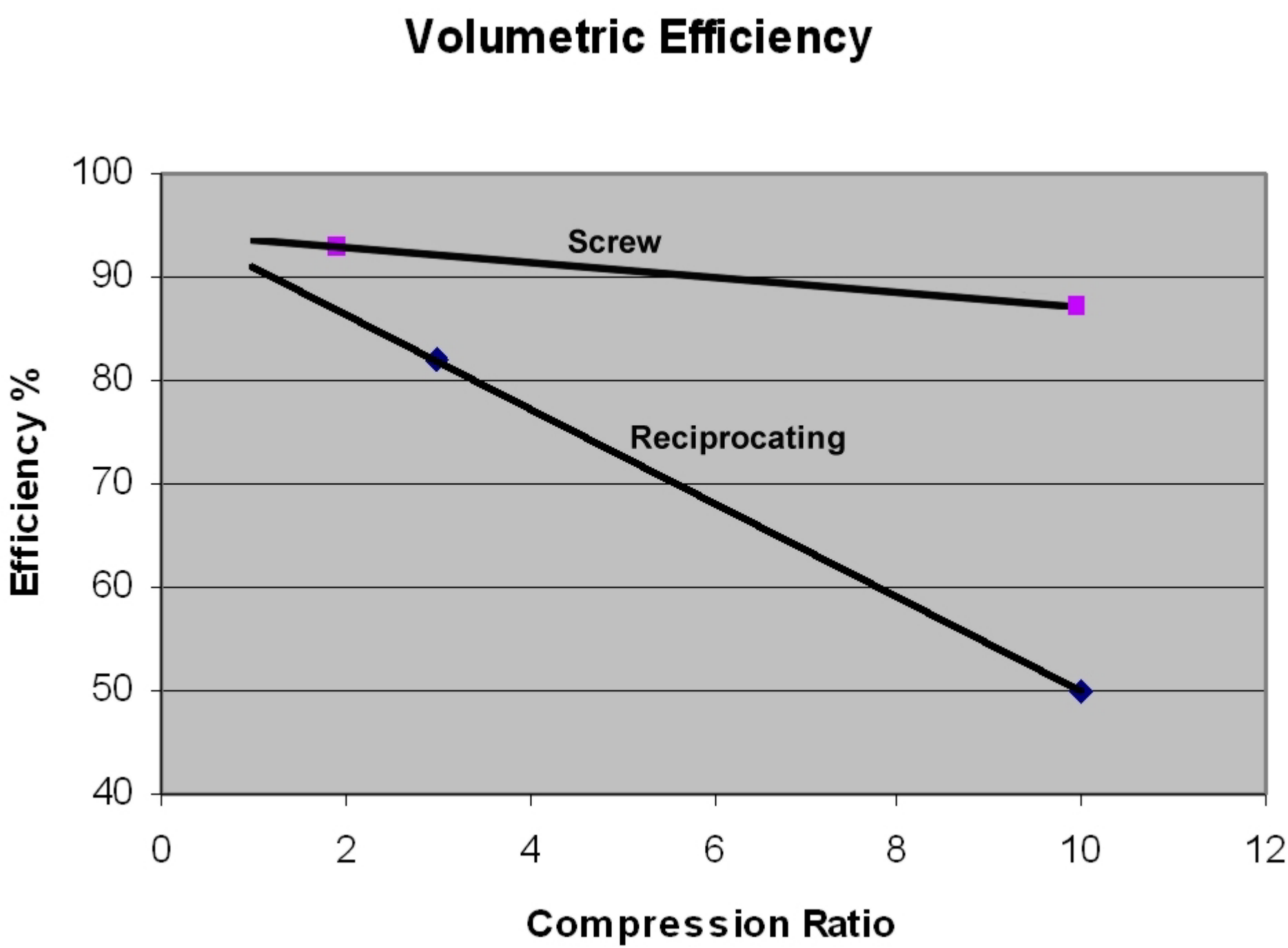
- In the reciprocating compressor the discharge valve determines when discharge begins and ends.
- Screw has no valves.
- Location of discharge ports determine when discharge begins.
- Most compressors are built for a given ratio of Vs to Vd by the location of the discharge ports.

Over Compression P-V Diagram

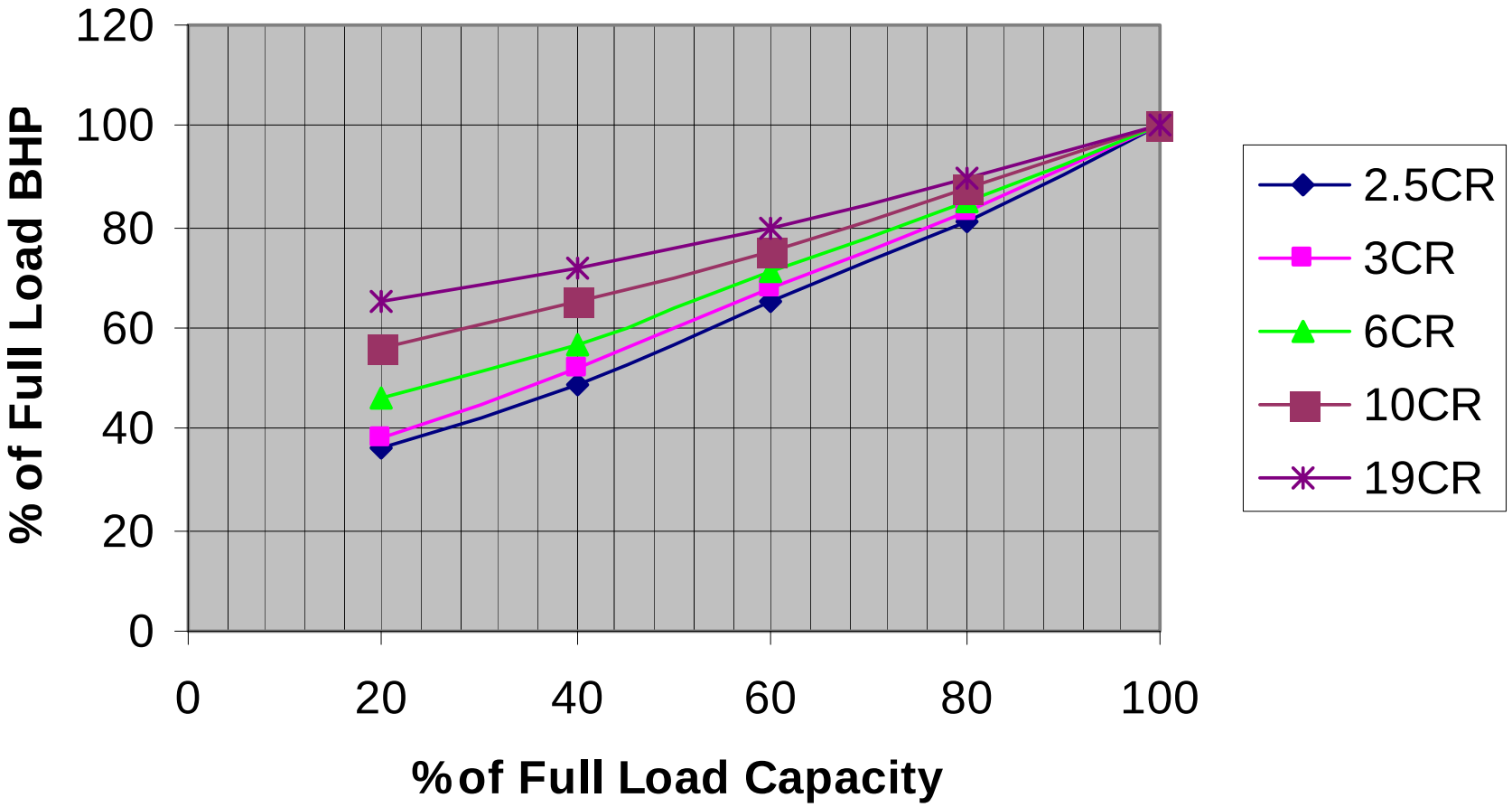


Under Compression
P-V Diagram

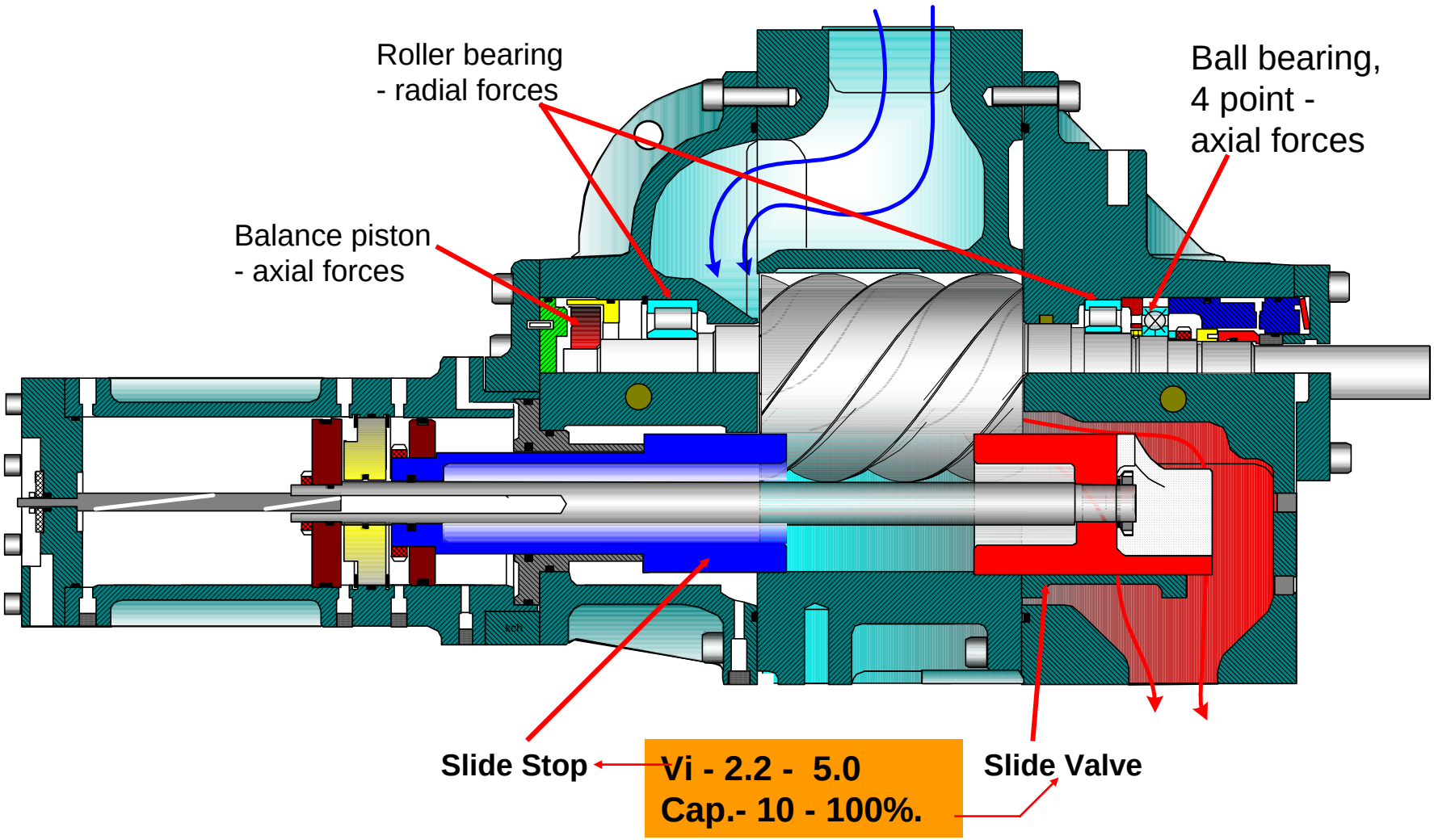



Volumetric Efficiency
100
90
80
70
60
50
40
Efficiency %
Screw
Reciprocating
0
2
4
6
8
10
12
Compression Ratio

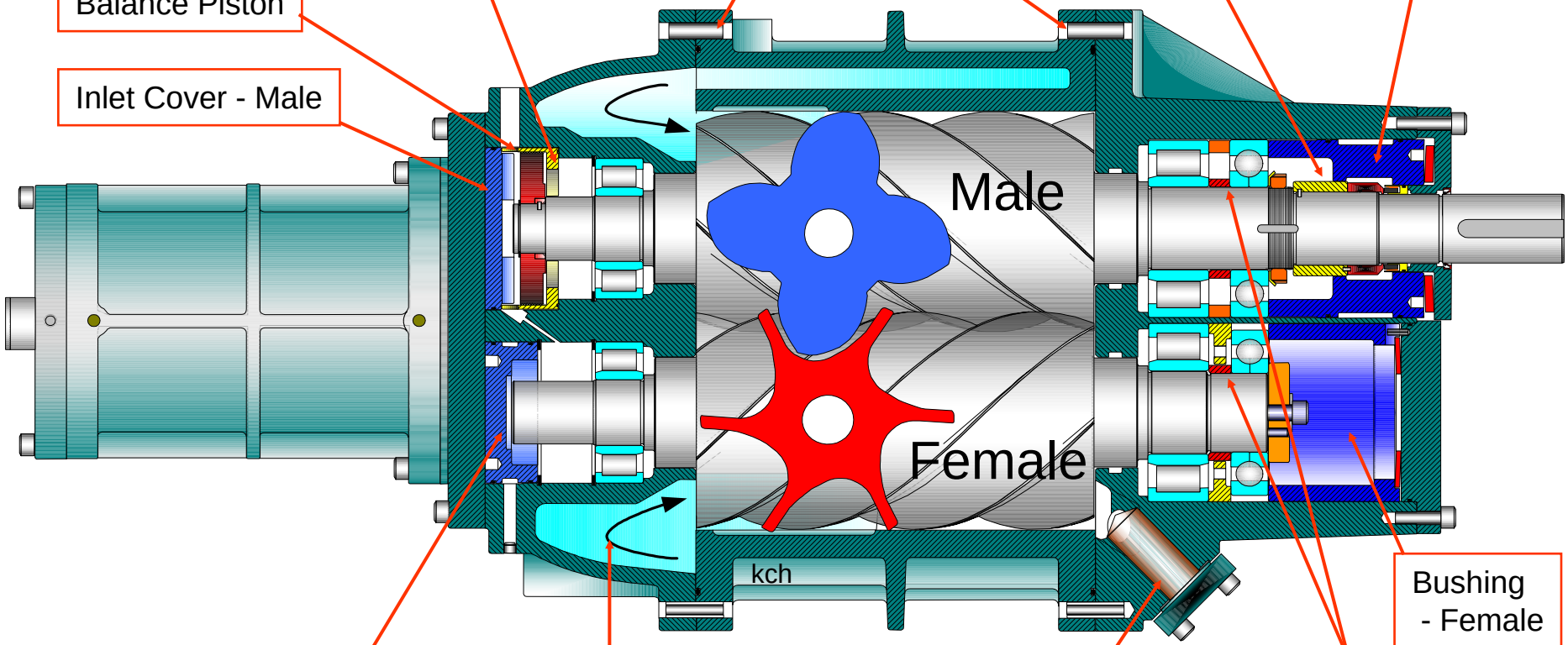
R717 Part Load - Slide Valve 193mm



FRICK - TDSH 163 – Screw Compressor



TDSH 283 Screw compressor - principle



Bushing for Balance Piston

Balance Piston

Inlet Cover - Male

Dowel Pin

External Bushing for Shaft Seal

External Bushing for Shaft Seal

Bushing - Female

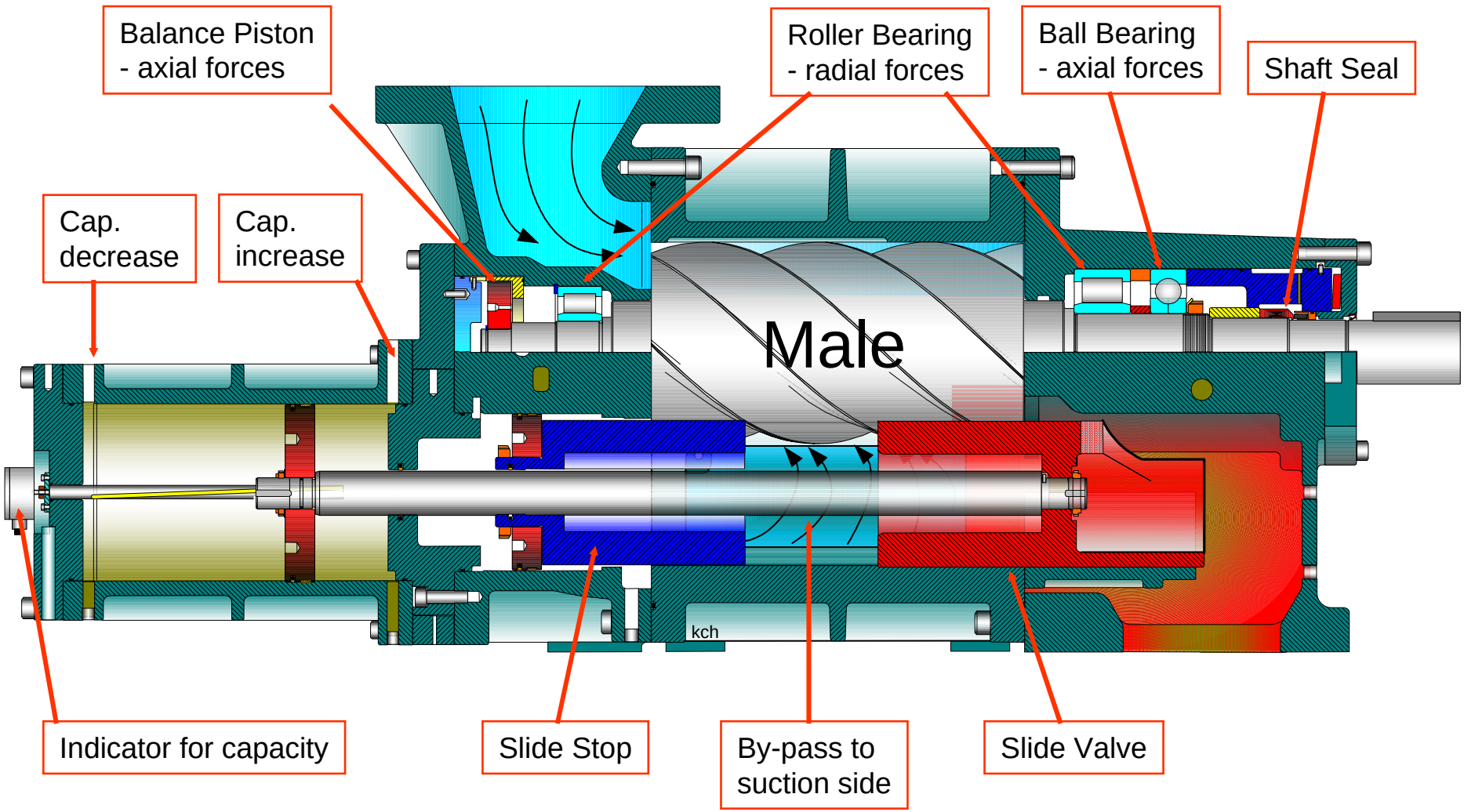
Adjusting Washer - Male/Female

Economizer Plug

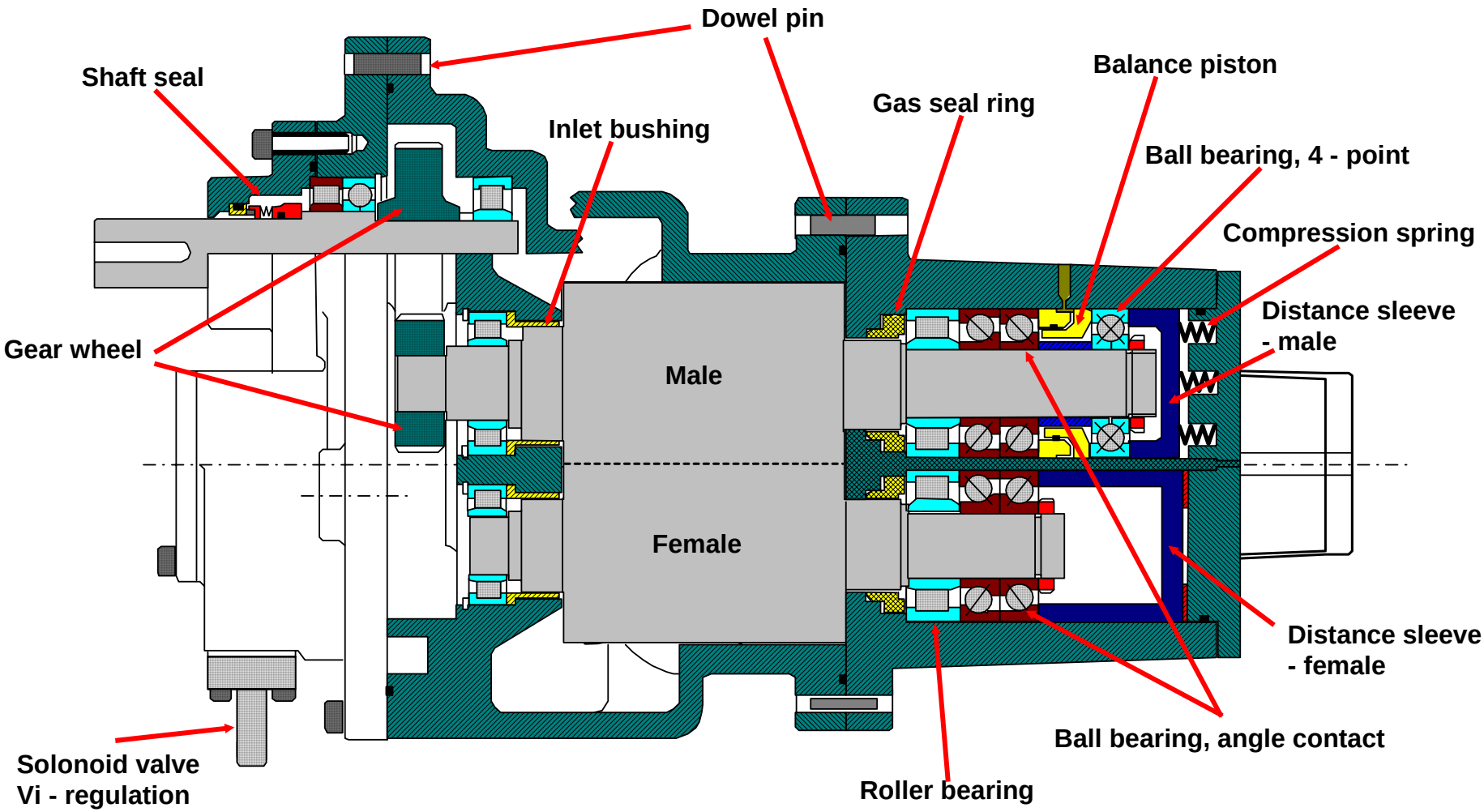
Suction Chamber

Inlet Cover - Male

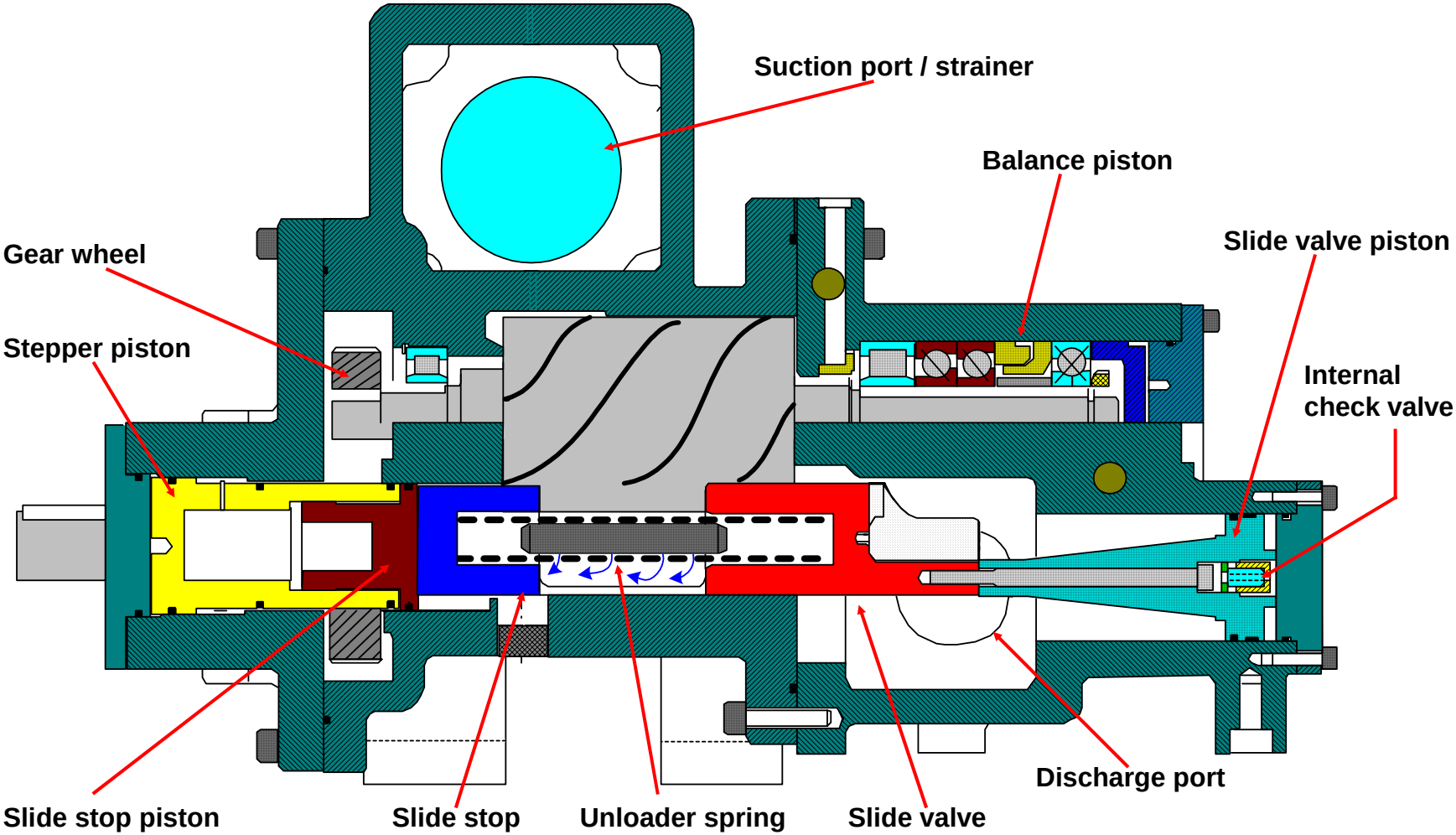
TDSH 283 Screw Compressor - principle



120 mm RXB

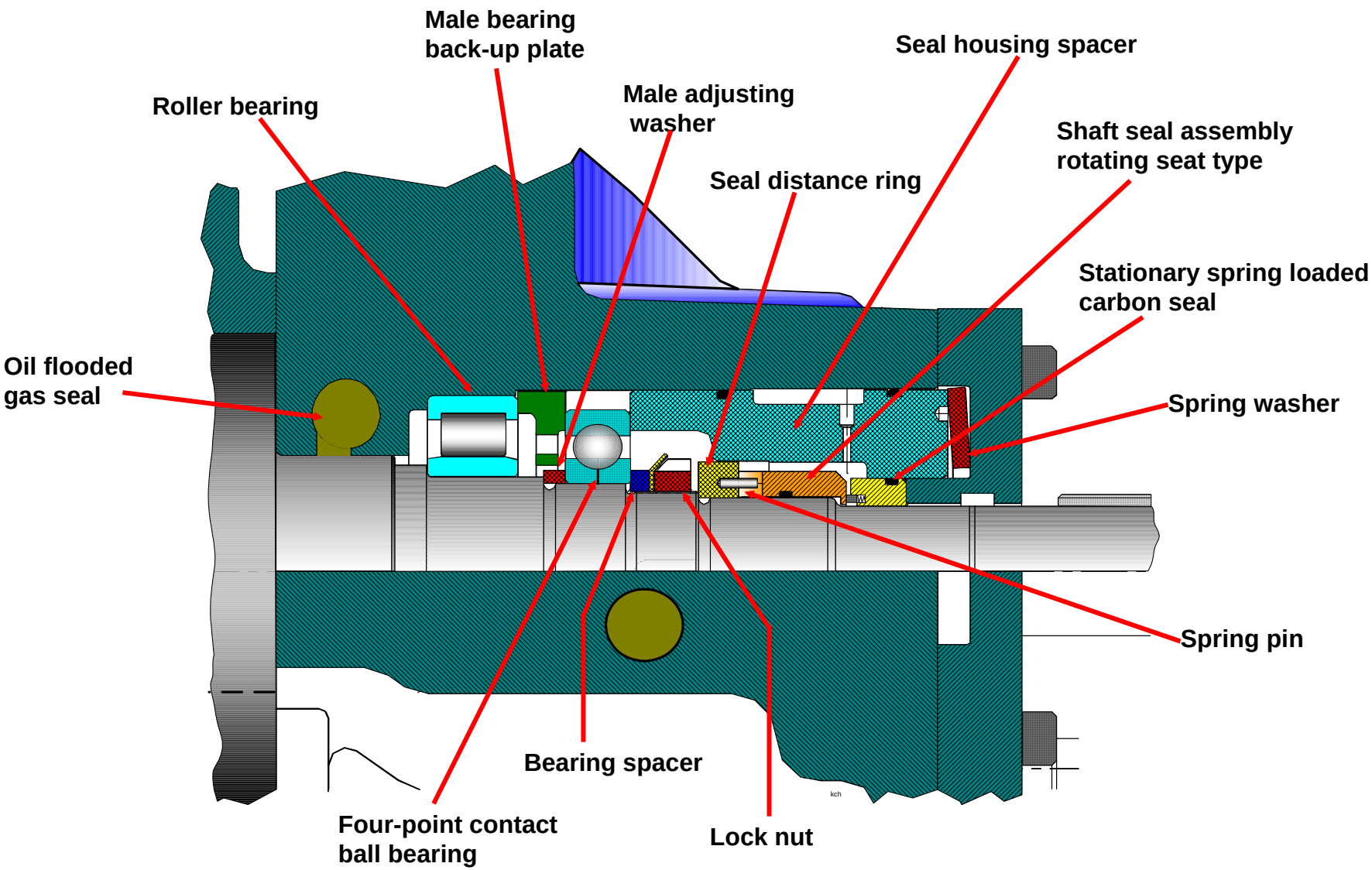

Dowel pin
Shaft seal
Balance piston
Gas seal ring
Inlet bushing
Ball bearing, 4 - point
Compression spring
Distance sleeve
- male
Gear wheel
Male
Female
Distance sleeve
- female
Ball bearing, angle contact
Solonoid valve
Vi - regulation
Roller bearing

120 mm RXB

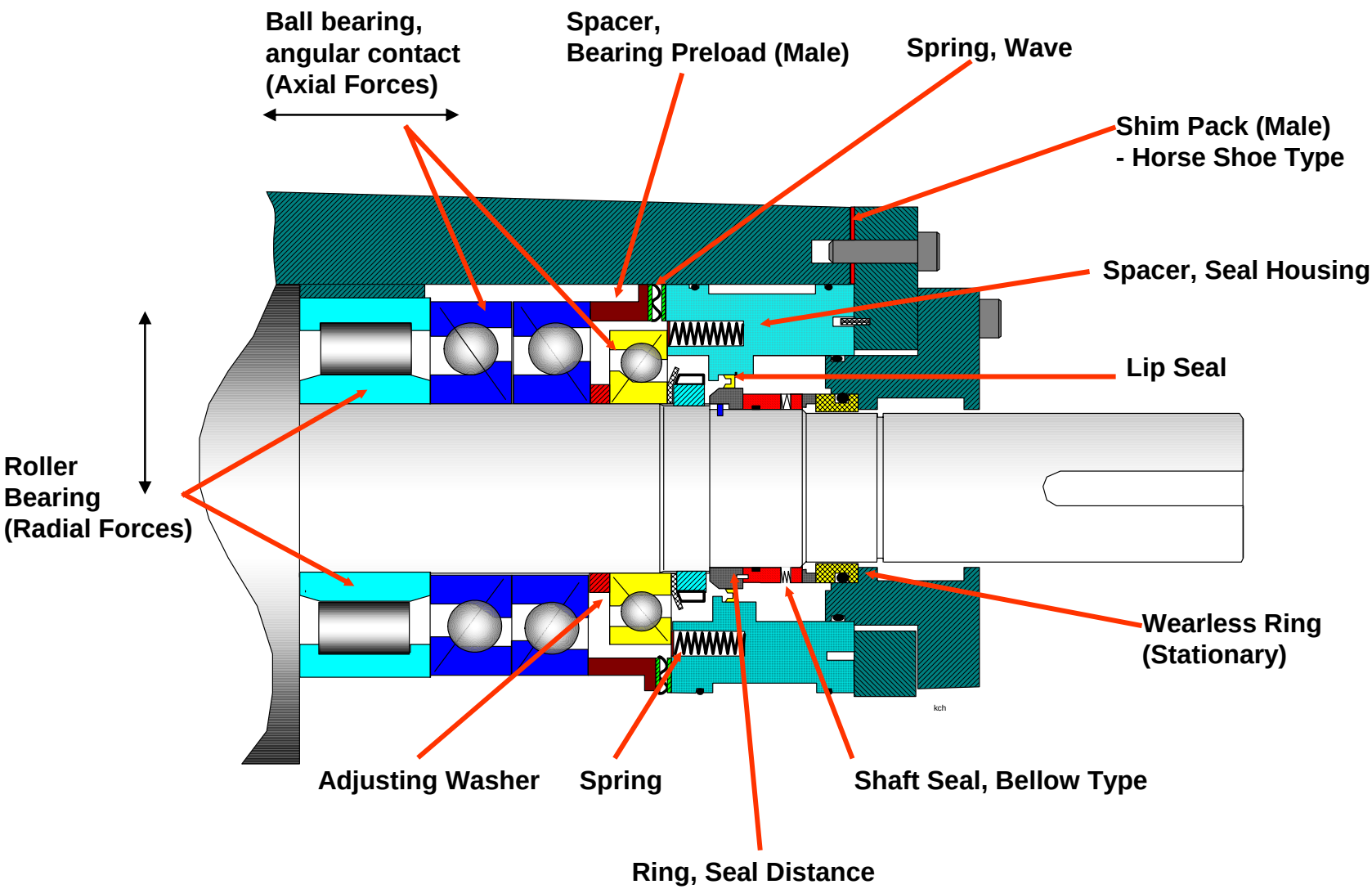

Suction port / strainer
Balance piston
Slide valve piston
Gear wheel
Stepper piston
Internal
check valve
Discharge port
Slide stop piston
Slide stop
Unloader spring
Slide valve

COMPRESSOR SEALS

TDSH 163 - Shaft seal assembly



TDSH 355 – Top view shaft seal assy.



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