

# Mechanical Glands and Seals

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# INTRODUCTION

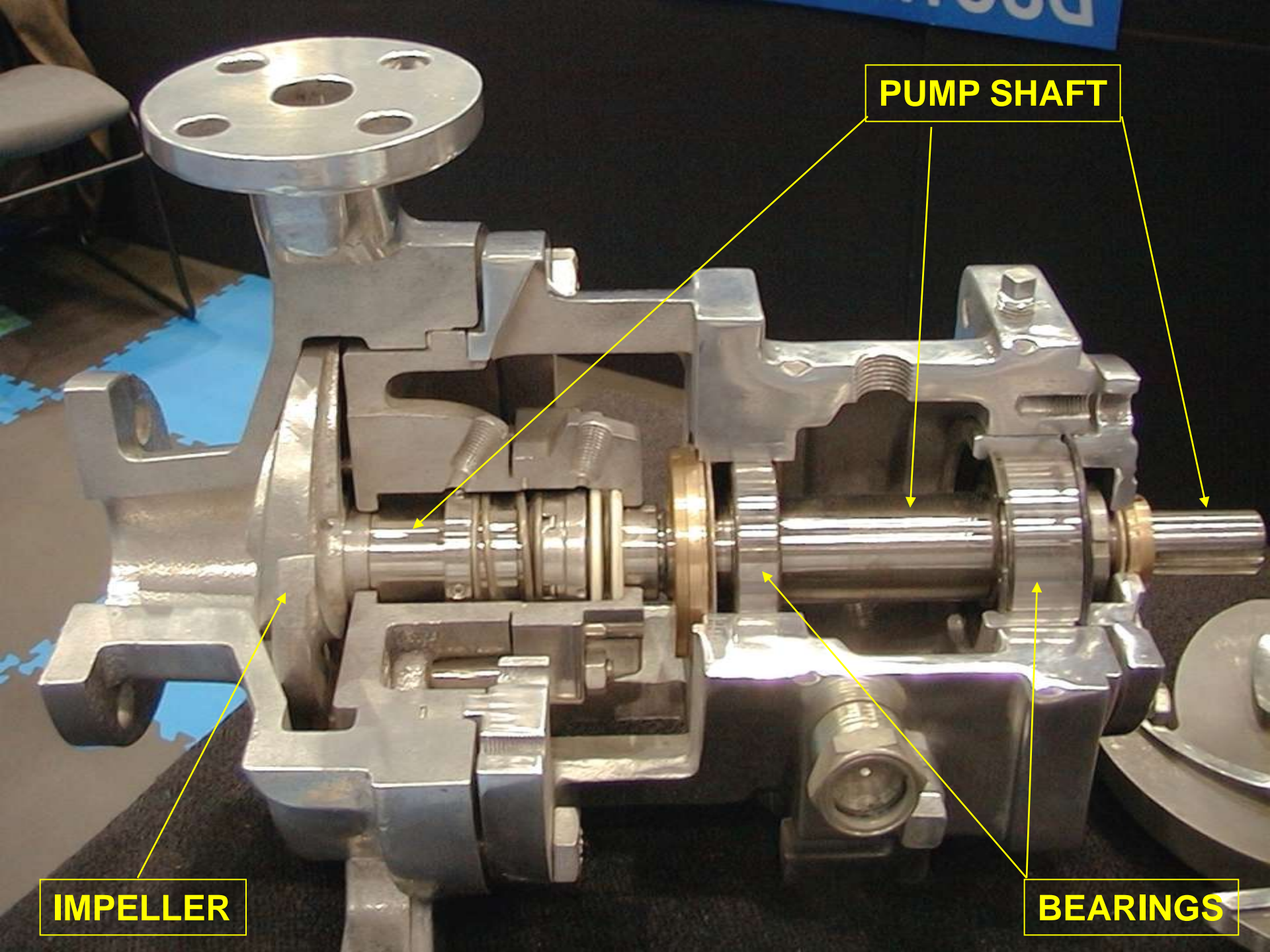
Packed glands and mechanical seals are simply a means of controlling leakage of a process where there is usually rotary movement entering a pressurized system. For the purposes of this discussion we will look at how mechanical seal usually out-perform common types of packed glands on rotating equipment.

As mechanical seals can be used to seal a many of different products on many types of equipment, we will mainly be looking at the use of mechanical seals on rotating shaft pumps.

Since our subject is dealing with pumps, let's first explore a basic understanding of the need to seal a process liquid in a centrifugal pump.

# CENTRIFUGAL PUMPS

A centrifugal pump is simply a shaft, suspended on bearings with an impeller attached to one end. The impeller is encased in a housing that is filled with a liquid. As the shaft is rotated, centrifugal force expels the liquid out into a piped process system. That is basically how a centrifugal pump works.

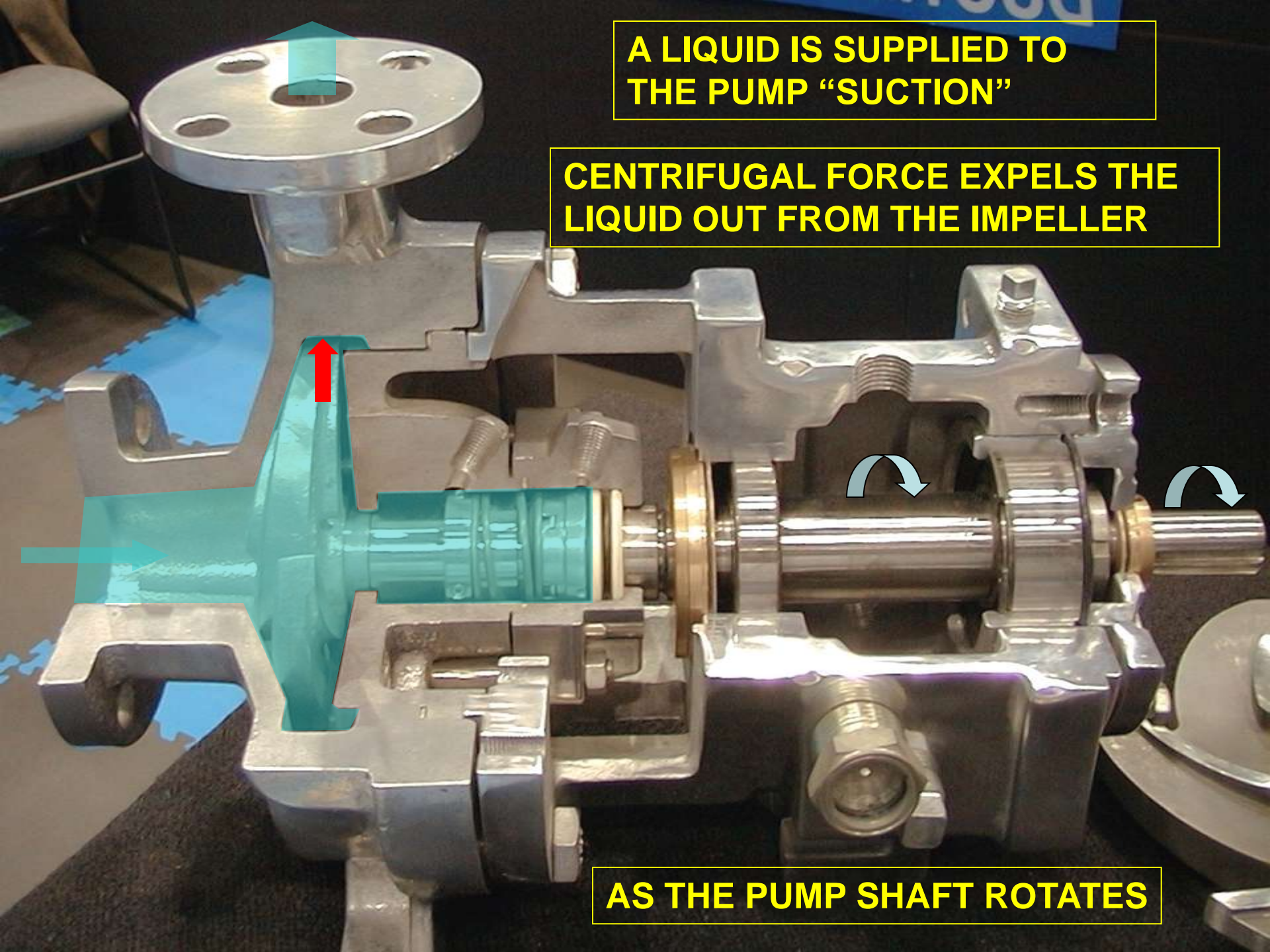


**PUMP SHAFT**

**IMPELLER**

**BEARINGS**





**A LIQUID IS SUPPLIED TO  
THE PUMP "SUCTION"**

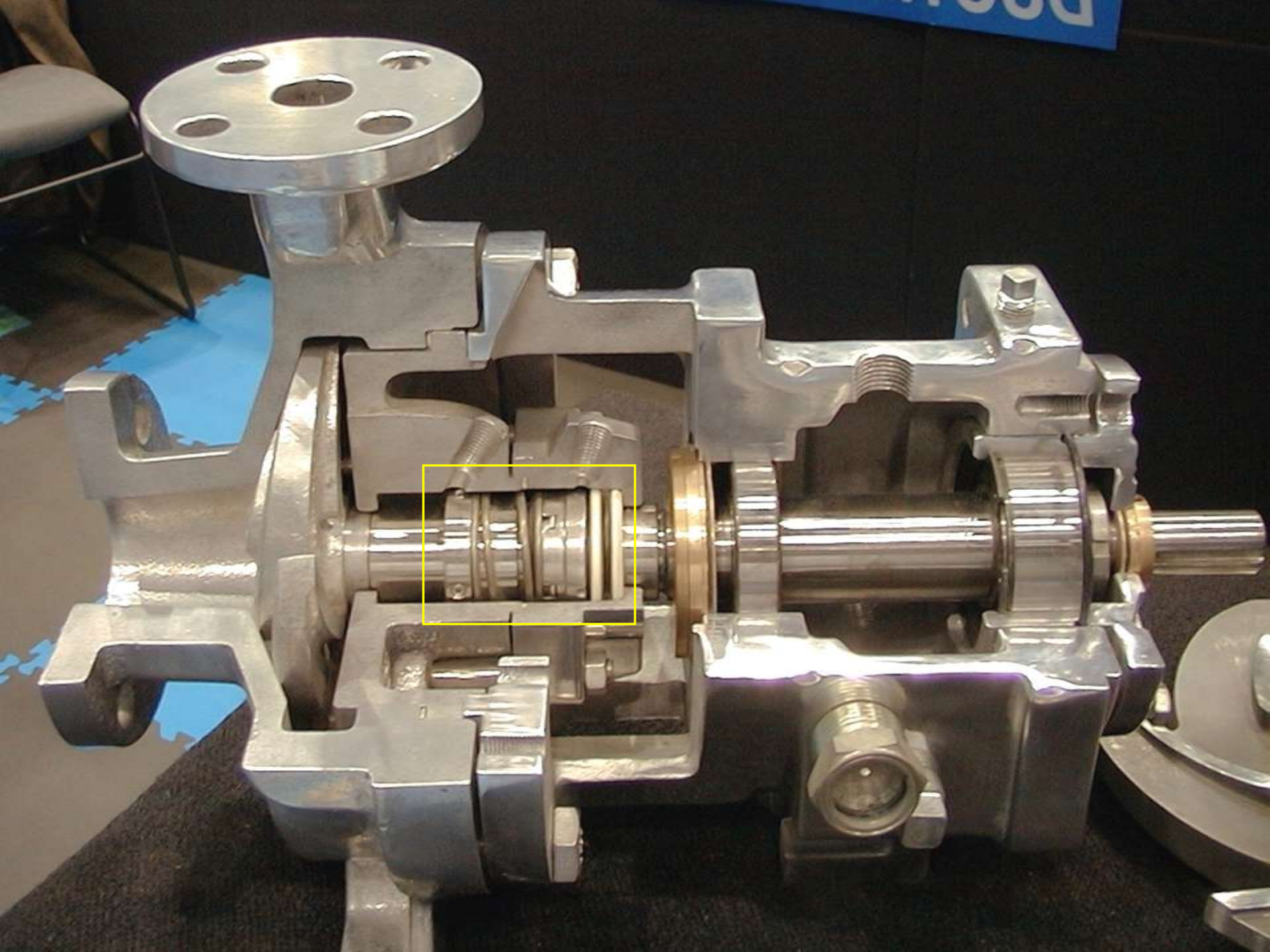
**CENTRIFUGAL FORCE EXPELS THE  
LIQUID OUT FROM THE IMPELLER**

**AS THE PUMP SHAFT ROTATES**

# CENTRIFUGAL PUMPS

The force of the expelled liquid creates pressure. Some form of seal must be applied to keep liquid from leaking around the shaft at the point where it enters the case to drive the impeller. This is where our mechanical seal comes into play.







# SEAL TYPE

The mechanical seal shown in the pump photograph is a typical mechanical seal. Probably the most widely recognized and also most common mechanical seal used in general service, low pressure applications.

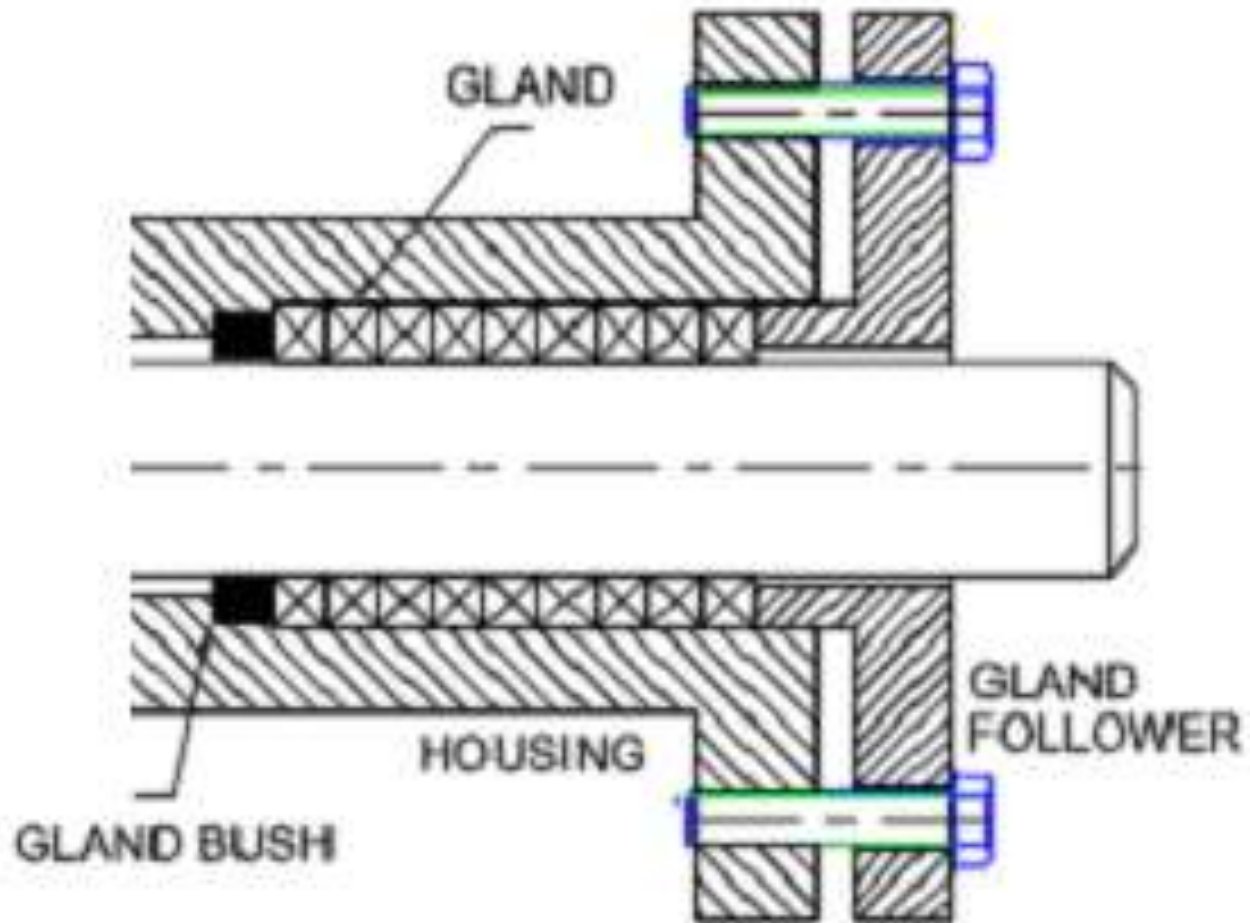


# SEALING THE LIQUID

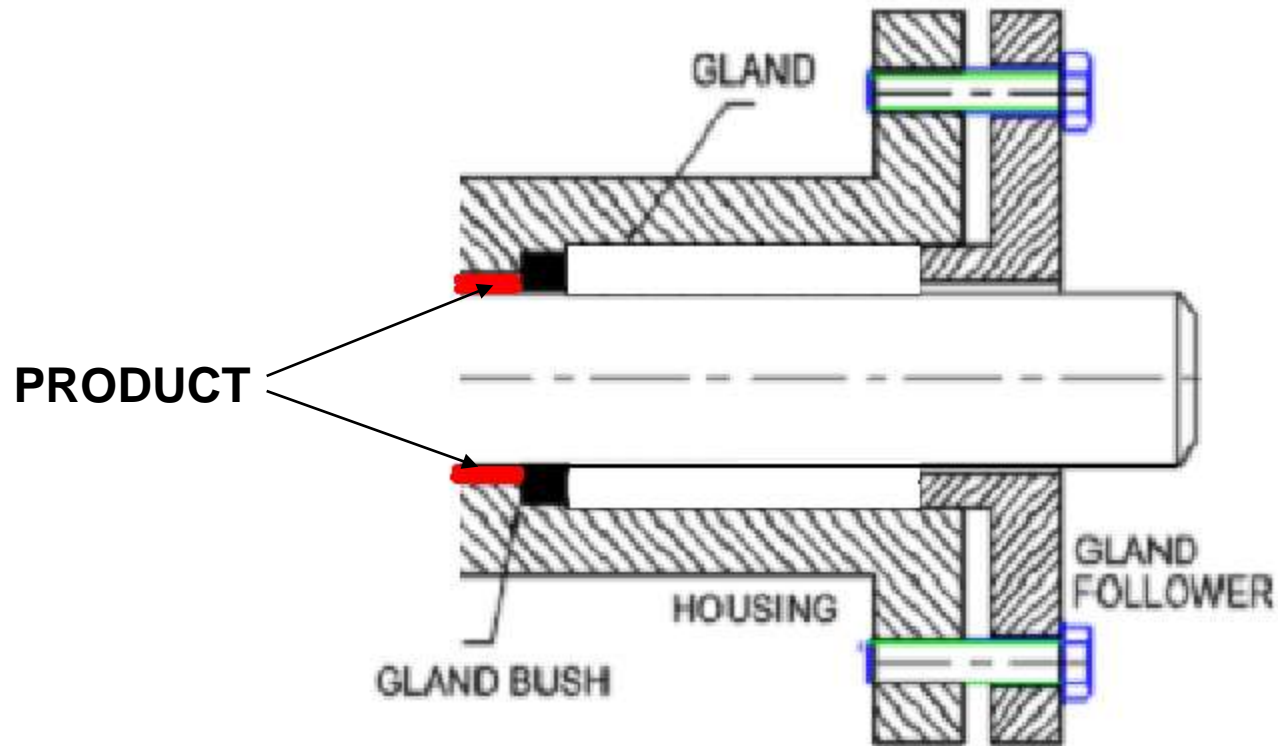
Mechanical seals were originally designed to lend a greater sealing capability than could be achieved using common packing.

Before the advent of mechanical seals, pump users relied primarily on “rope” or braided style packing to achieve a “seal” around the shaft. A series of pieces or “rings” were installed into the pump “stuffing box” and they were compressed tightly so that they created a difficult leak path for the liquid to negotiate in order to leak to atmosphere.

# GLANDS

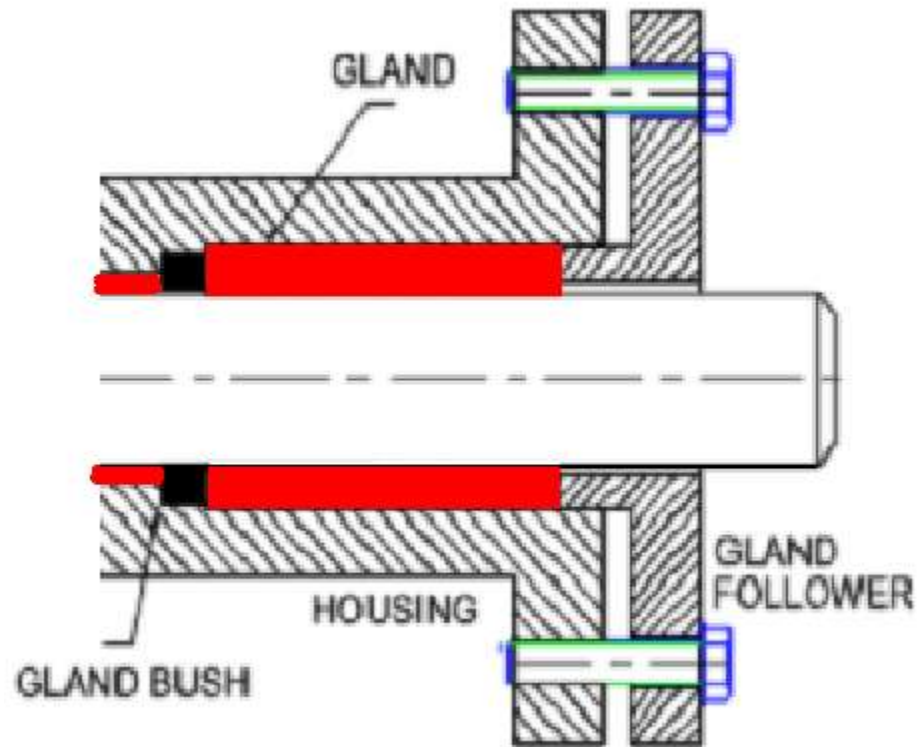


# NO GLAND PACKING

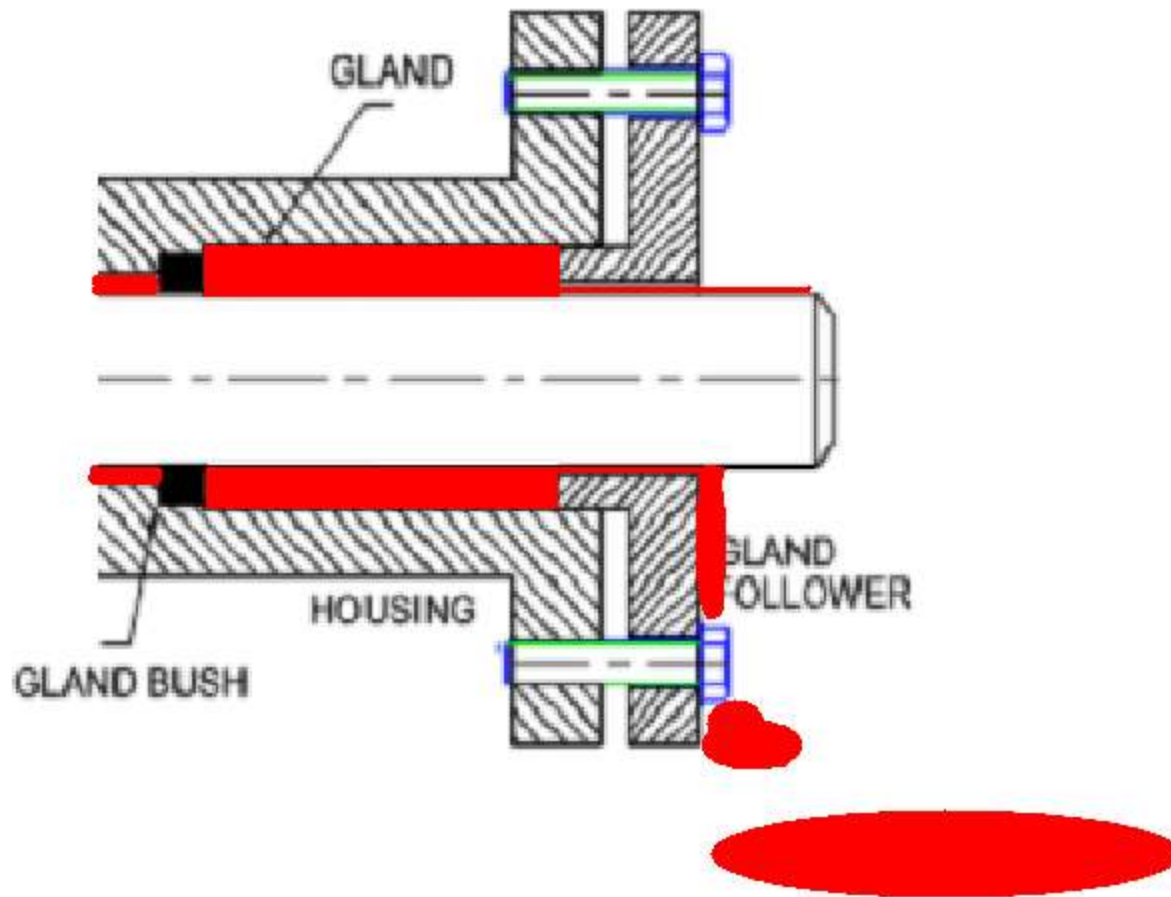




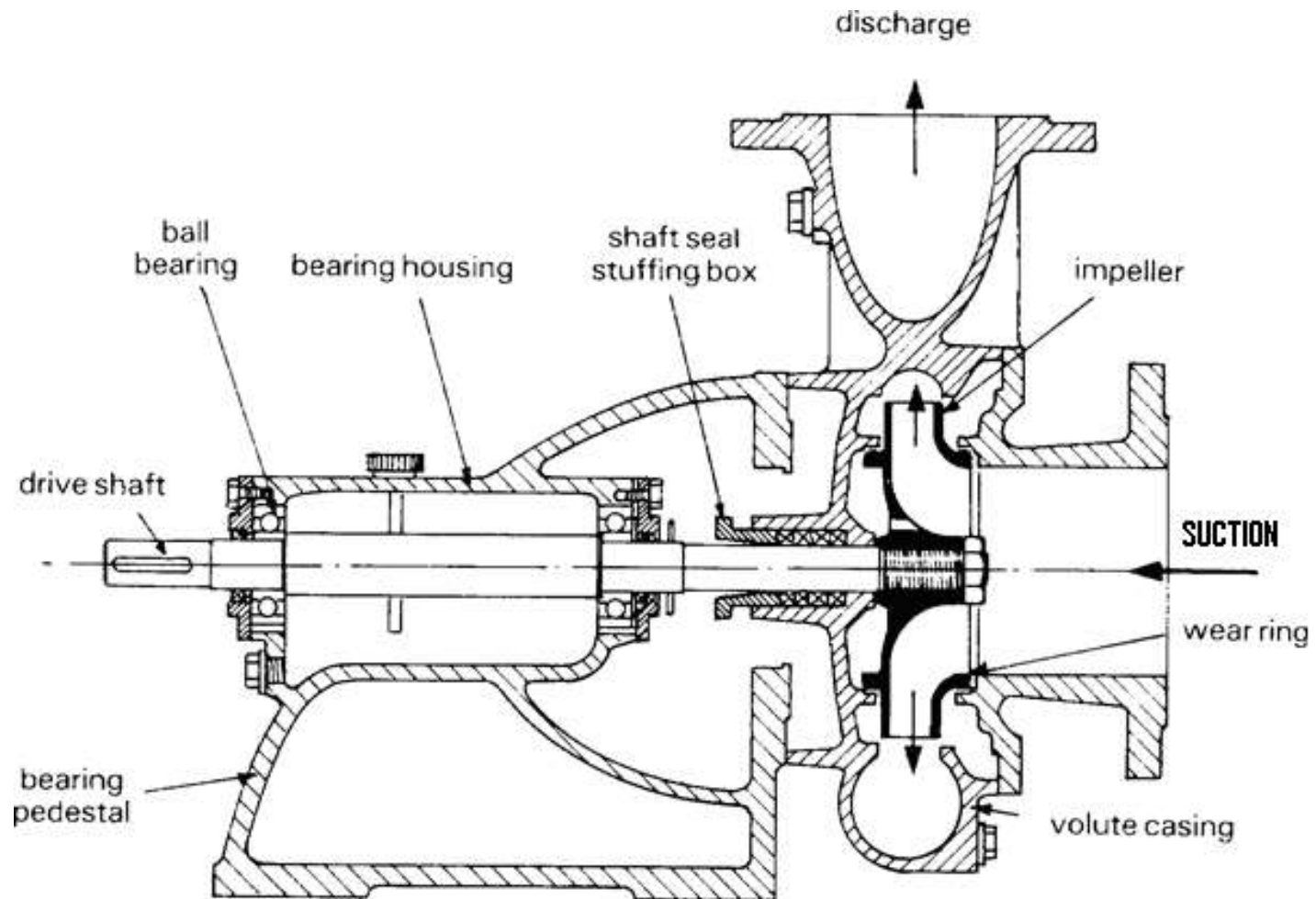
# NO GLAND PACKING



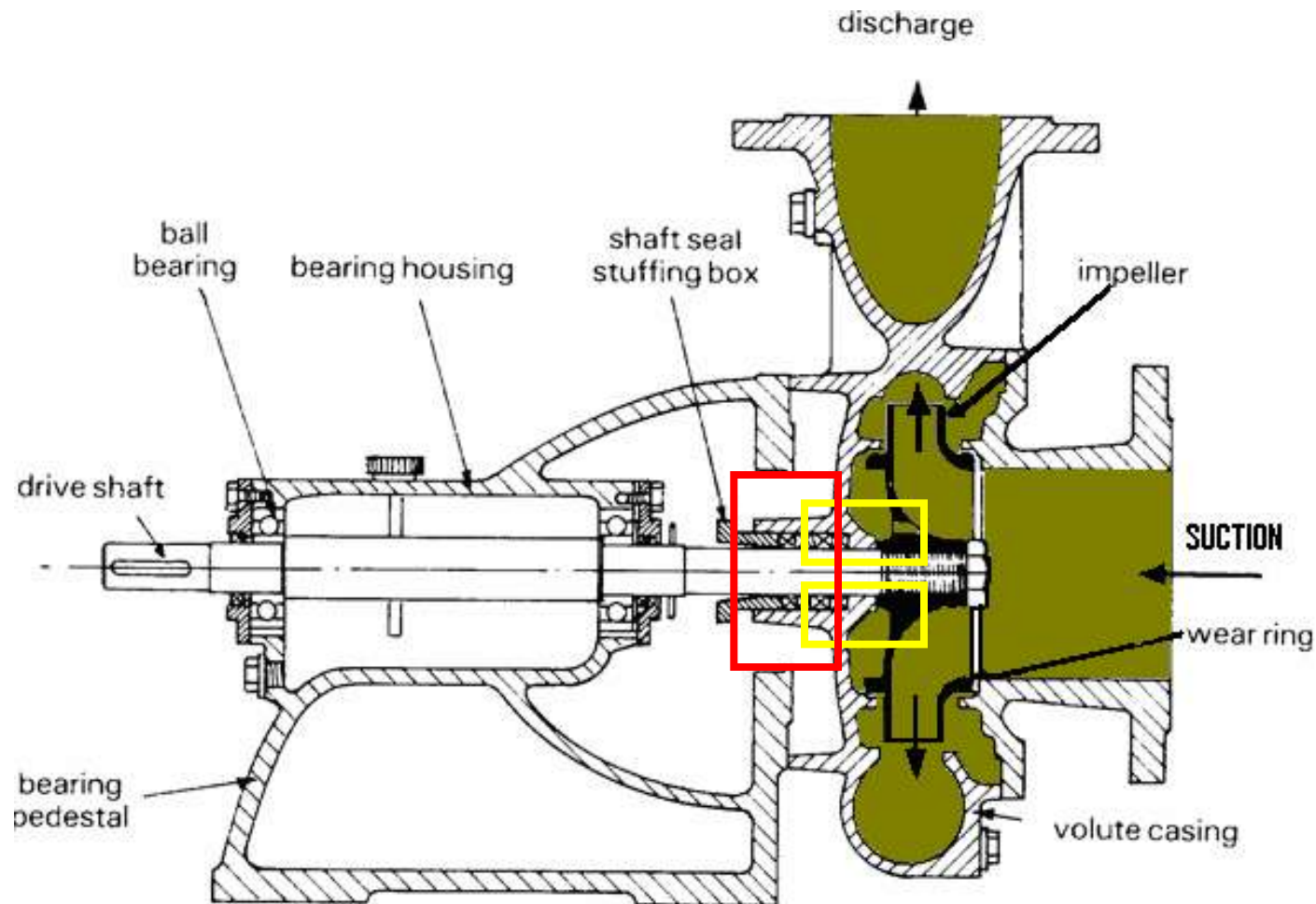
# NO GLAND PACKING



# Typical Packed Gland Arrangement



# What factors do you think affect this sealing selection





## FACTORS AFFECTING SELECTION

- APPLICATION
- PUMP
  - ROTARY ?
  - CENTRIFUGAL ?
  - RECIPROCATING ?
- What type of equipment?

## FACTORS AFFECTING SELECTION

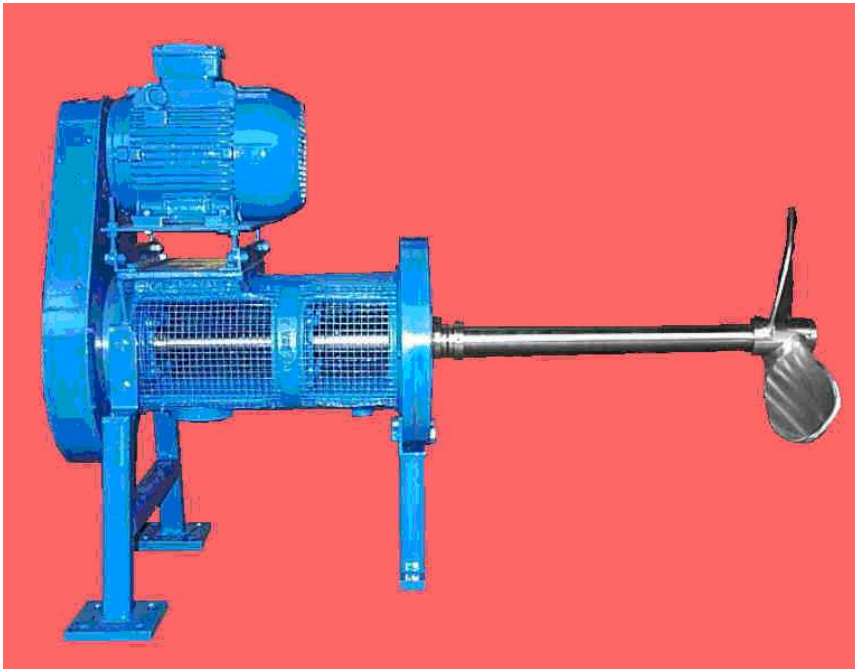
- APPLICATION
- AGITATOR
  - TOP ENTRY ?
  - SIDE ENTRY ?
  - BOTTOM ENTRY ?
- Where is it located in the equipment?

# FACTORS AFFECTING SELECTION



- AGITATOR
- TOP ENTRY ?

# FACTORS AFFECTING SELECTION



- AGITATOR
- SIDE ENTRY ?



# FACTORS AFFECTING SELECTION



- AGITATOR
- BOTTOM ENTRY ?

## FACTORS AFFECTING SELECTION

- APPLICATION

- What type of equipment?

- VALVES

**GATE VALVE**

**BALL VALVE**

**PLUG VALVE**

**GLOBE VALVE**

## FACTORS AFFECTING SELECTION

- APPLICATION
  - BLOWERS
- OR
- What type of sealing for this equipment?
  - FANS

## FACTORS AFFECTING SELECTION

- PRODUCT
- Constituents of a product?
- Contact with packing
- Can a leak be tolerated



## FACTORS AFFECTING SELECTION

- **TEMPERATURE**



- Constituents of product.
- Constant Temperature
- Range of Temperature

## FACTORS AFFECTING SELECTION

- **PRESSURE**



- Pressure of product on stuffing box.
- Suction/Delivery pressure.
- Pressure fluctuation.

# FACTORS AFFECTING SELECTION

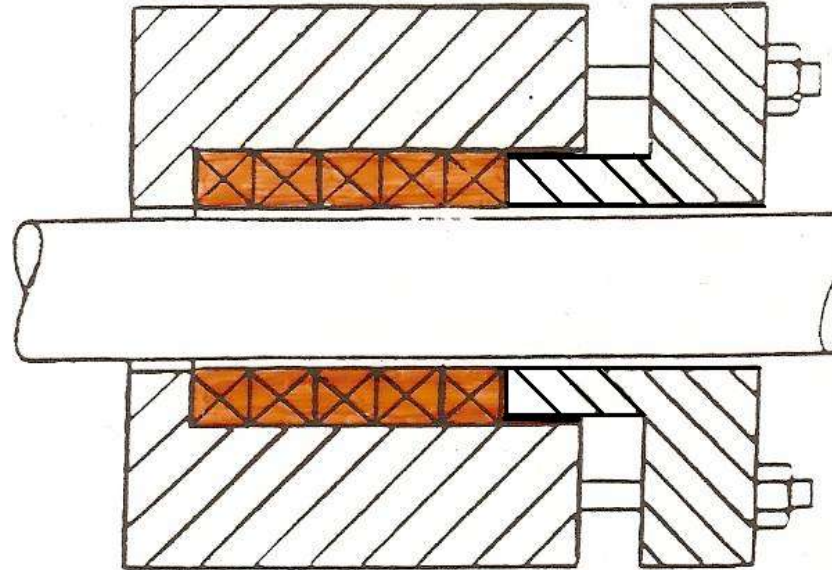
- **SHAFT**



- Diameter of shaft
- Speed
- Material

# COMMON PACKING ARRANGEMENTS

**Positive  
product  
pressure**



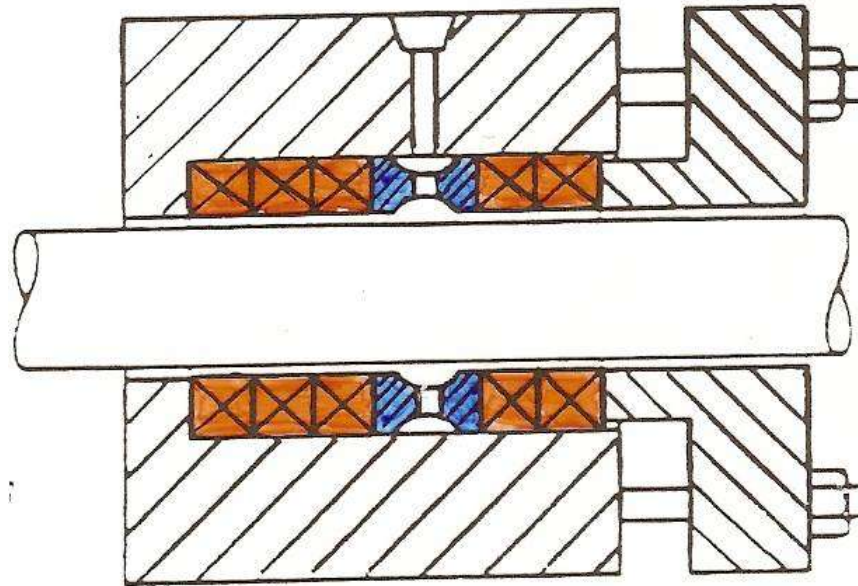
**Atmospheric  
pressure**

**Leakage**

**Typical stuffing box arrangement for pumps handling  
clean non-abrasive products with suction pressure  
above atmospheric pressure.**

# COMMON PACKING ARRANGEMENTS

**Positive  
product  
pressure**



**Fluid injection  
at one  
atmosphere  
above suction  
pressure**

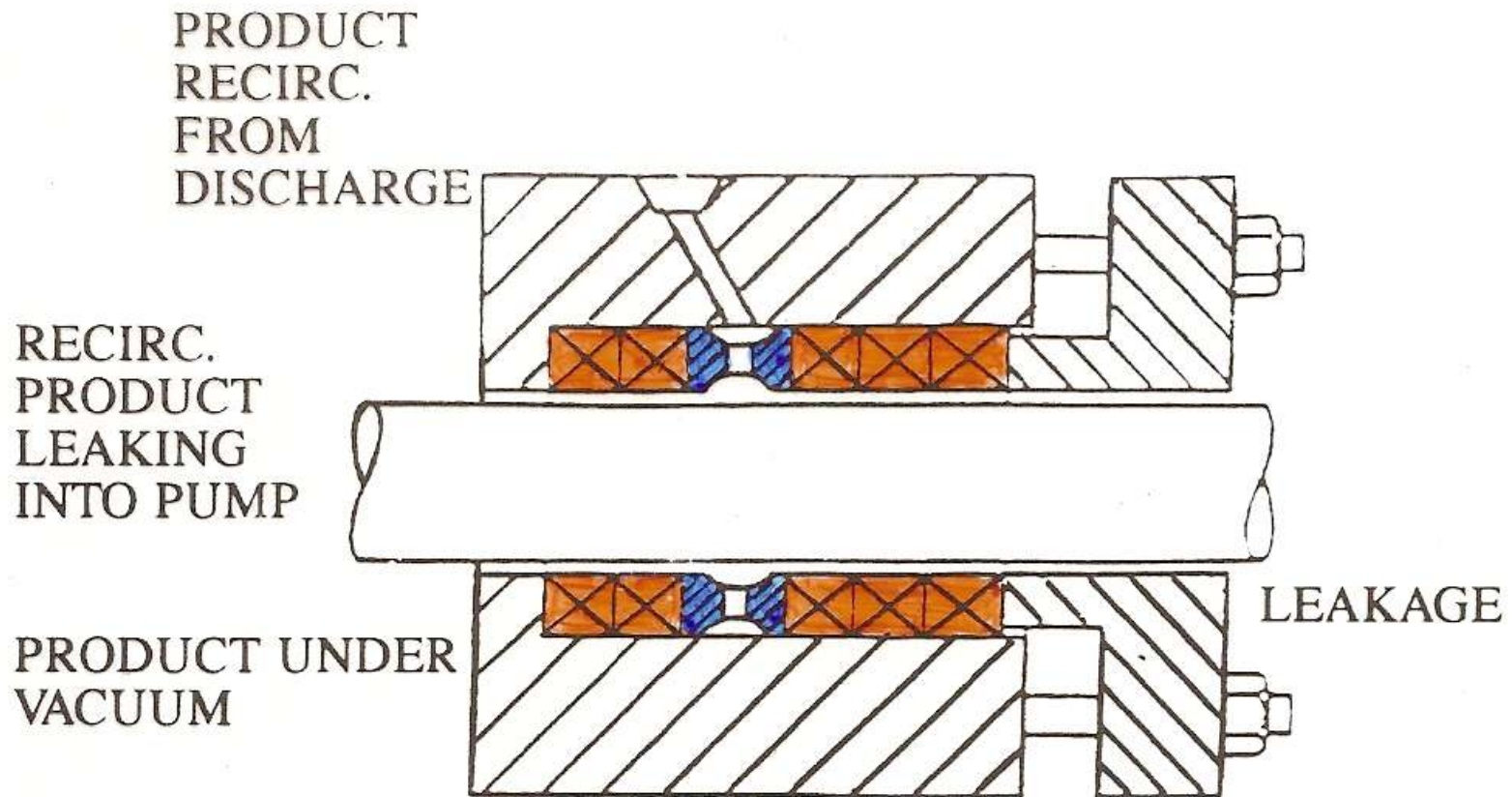
**Leakage of  
flush into  
pump**

**Leakage**

**Typical stuffing box arrangement for abrasive and slurry duties a clean, compatible flush via a lantern ring at 1 atmosphere above pressure on stuffing box is recommended.**

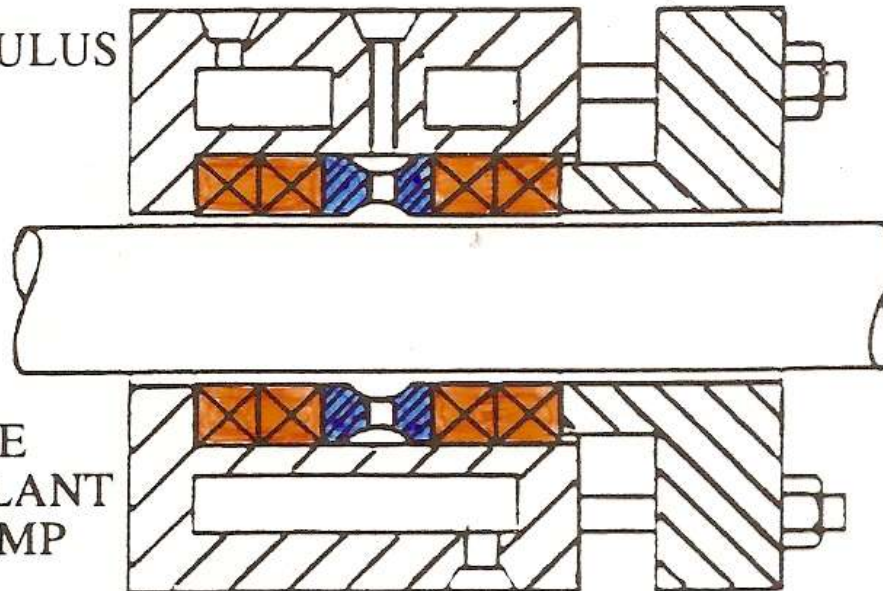


# COMMON PACKING ARRANGEMENTS



# COMMON PACKING ARRANGEMENTS

COOLING OR  
HEATING ANNULUS  
AROUND  
STUFFING  
BOX



INJECTION  
OF COOLANT  
VIA LANTERN  
RING IF  
REQUIRED

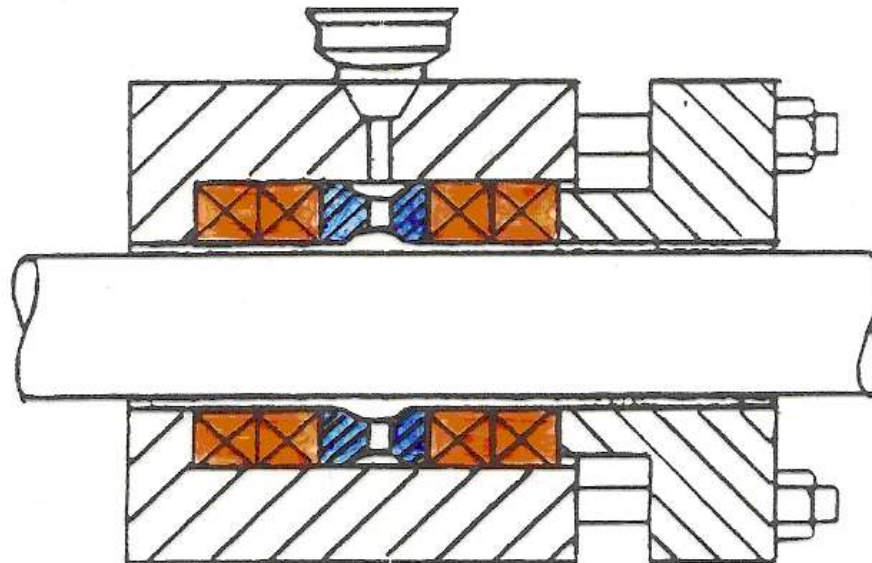
LEAKAGE  
OF COOLANT  
INTO PUMP

LEAKAGE

# COMMON PACKING ARRANGEMENTS

PRODUCT

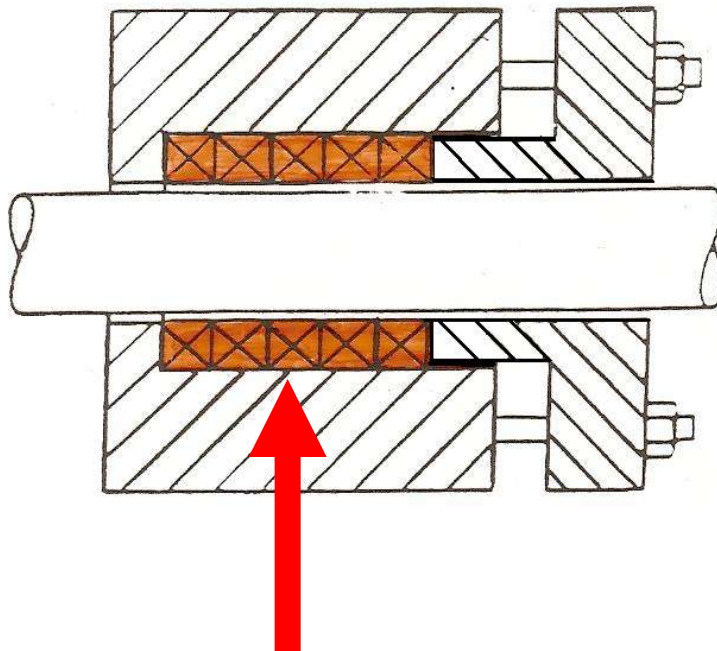
COMPATIBLE  
GREASE  
INJECTION  
VIA  
LANTERN  
RING



INGRESS  
OF GREASE  
INTO PRODUCT

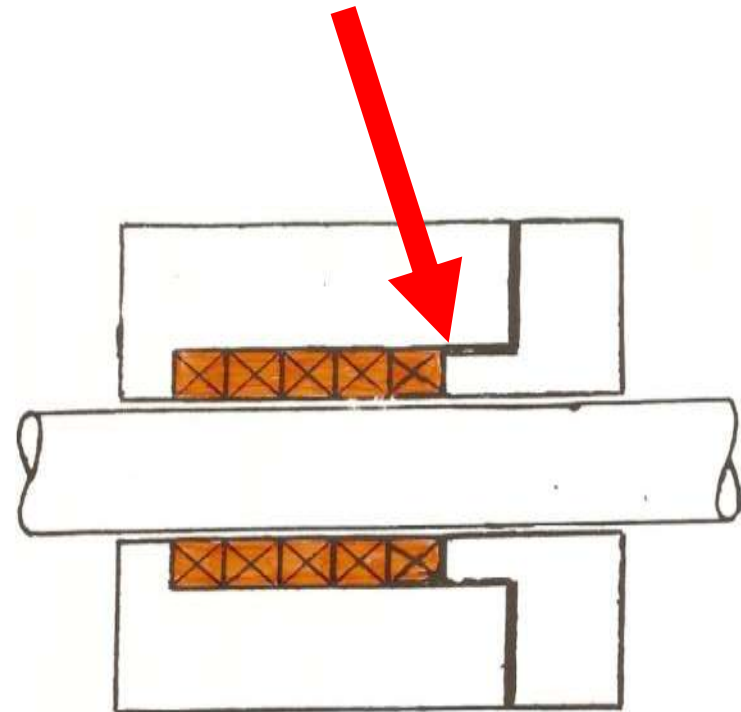
GREASE  
LEAKAGE

# COMMON FAULTS

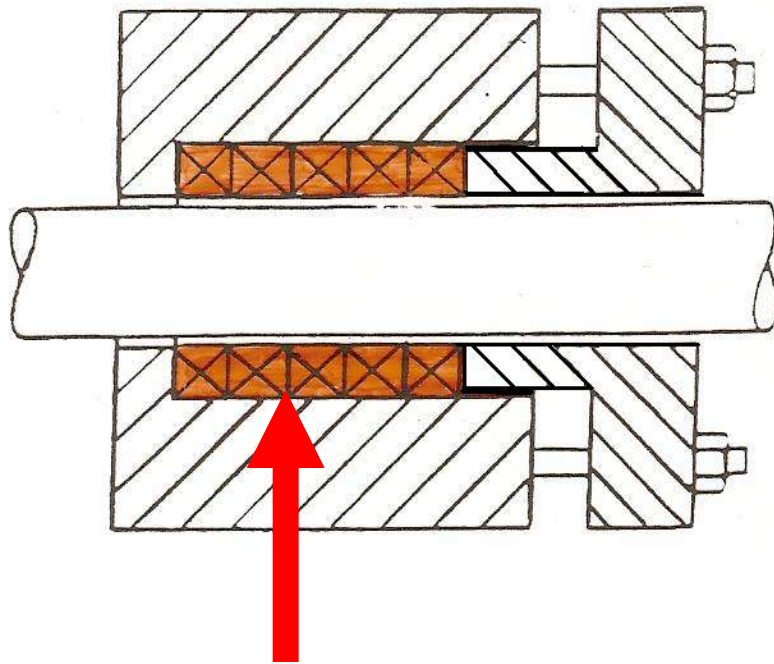


**RIGHT ?**

**WRONG ?**

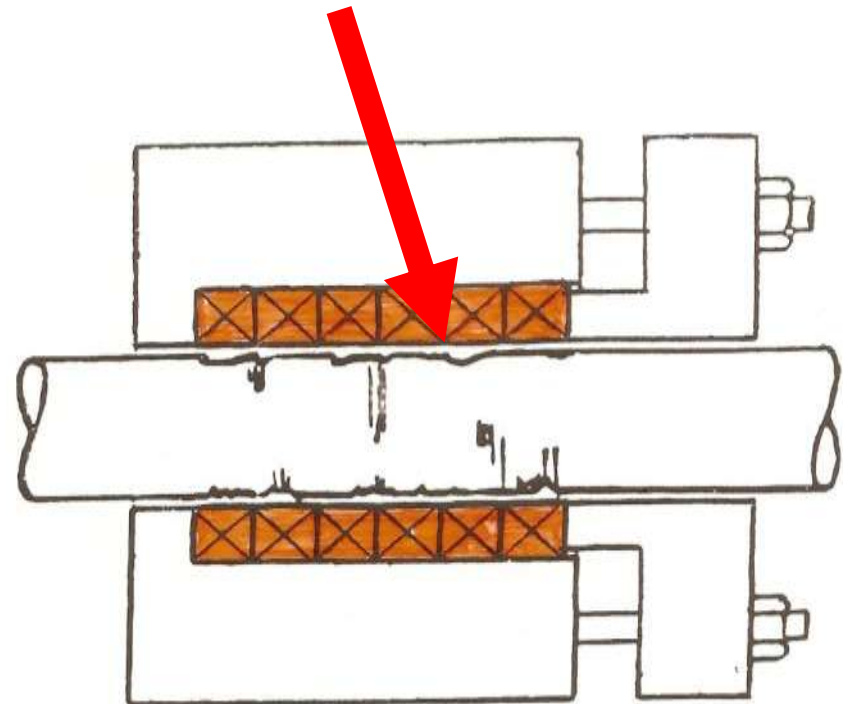


# COMMON FAULTS



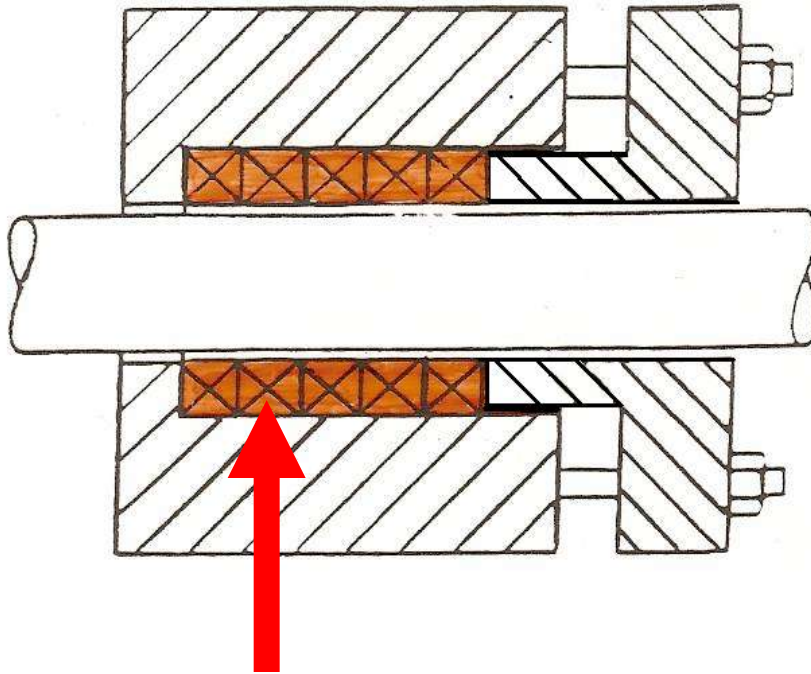
**RIGHT ?**

**WRONG ?**



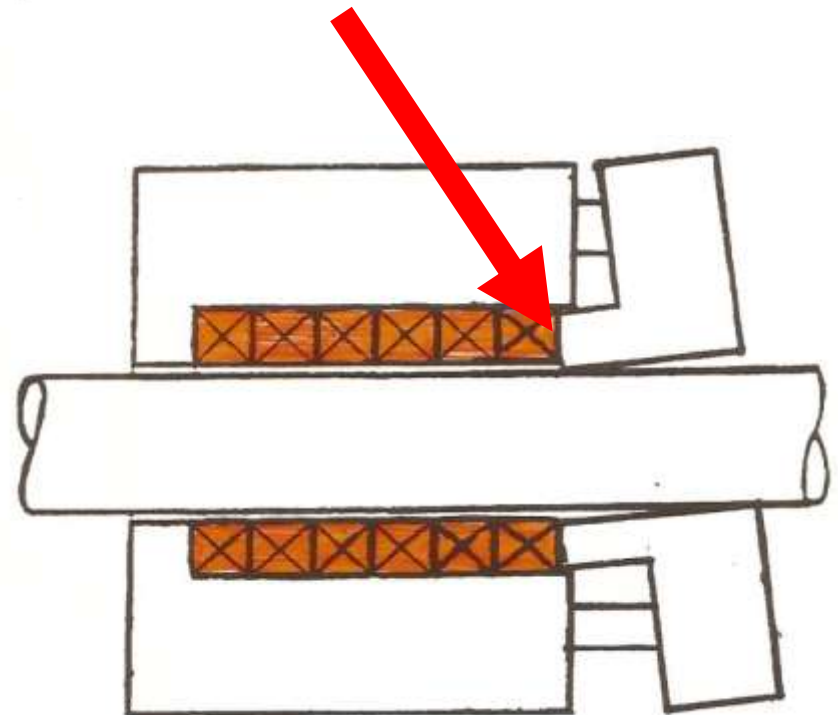


## COMMON FAULTS



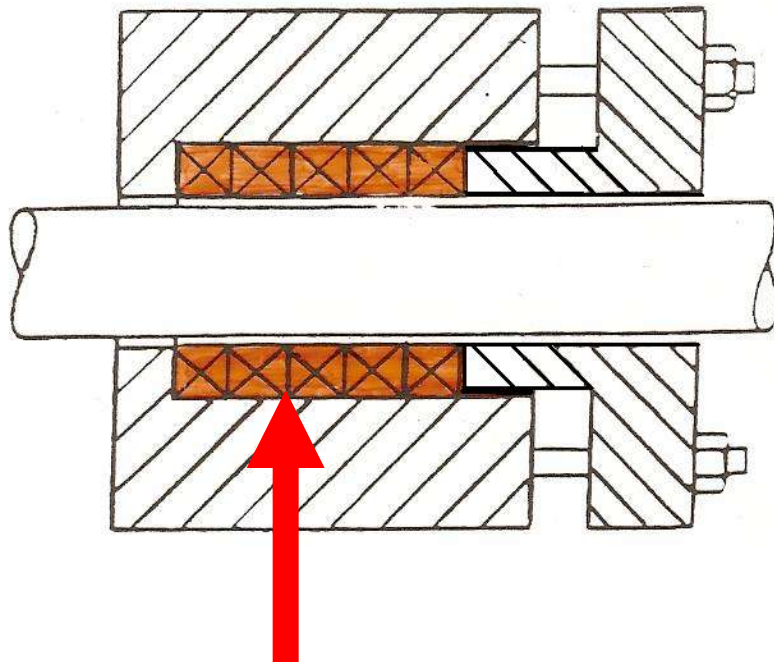
**RIGHT ?**

**WRONG ?**



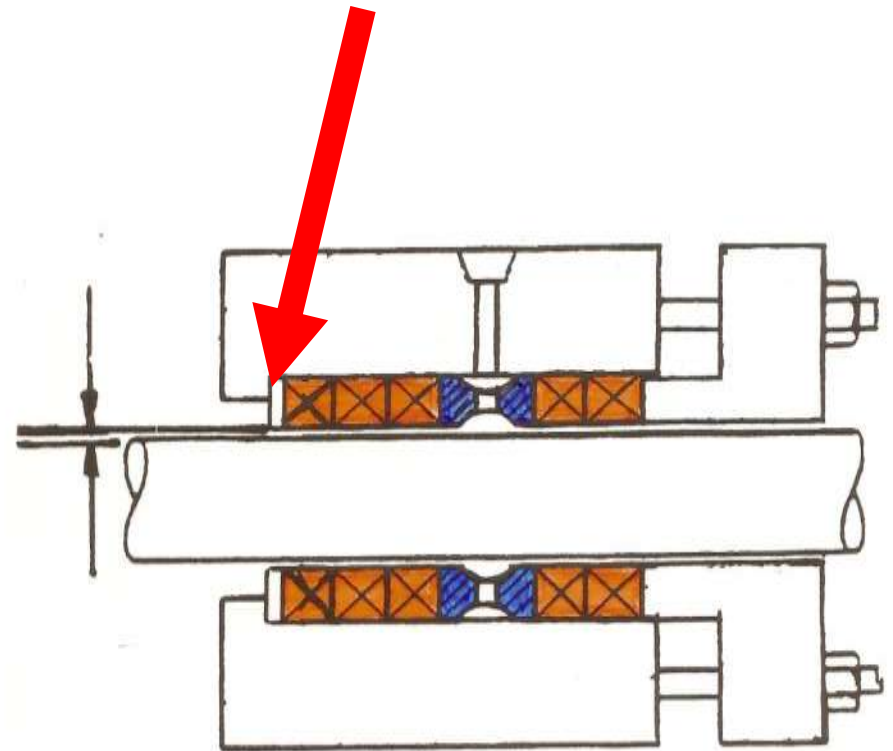


## COMMON FAULTS

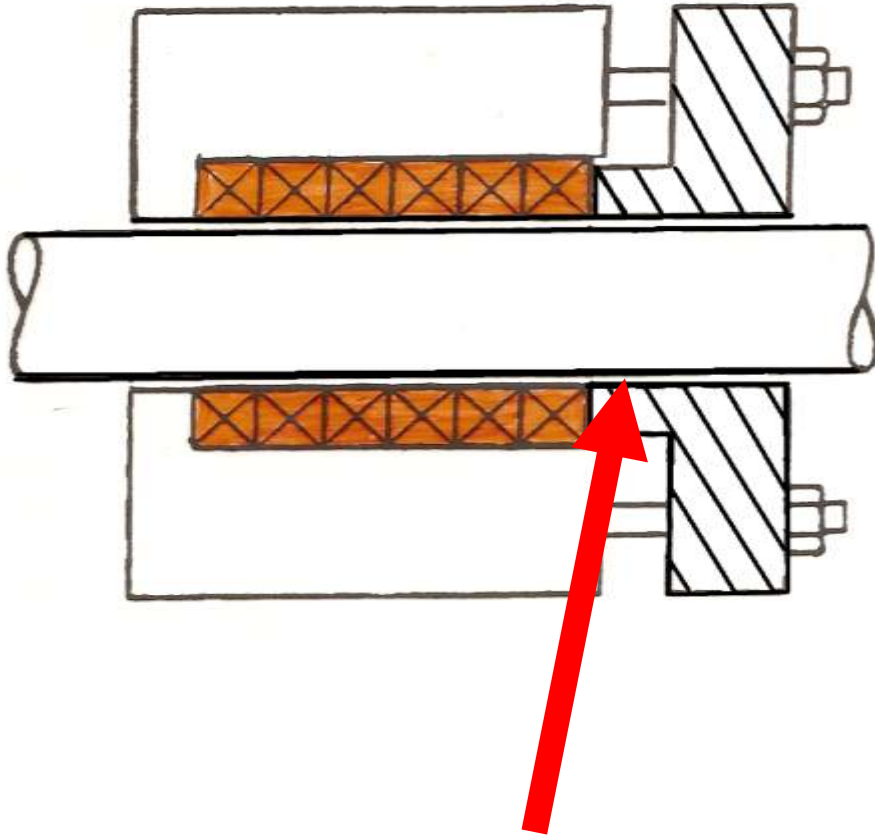


**RIGHT ?**

**WRONG ?**

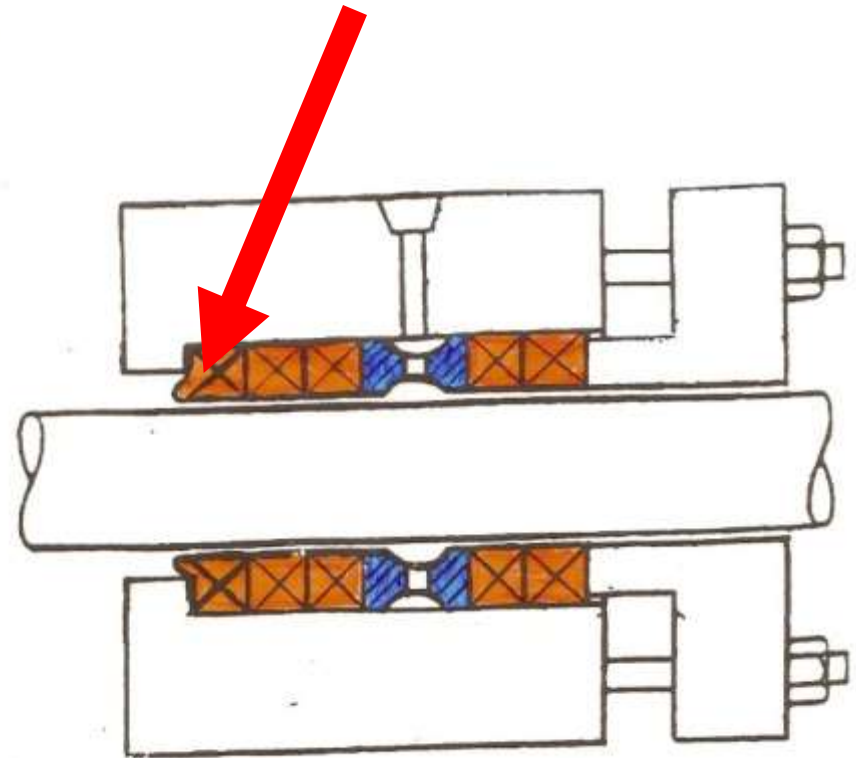


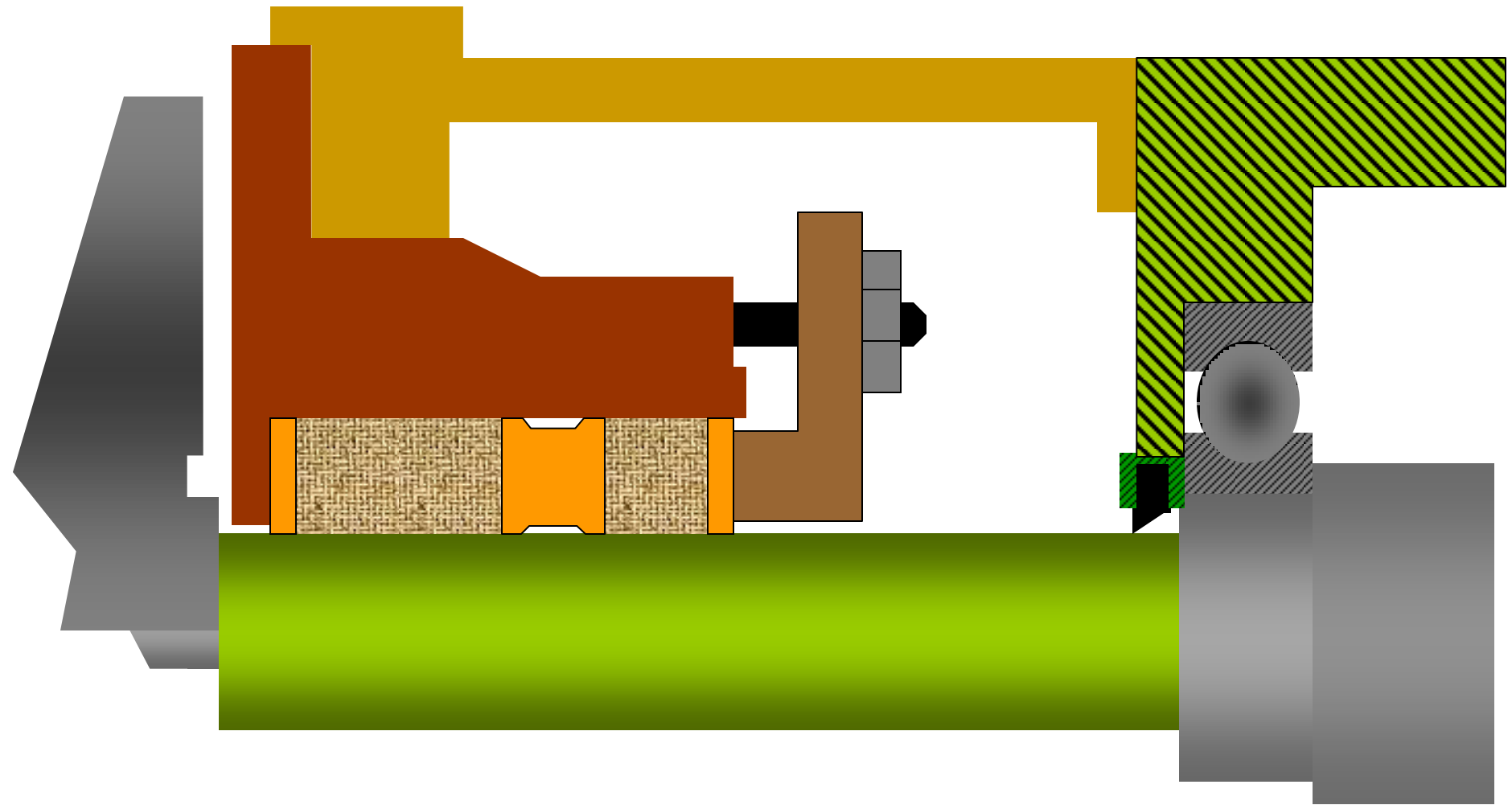
## COMMON FAULTS



**WRONG?**

**WRONG ?**

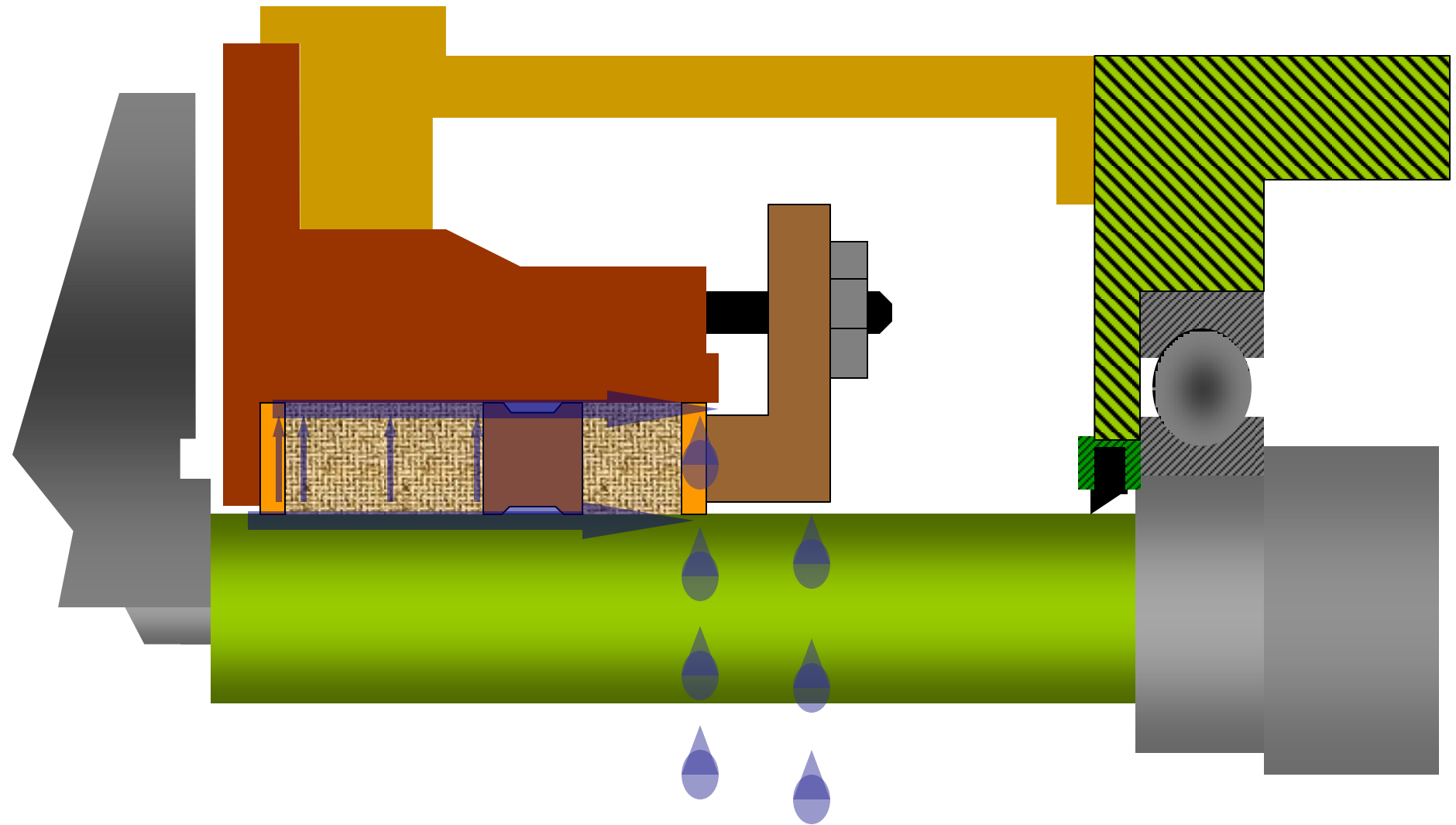


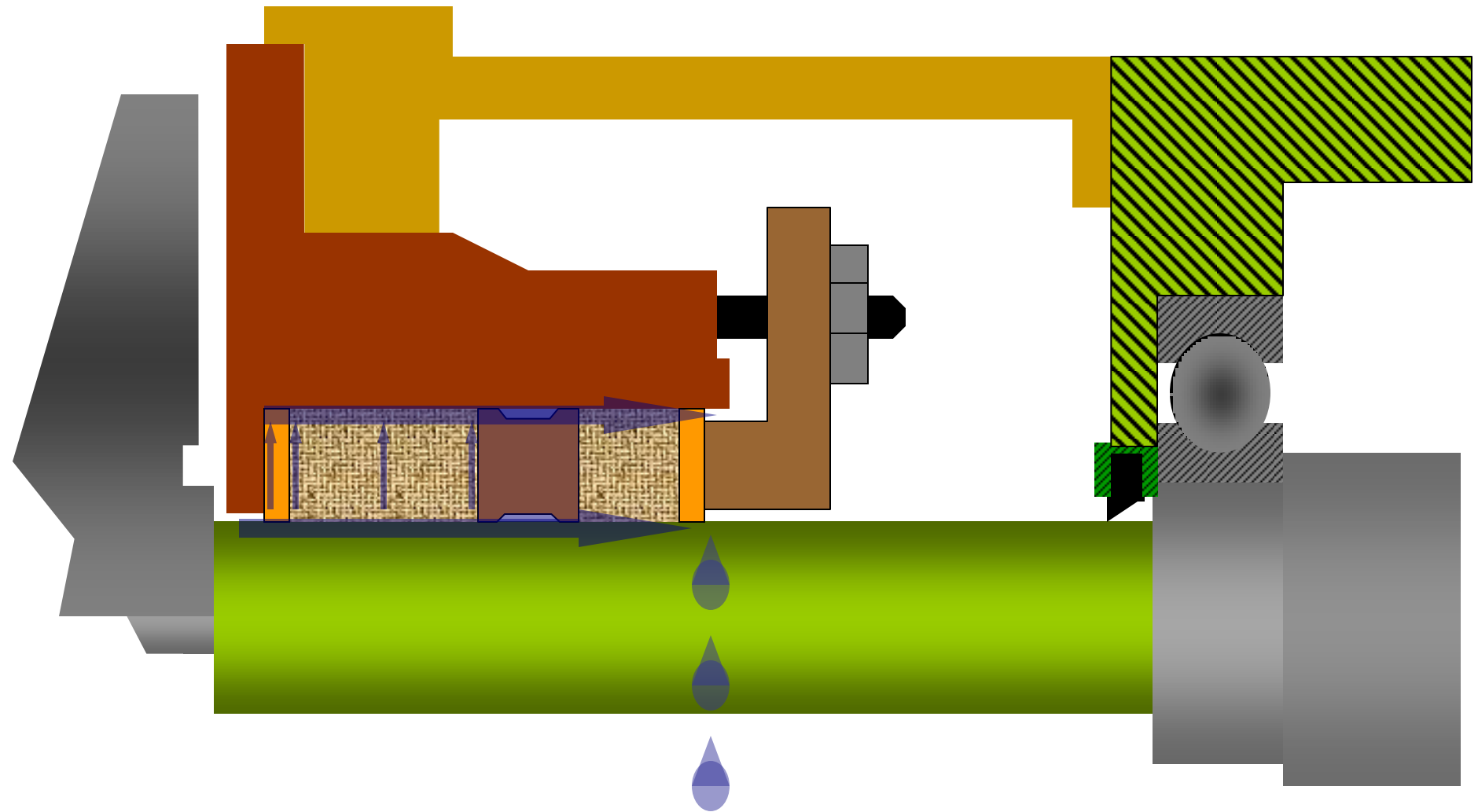


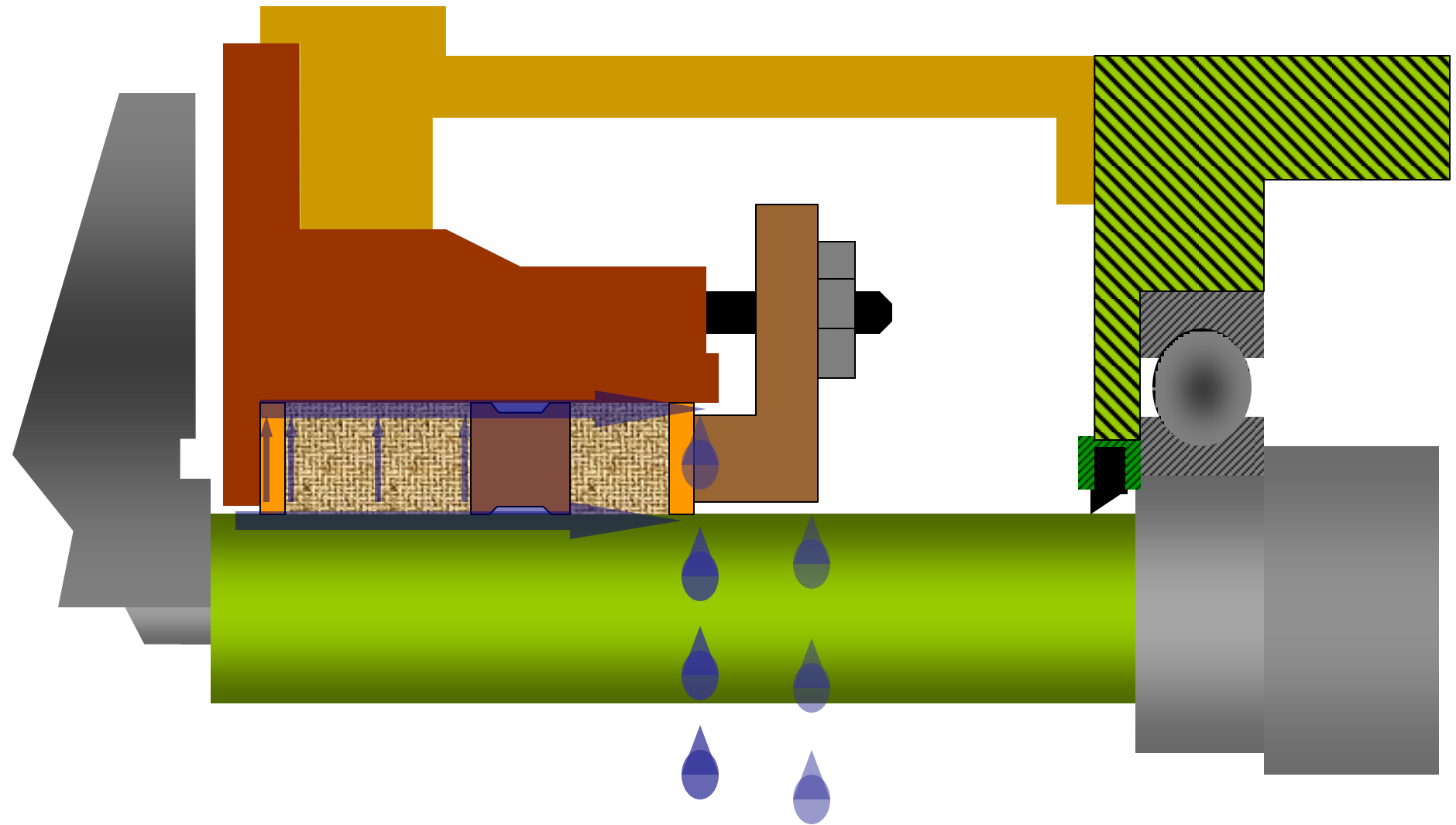
# SEALING THE LIQUID

Early packing styles did not seal very well. In fact, until recently, braided packing styles required varying amounts of leakage for lubrication. If leakage was not permitted to occur, the packing would literally “burn up” and often cause severe damage to the pump shaft. Even with adequate leakage for lubrication, pump shaft wear was a commonly expected occurrence and as the shaft wore it would in turn, cause poor shaft packing life.

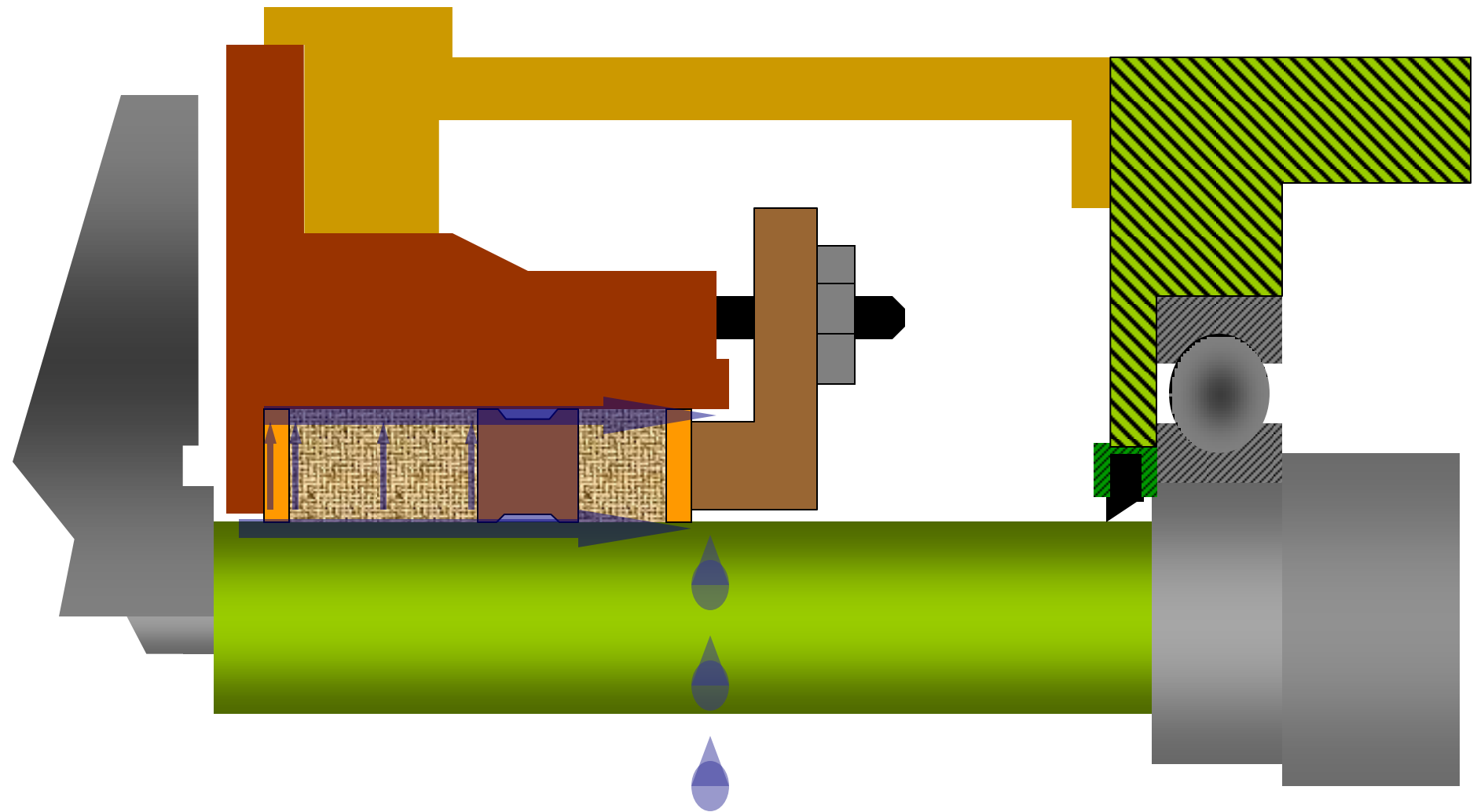
As leakage becomes more excessive, the gland is tightened to reduce leakage.

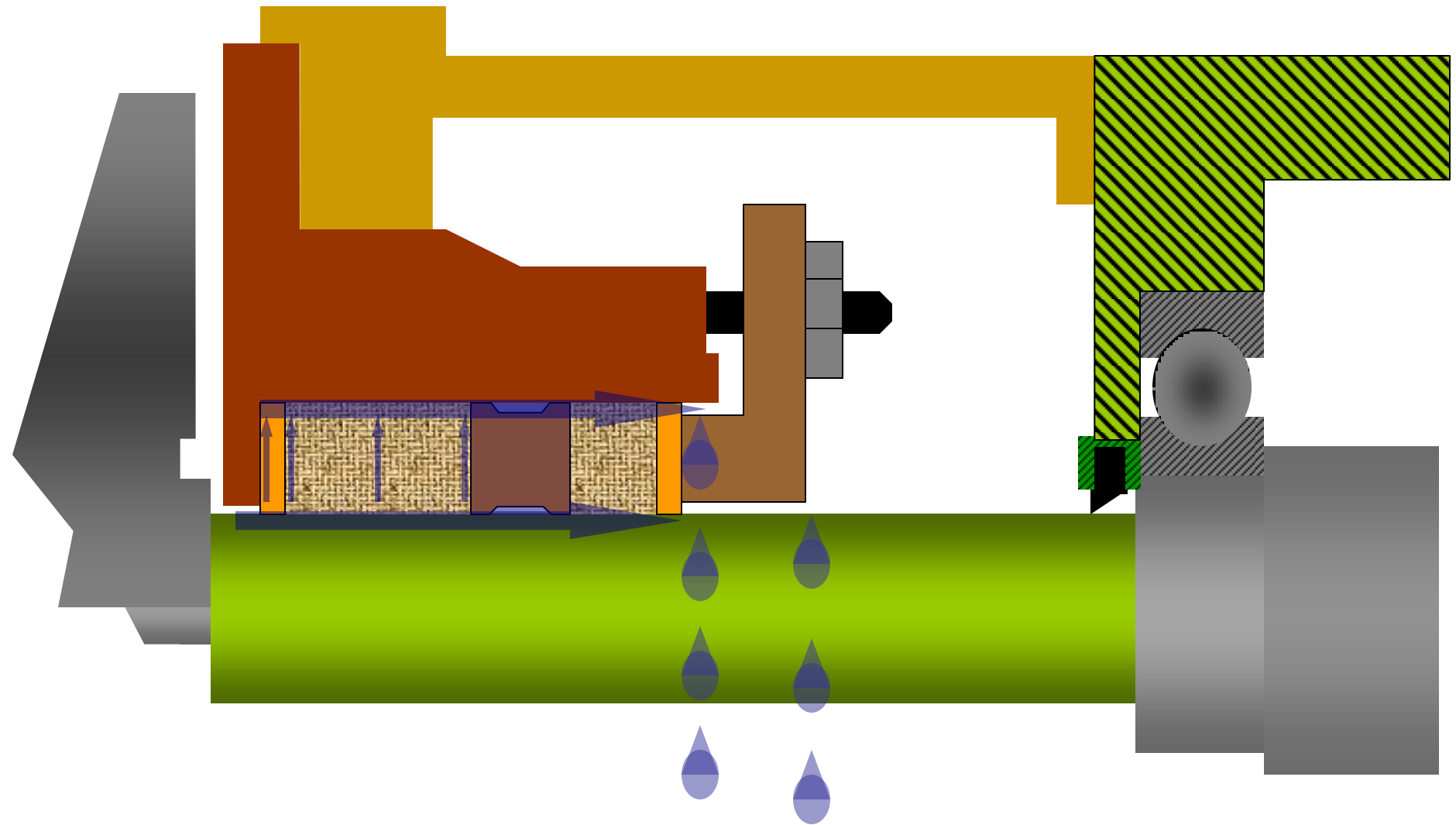










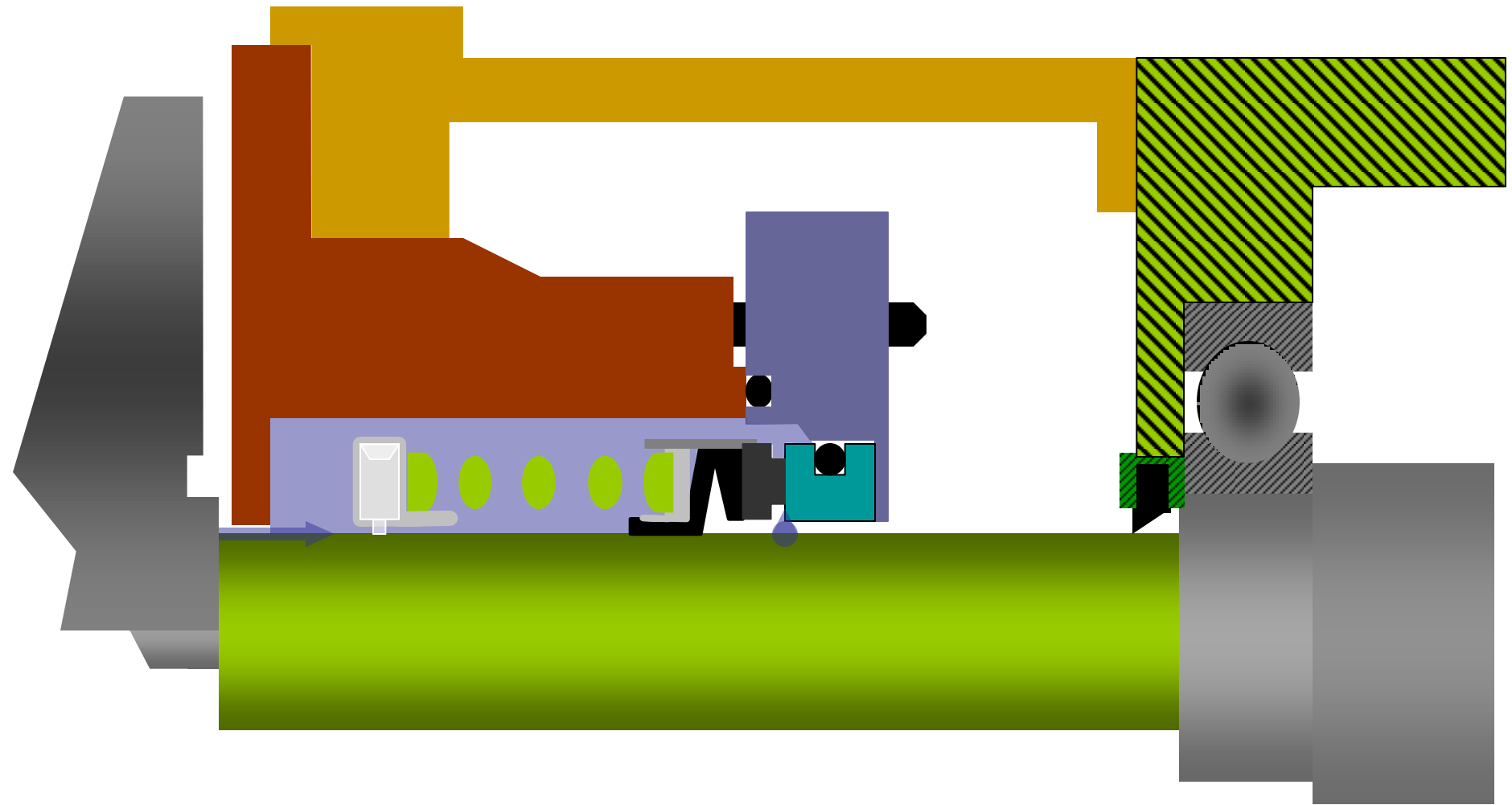


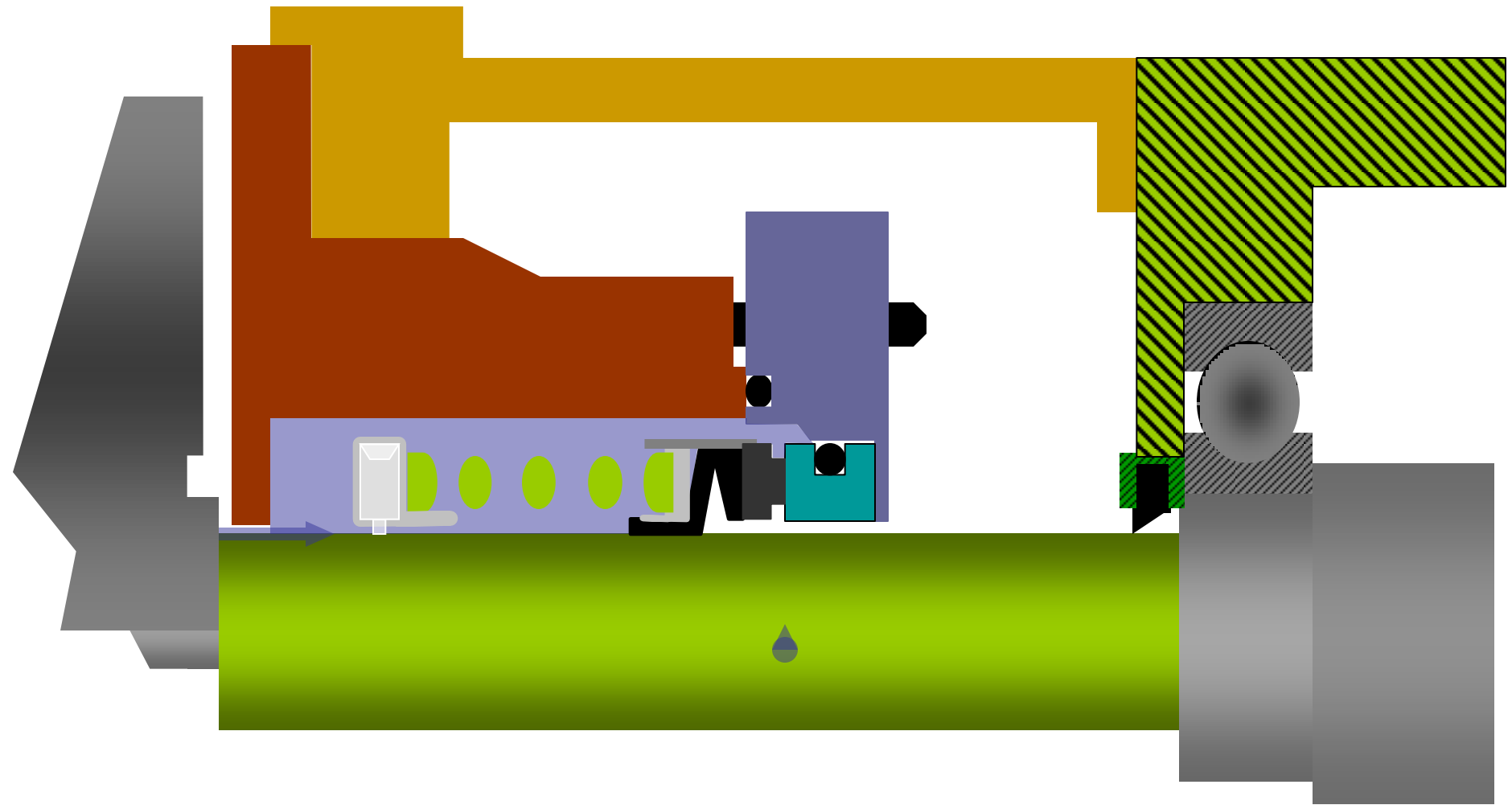
# Mechanical Seals

# SEALING THE LIQUID

With the introduction of mechanical seals, this leakage could be controlled to a much greater degree.

Let's look at the same pump with a mechanical seal installed. Note that the seal shown is a typical mechanical seal with O-Ring type stationary sealing points and a set screw collar.





# SEALING THE LIQUID

You have probably taken notice of the illustration showing minor leakage to atmosphere. It is appropriate to point out at this time...

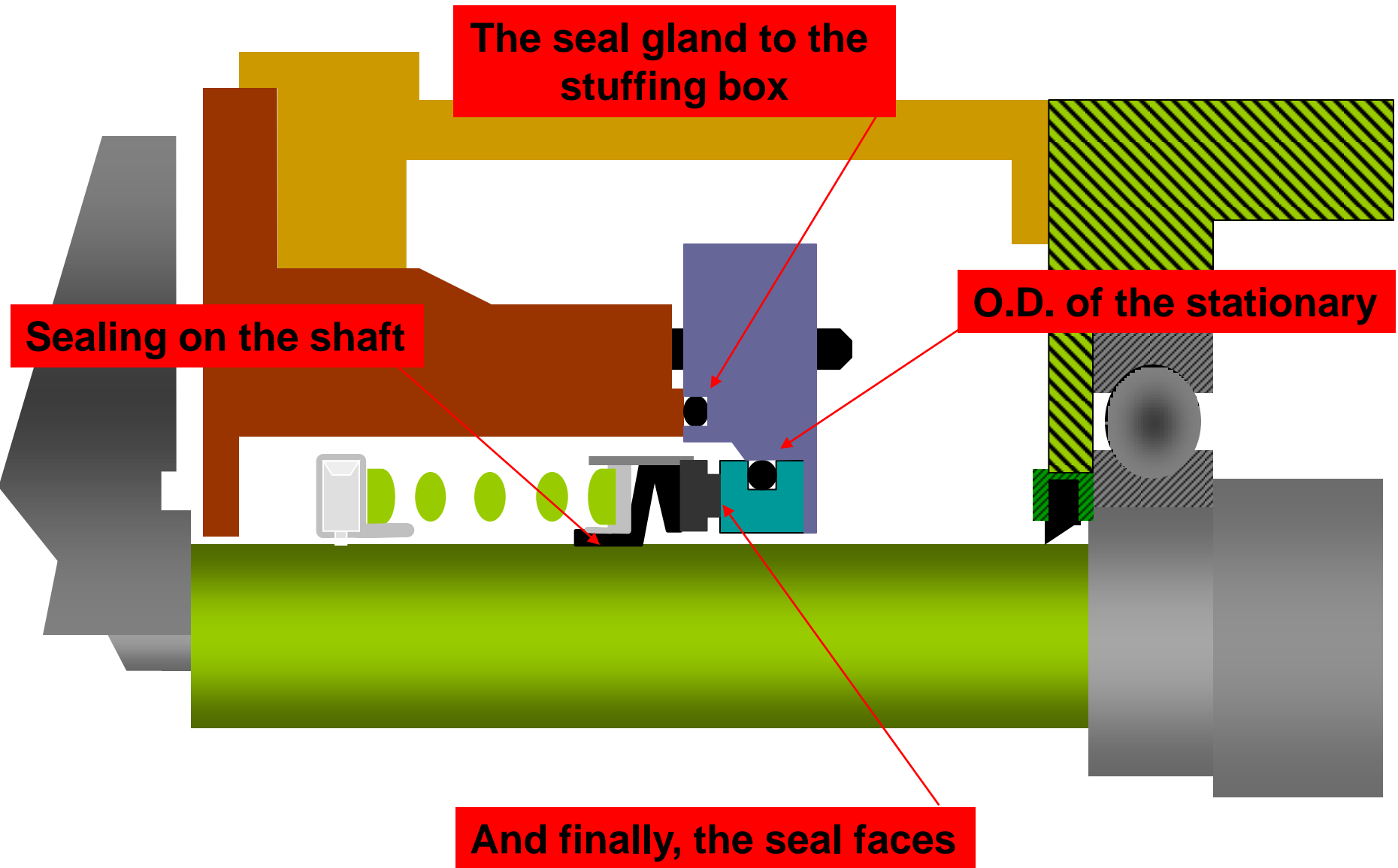


# All Mechanical Seals Leak

# SEALING THE LIQUID

It is a fact, all mechanical seals leak. Like packing, the mechanical seal “faces” must also be lubricated. With proper application and design however, the leakage is so minute that actual droplets of liquid are not detected. Instead, the lubricating liquid will vaporize as it crosses the seal faces and the leakage is a gas or vapor.

Since we are discussing the sealing of the liquid at the faces, let's take a look at the sealing points of a typical mechanical seal. Again, viewing the same pump and seal, note that there are four sealing points to consider.



# BRIEF DISCUSSION ABOUT MECHANICAL SEAL FACE DYNAMICS

# FACE FLATNESS

The mechanical seal faces are obviously the most critical sealing point of a mechanical seal assembly.

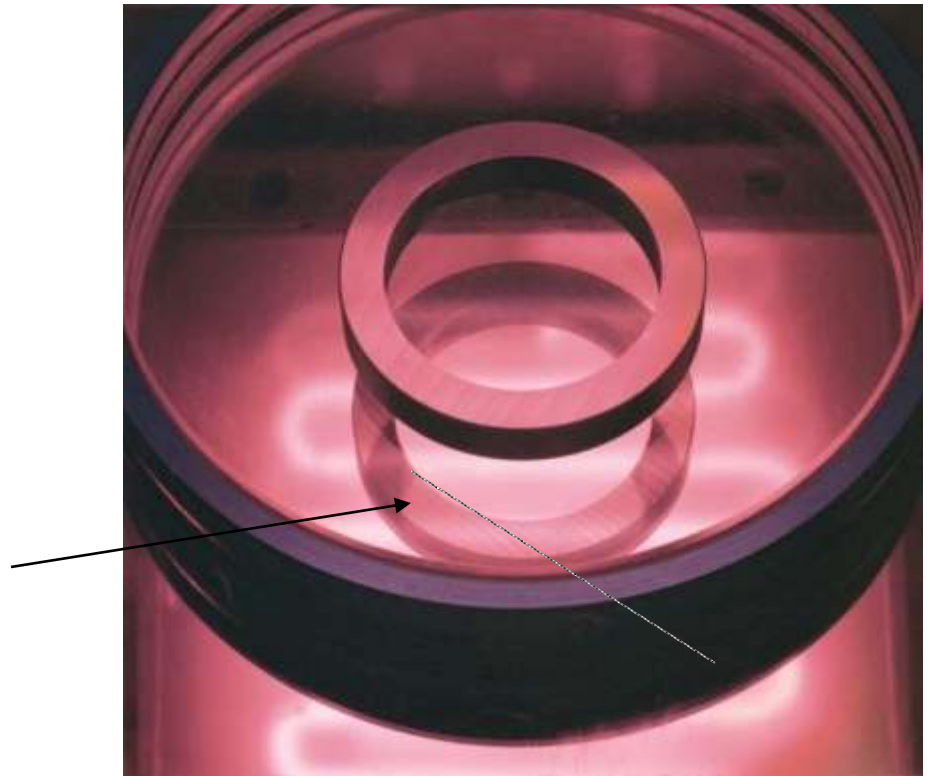
Although the faces can be manufactured from a myriad of different materials, one is typically carbon, while the other is usually a hard material. (i.e. Alox (Aluminum Oxide Ceramic), Tungsten Carbide, Silicon Carbide, etc.)

In order for a “seal” to be achieved, the faces must be very flat. This is achieved by machining the faces, then “lapping” them to a fine finish.

Flatness is measured in “Light Bands”. After lapping, the faces are placed on an “Optical Flat”, a clear glass surface where a monochromatic light is shined on the face. This single wavelength light will produce an image of rings or lines on the face. Each ring/line is “One Light Band”. Each light band is equivalent to .000011” or eleven millionths of an inch. This refers to the variations in the surface of the face. On most face materials, one light band is the standard.

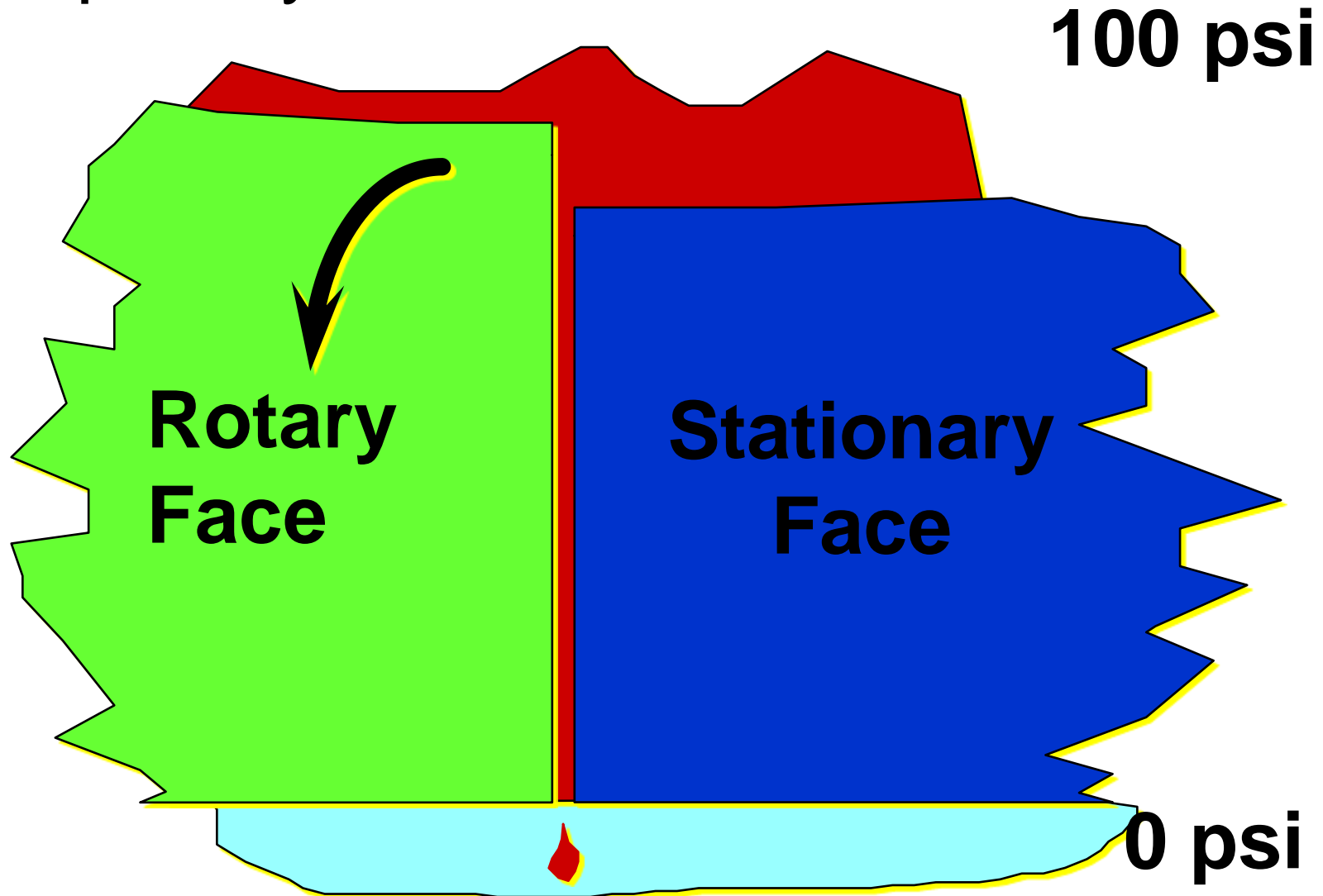
# FACE FLATNESS

- This illustration shows a face being inspected on an Optical Flat.
- Take notice of the light bands that are visible on the reflection of the face.
- Laying a straight edge on a tangent to the inside circumference of the face, how many light bands are crossed?





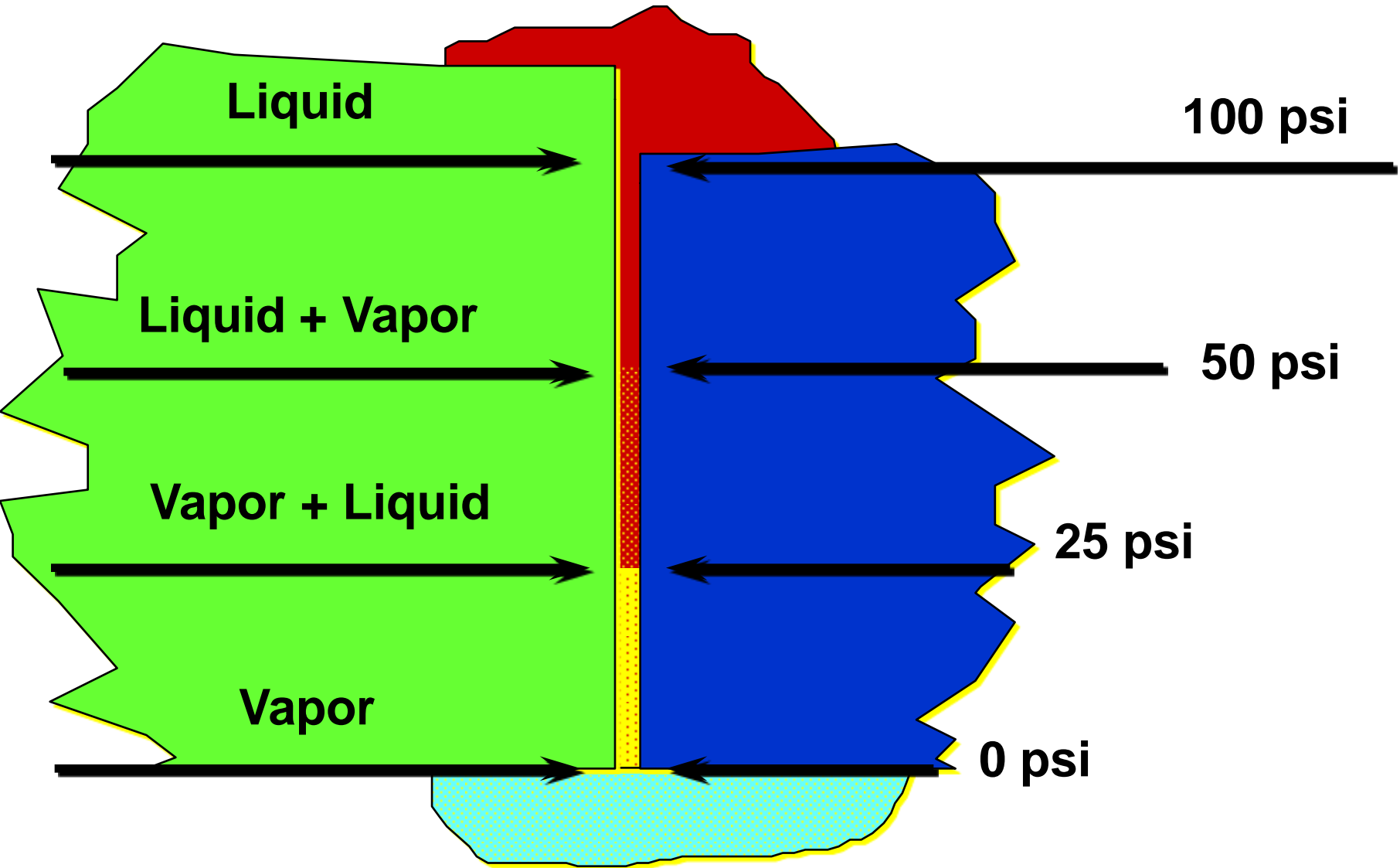
# Optically Flat Faces



# FACE FLATNESS

As was stated earlier, it is hoped that the application and design of the mechanical seal is suited for the service. If so, there is leakage of only vapor through the seal faces.

# Pressure Drop & Vaporization



# TYPES OF MECHANICAL SEALS

# SEAL TYPES

There are obviously many different types and configurations of mechanical seals. Shaft mounted and cartridge, balanced and unbalanced, pusher and non-pusher, single and multiple, etc., etc.

Here we will examine the basic differences without going into a great detail.

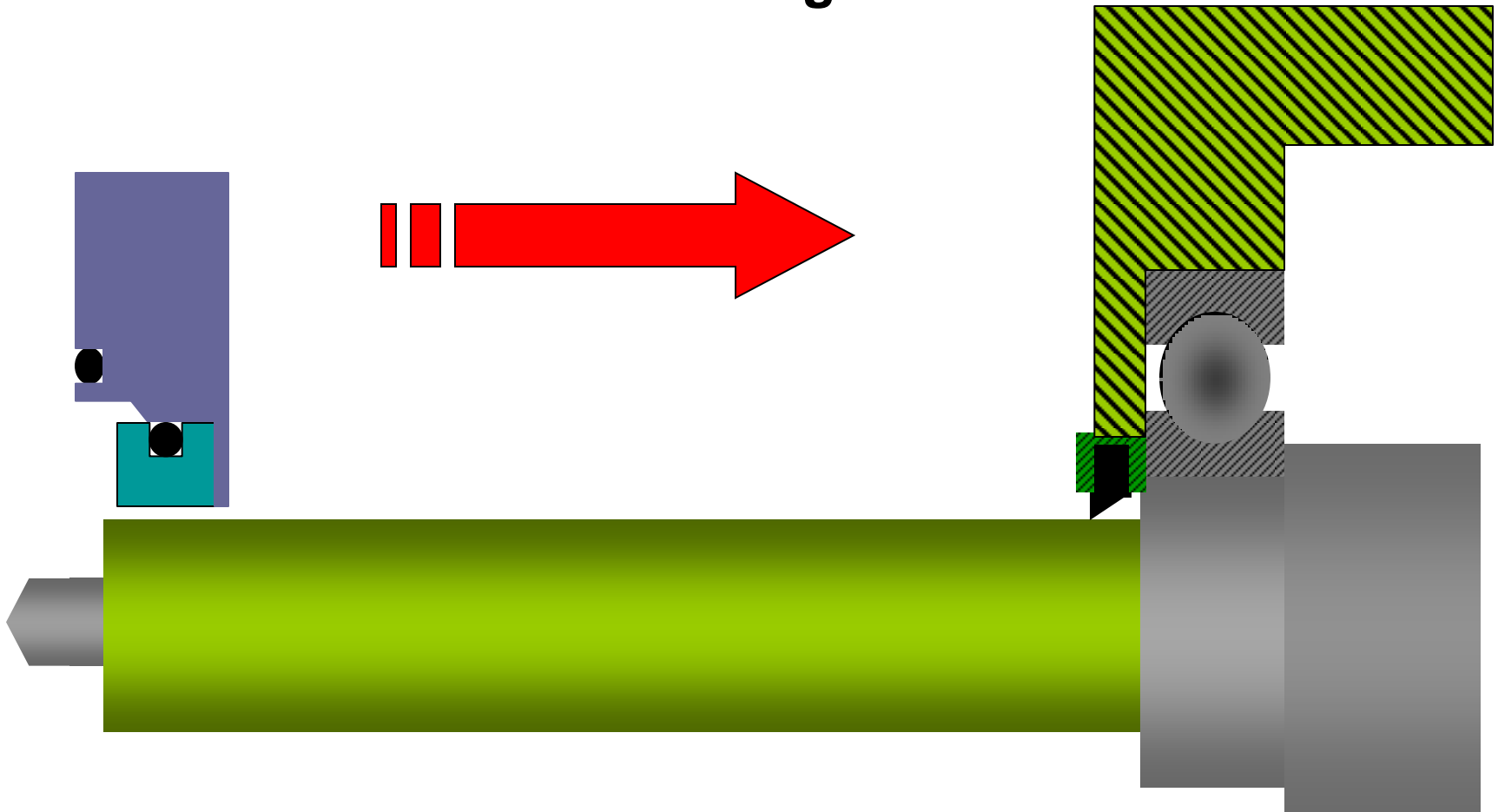
# SEAL TYPES

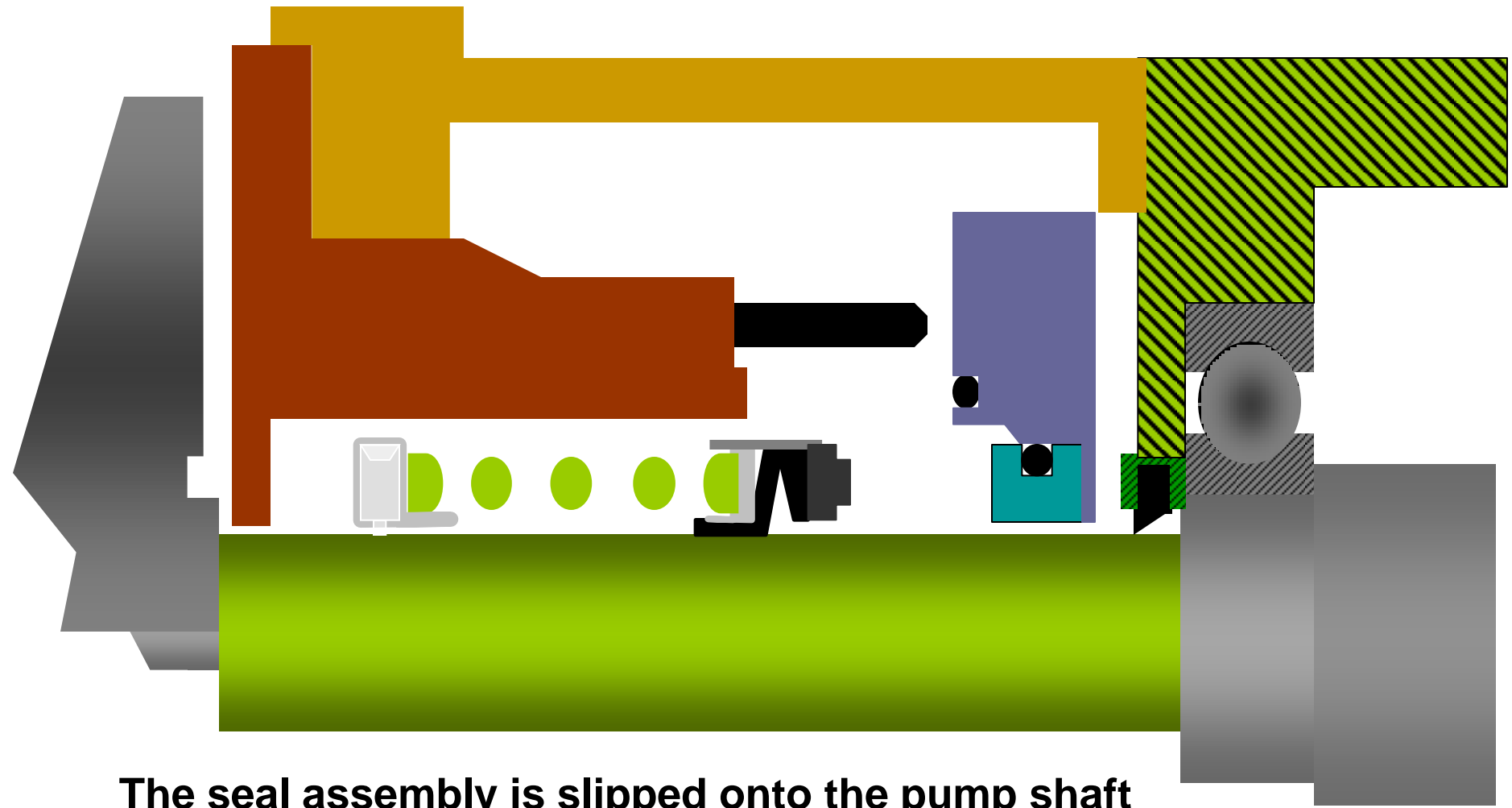
First, let us examine shaft mounted vs. cartridge.

A shaft mounted seal requires the pump user or assembler to actually install individual seal components into the equipment.

Let's look at the installation of the RS-1 that we were looking at previously.

**The stationary seat must be inserted into the seal gland.**



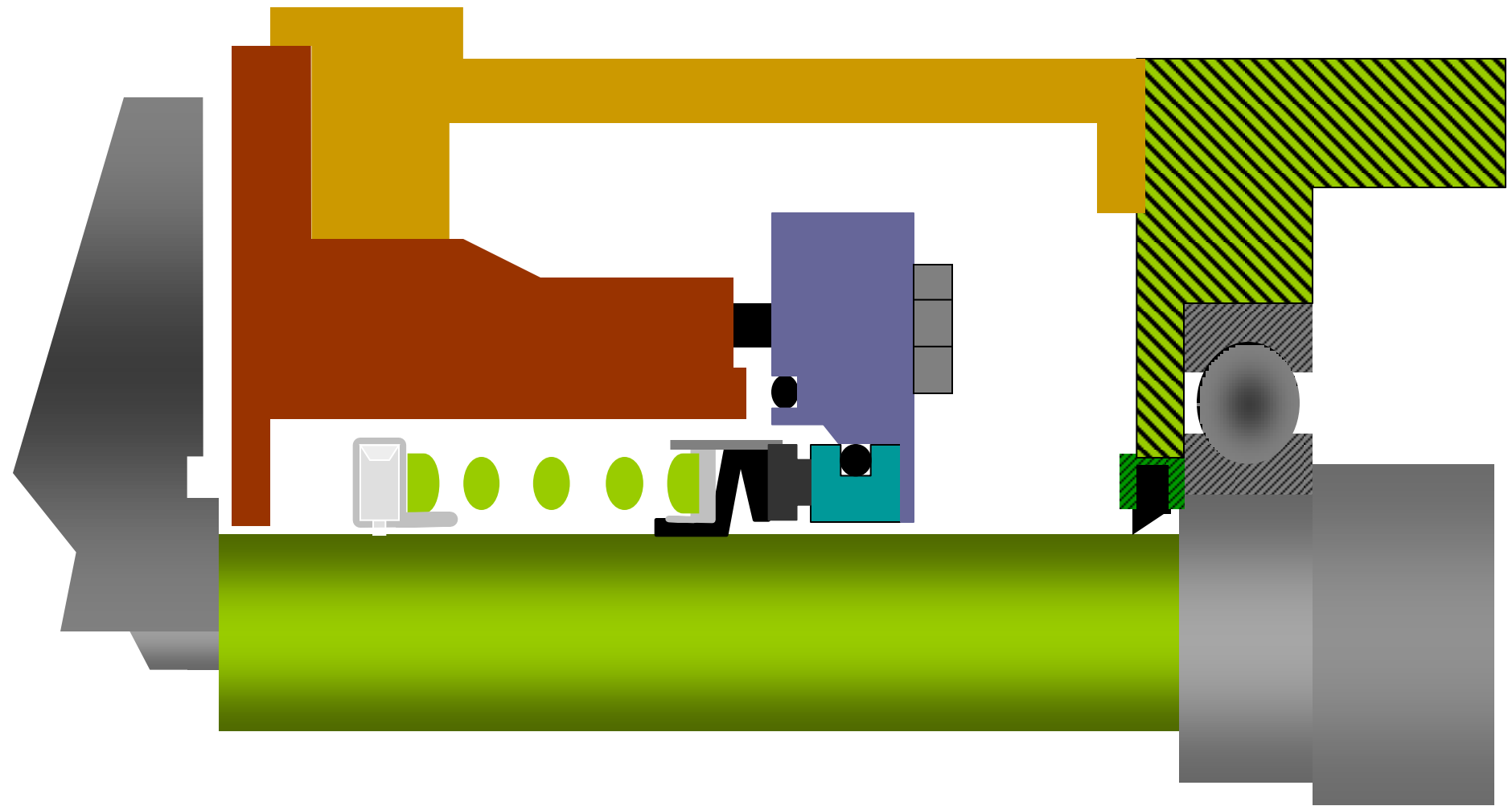


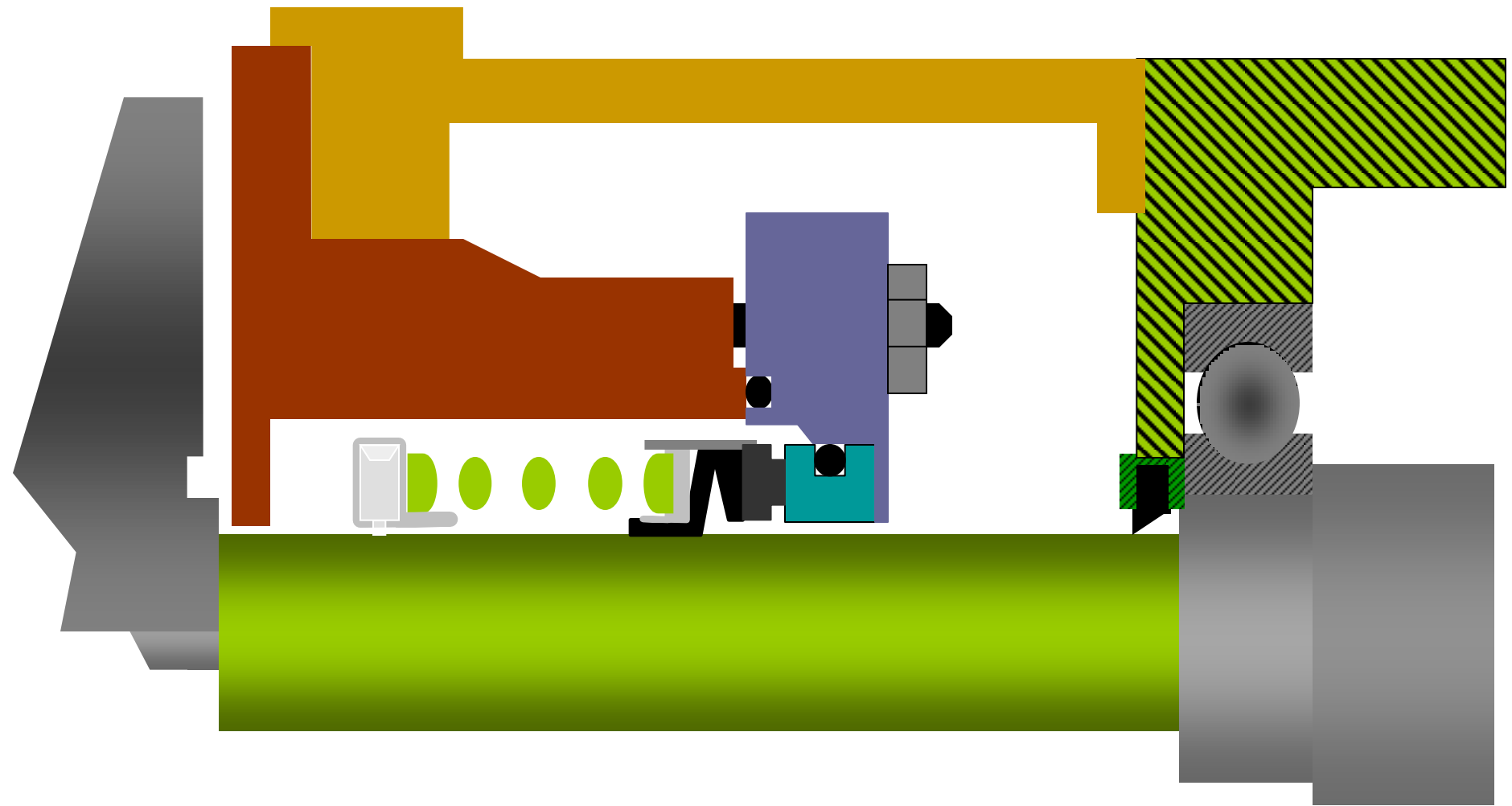
**The seal assembly is slipped onto the pump shaft and the set screws tightened in the correct position to insure proper “installed length” of the assembly.**





**The gland is tightened evenly so that the seal is compressed to it's recommended length.**





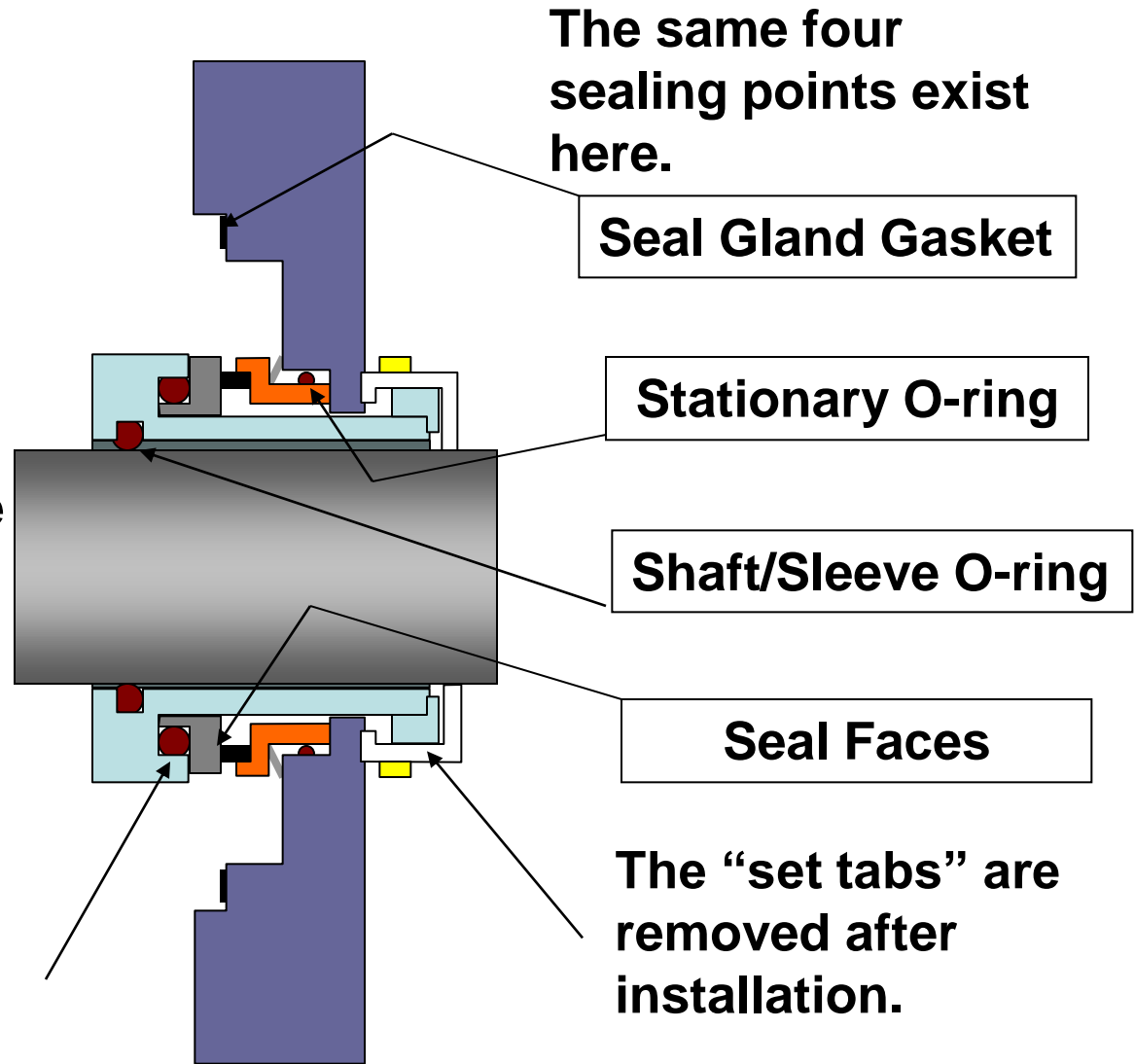
# SEAL TYPES

A cartridge type mechanical seal is a pre-assembled package of seal components making installation much easier with fewer points for potential installation errors to occur.

The assembly is “pre-set” so that no installed length calculations must be performed for determining where to set the seal. This pre-set is achieved by the use of “set tabs” that are removed once the seal is installed and the pump assembled.

Although the assembly may look complicated, it is basically no different than a shaft mounted arrangement as far as sealing components and sealing points are concerned.

One additional sealing point exists in this particular cartridge assembly. Have you found it?



# SEAL TYPES

Remember the number of steps involved in installing the shaft mounted seal.

Now let's look at installing the cartridge seal that we just examined.

# **CARTRIDGE SEAL INSTALATION**

# CARTRIDGE SEAL INSTALATION

**CHECK PUMP SHAFT FOR BURRS**

**CHECK GLAND BOSS FOR NICKS**

**LUBRICATE SECONDARY SEALS**

**SLIDE SEAL ONTO PUMP SHAFT**

**ALSO**



# CARTRIDGE SEAL INSTALATION

**ASSEMBLE PUMP COMPONENTS**

**SET IMPELLER CLEARANCE**

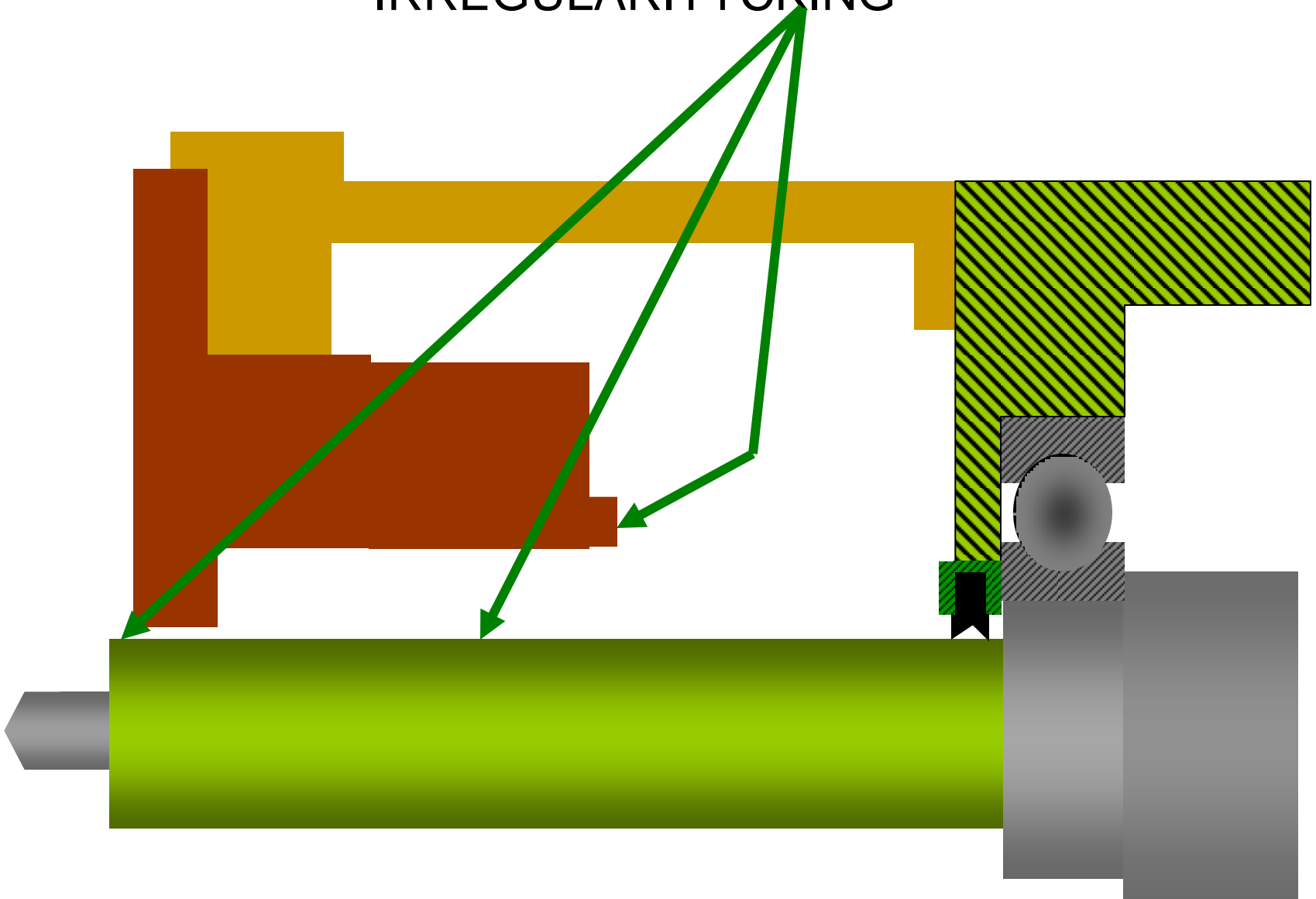
**BOLT UP SEAL GLAND**

**TIGHTEN SET SCREWS AND PULL TABS**

# CARTRIDGE SEAL INSTALLATION

- **BURRS ON THE PUMP SHAFT COULD CUT SHAFT/SLEEVE O-RINGS WHEN INSTALLING THE SEAL RESULTING IN LEAKAGE**
- **NICKS OR ANY OTHER IRREGULARITY ON THE GLAND BOSS COULD RESULT IN IMPROPER SEALING OF THE GLAND GASKET/O-RING**

# CHECK SHAFT AND GLAND BOSS FOR BURRS, NICKS OR OTHER IRREGULARITYCKING



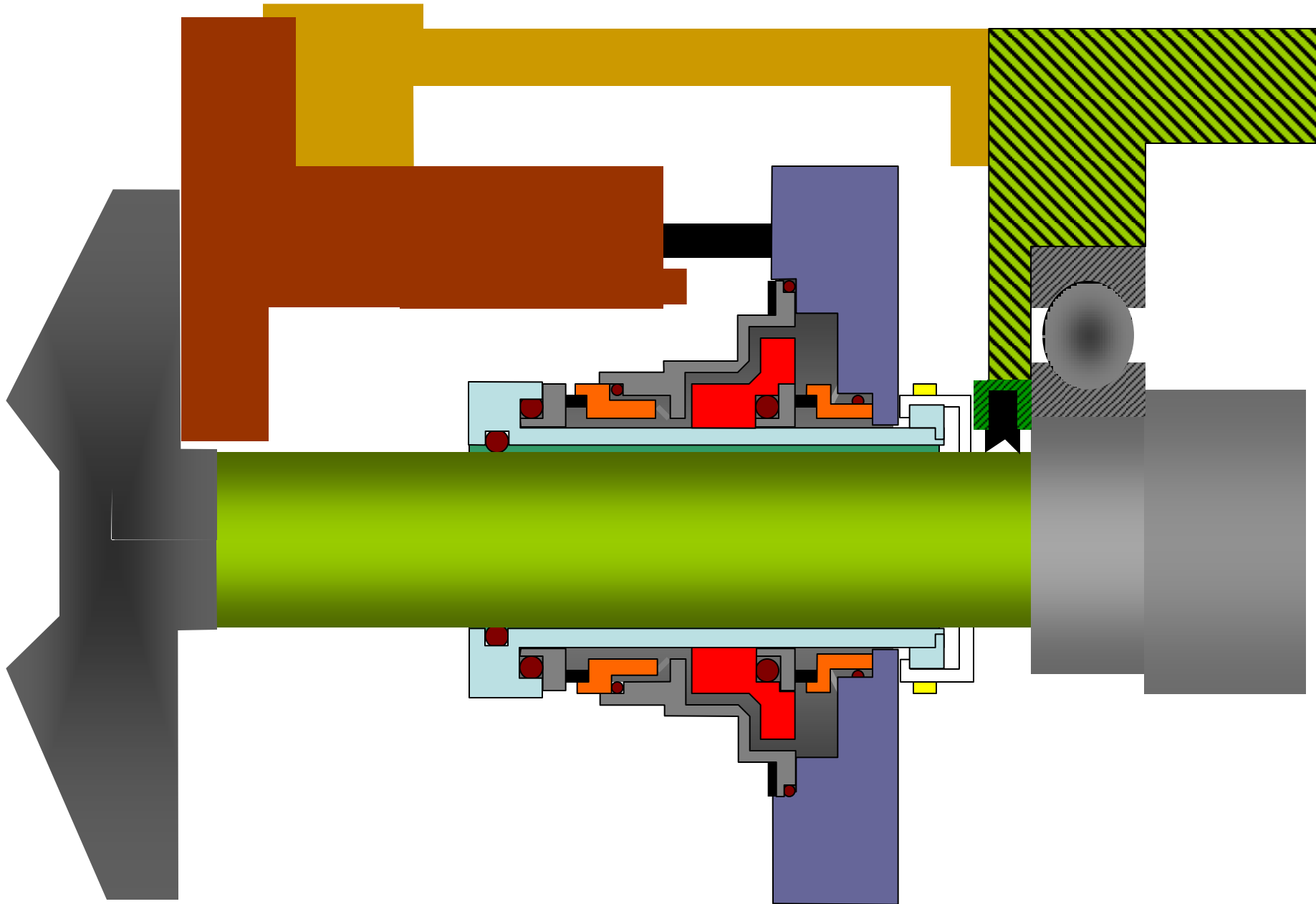
# CARTRIDGE SEAL INSTALLATION

- **LUBRICATE O-RINGS/GASKETS SO THAT THEY DON'T HANG UP, TEAR OR "ROLL OUT" WHEN SLIDING THE SEAL ONTO THE PUMP SHAFT**
- **LUBRICATING THE GLAND O-RING WILL PREVENT IT FROM FALLING OUT OF THE O-RING GROOVE BEFORE BOLTING UP THE GLAND**

# CARTRIDGE SEAL INSTALLATION

- **GENTLY SLIDE THE SEAL ASSEMBLY ONTO THE PUMP SHAFT UNTIL THE SHAFT/SLEEVE O-RING IS RESISTING**
- **APPLY EVEN PRESSURE TO THE END OF THE SEAL SLEEVE UNTIL THE SHAFT/SLEEVE O-RING SLIDES ONTO THE PUMP SHAFT**
- **ASSEMBLE THE REMAINING PUMP COMPONENTS TAKING CARE NOT TO IMPACT THE SEAL ASSEMBLY**

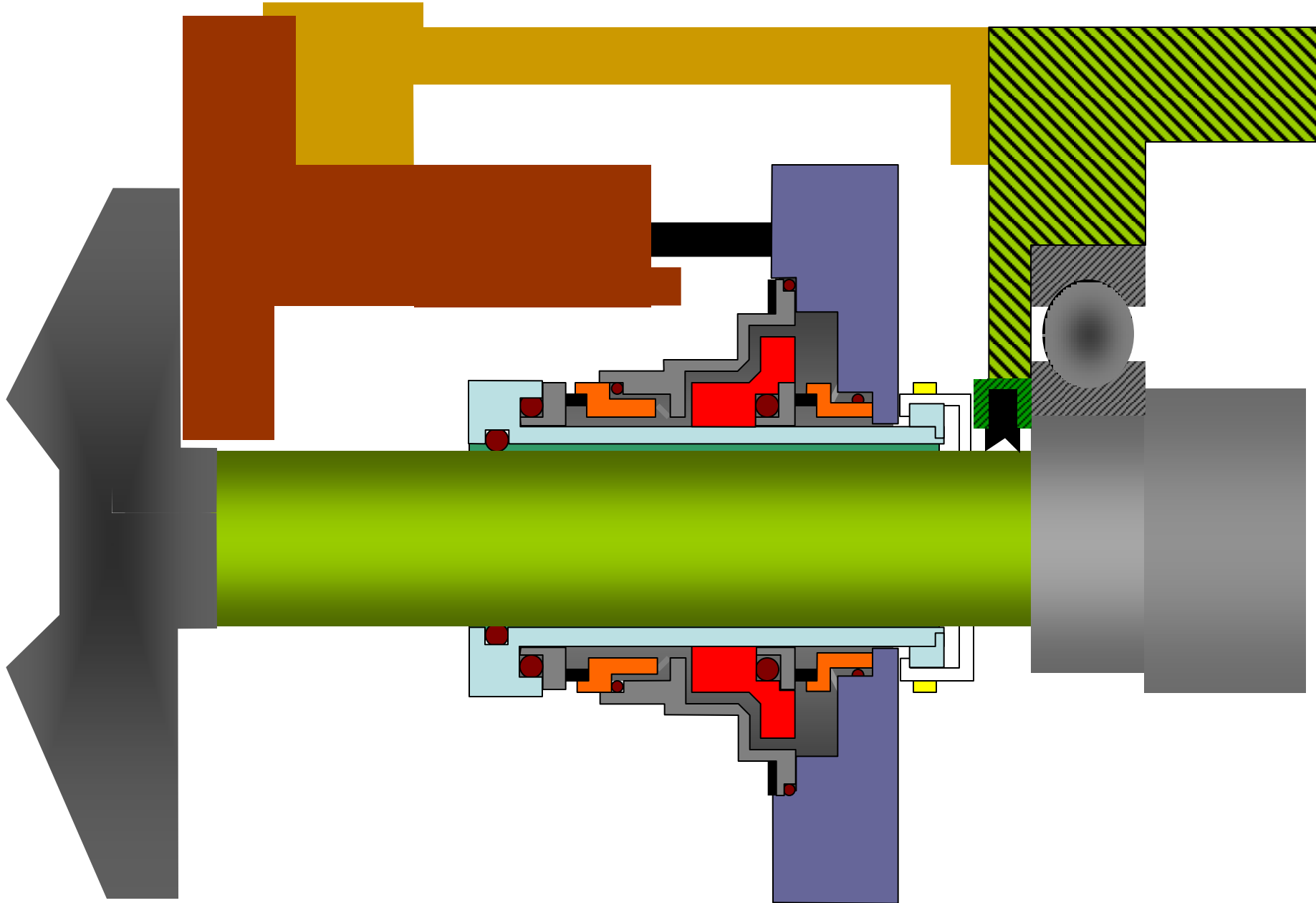
# CARTRIDGE SEAL INSTALLATION



# CARTRIDGE SEAL INSTALLATION

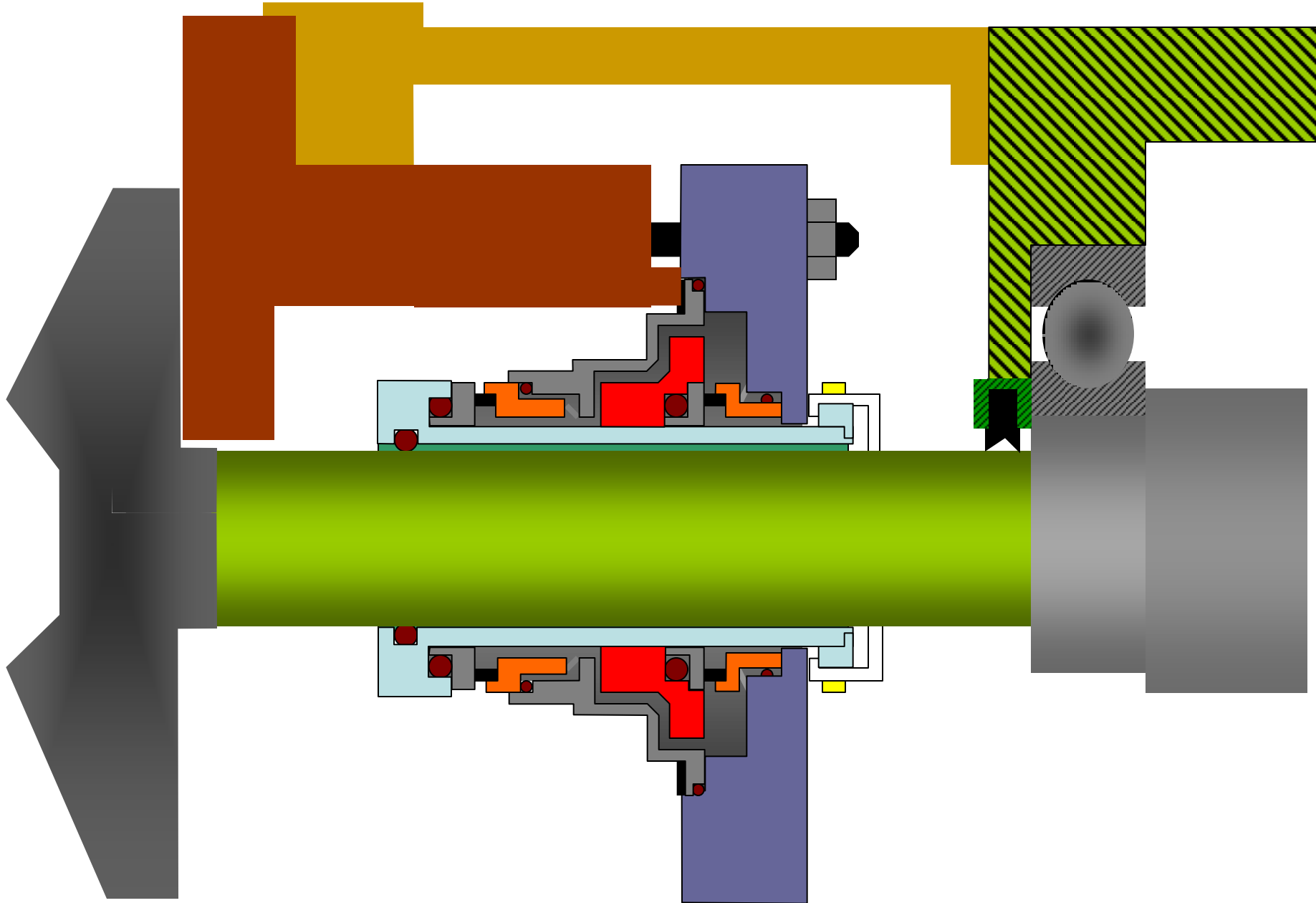
- ONCE ALL PUMP COMPONENTS ARE ASSEMBLED, SET IMPELLER CLEARANCE.  
DO NOT SET IMPELLER CLEARANCE AFTER THE SEAL HAS BEEN BOLTED UP AND SET
- CHECK GLAND ORIENTATION REQUIREMENTS AND BOLT UP THE GLAND ACCORDINGLY

# CARTRIDGE SEAL INSTALLATION





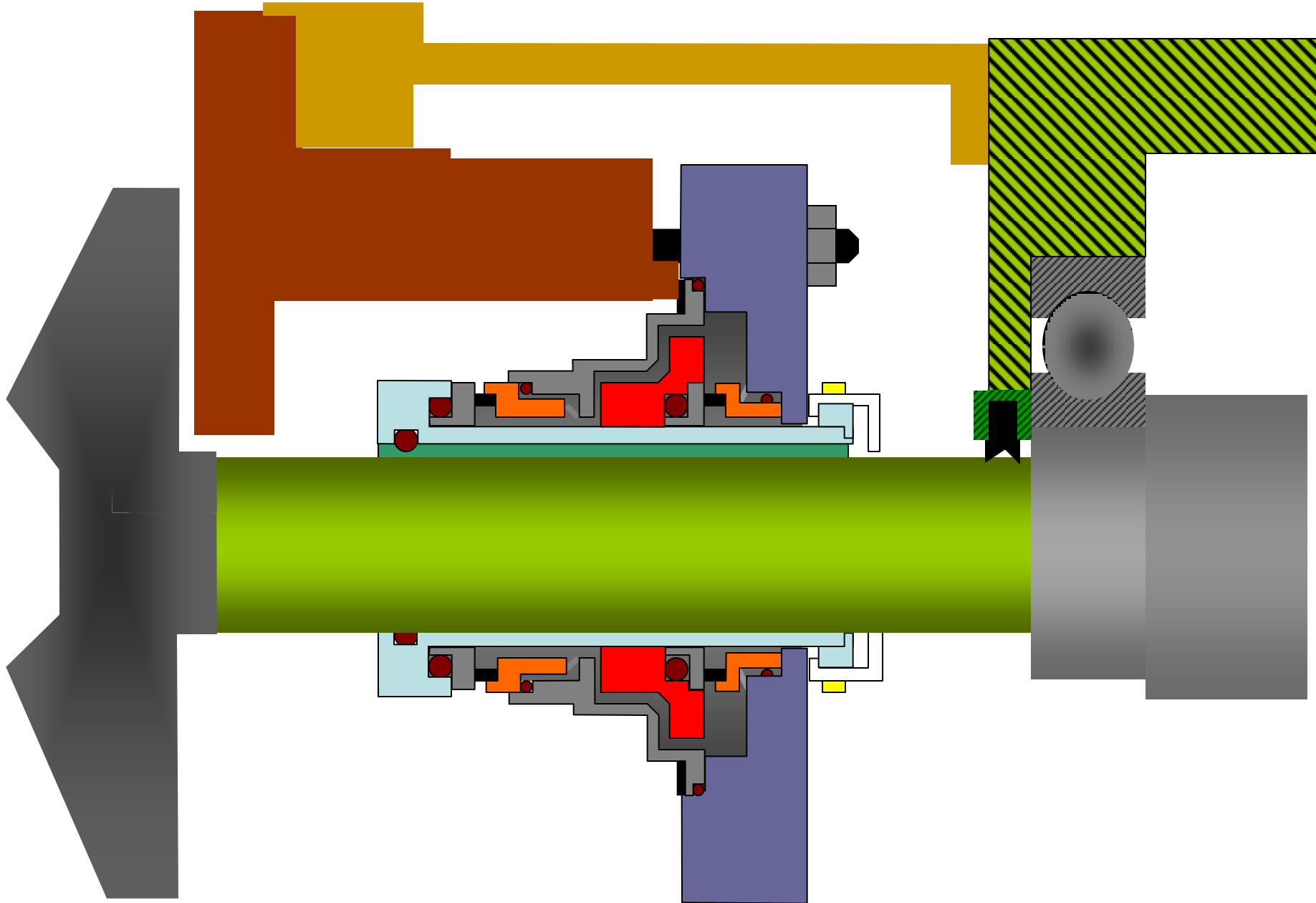
# CARTRIDGE SEAL INSTALLATION



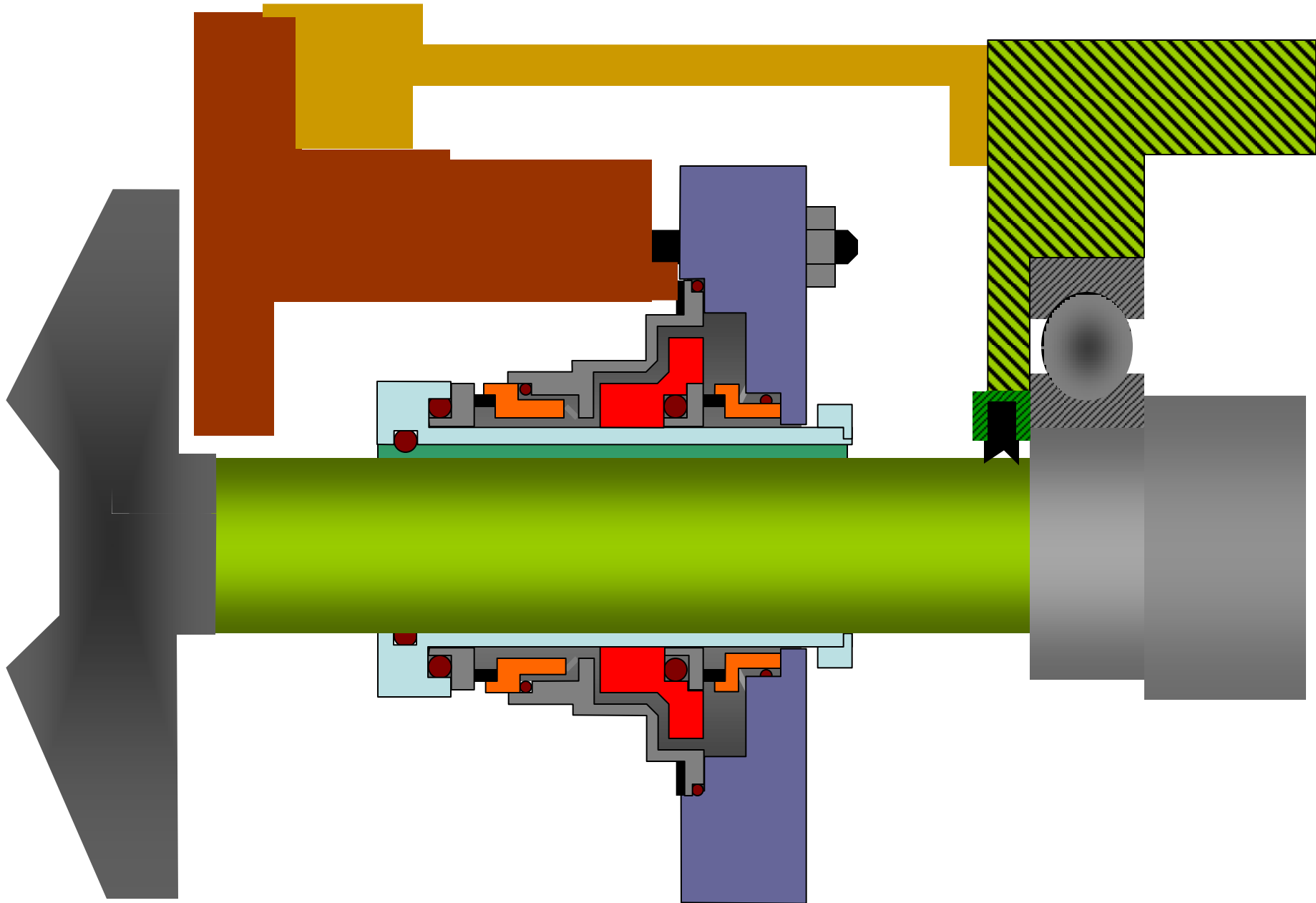
# CARTRIDGE SEAL INSTALLATION

- TIGHTEN ONE SET SCREW UNTIL IT TOUCHES THE PUMP SHAFT LIGHTLY
- MOVE TO THE OPPOSITE SET SCREW AND TIGHTEN IT FULLY
- FULLY TIGHTEN ALL SET SCREWS
- REMOVE SET TABS
- IF THE PUMP IS TO BE STORED WITH A SEAL INSTALLED, DO NOT TIGHTEN SET SCREWS OR REMOVE SET TABS

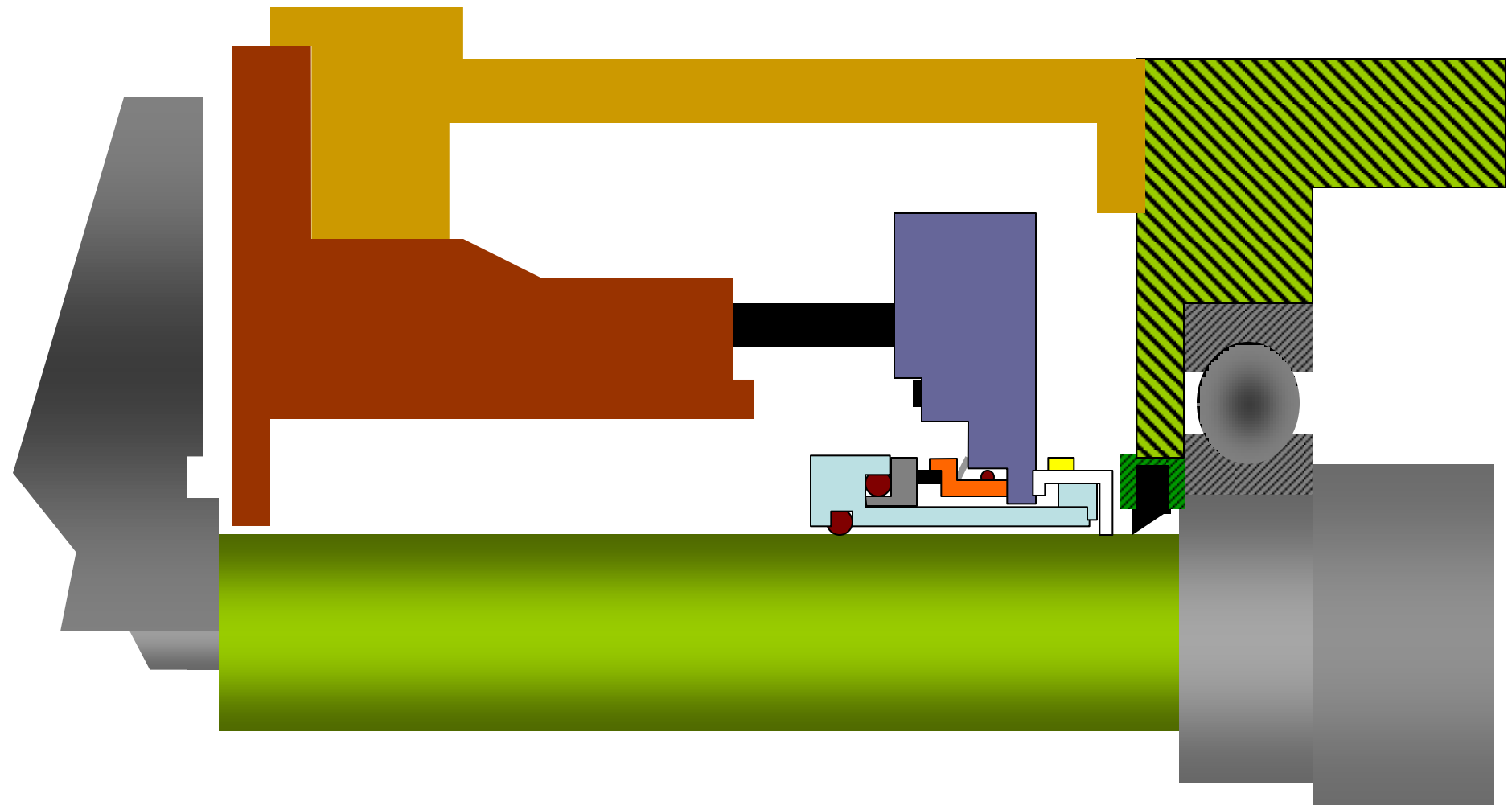
# CARTRIDGE SEAL INSTALLATION

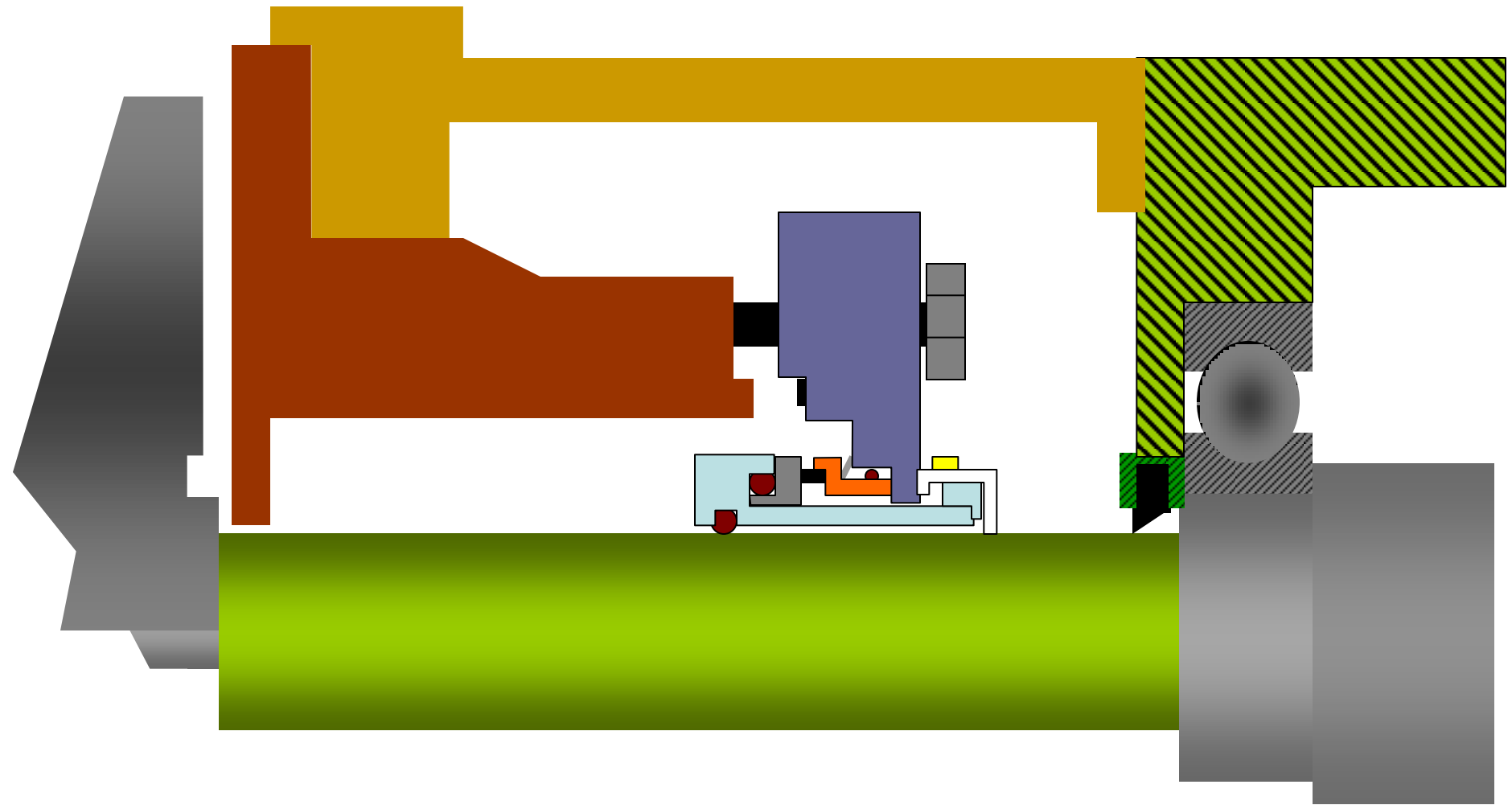


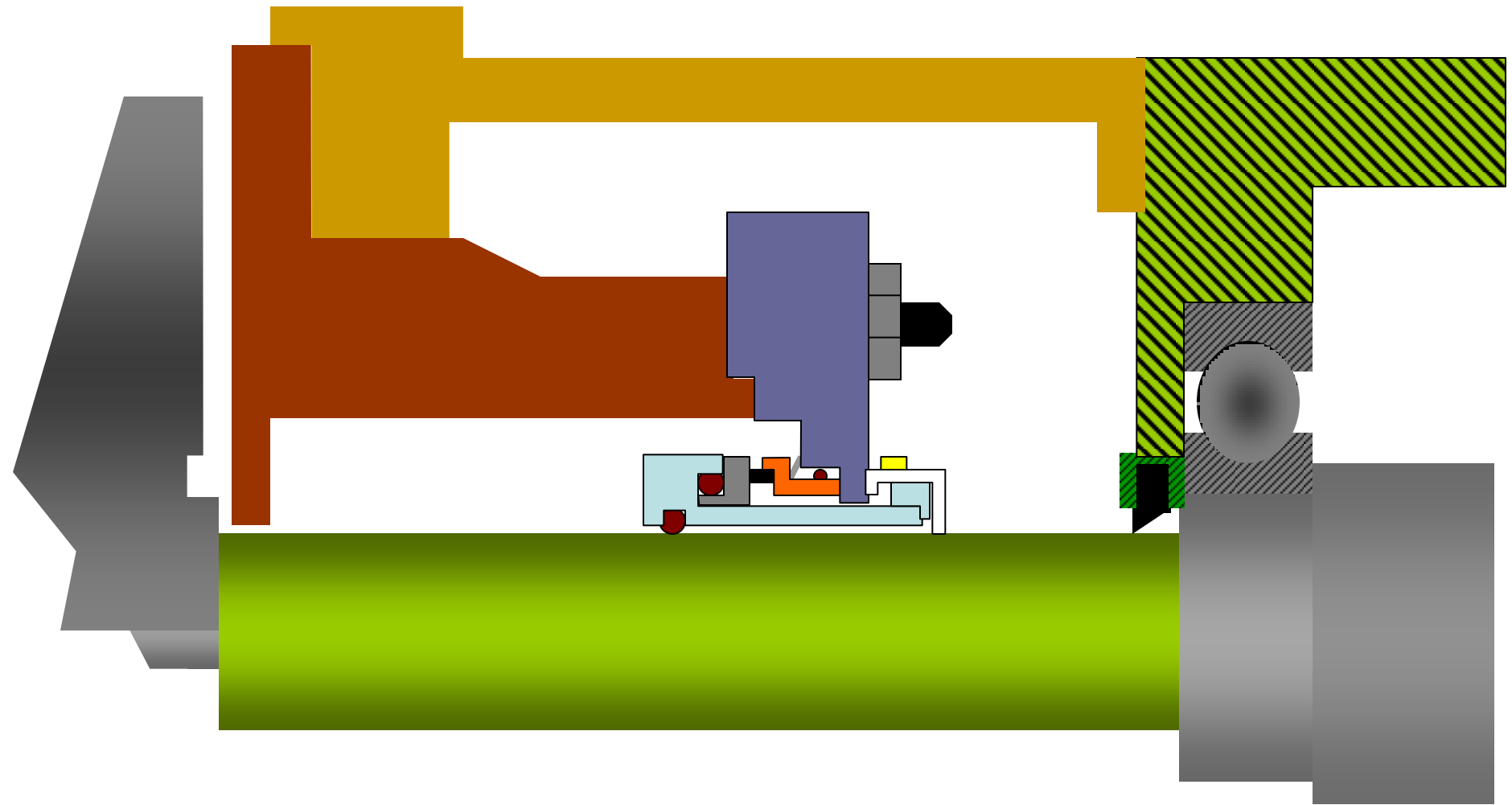
# CARTRIDGE SEAL INSTALLATION



THE INSTALATION IS BSICALY THE SAME FOR  
ALL TYPES OF CARTRIDGE SEAL AS IN THE LESS  
COMPLICATED UNIT









# STORING ASSEMBLED PUMP

IF THE PUMP IS TO BE PLACED IN STORES WITH A CARTRIDGE SEAL PRE-INSTALLED, DO NOT TIGHTEN GLAND BOLTS OR SET SCREWS

LEAVE GLAND BOLTS HAND TIGHT AND DO NOT REMOVE SET TABS

- If gland orientation does not match up with piping configuration in the “Unit”, the seal can be rotated without disturbing seal faces

# PUSHER VS. NON-PUSHER

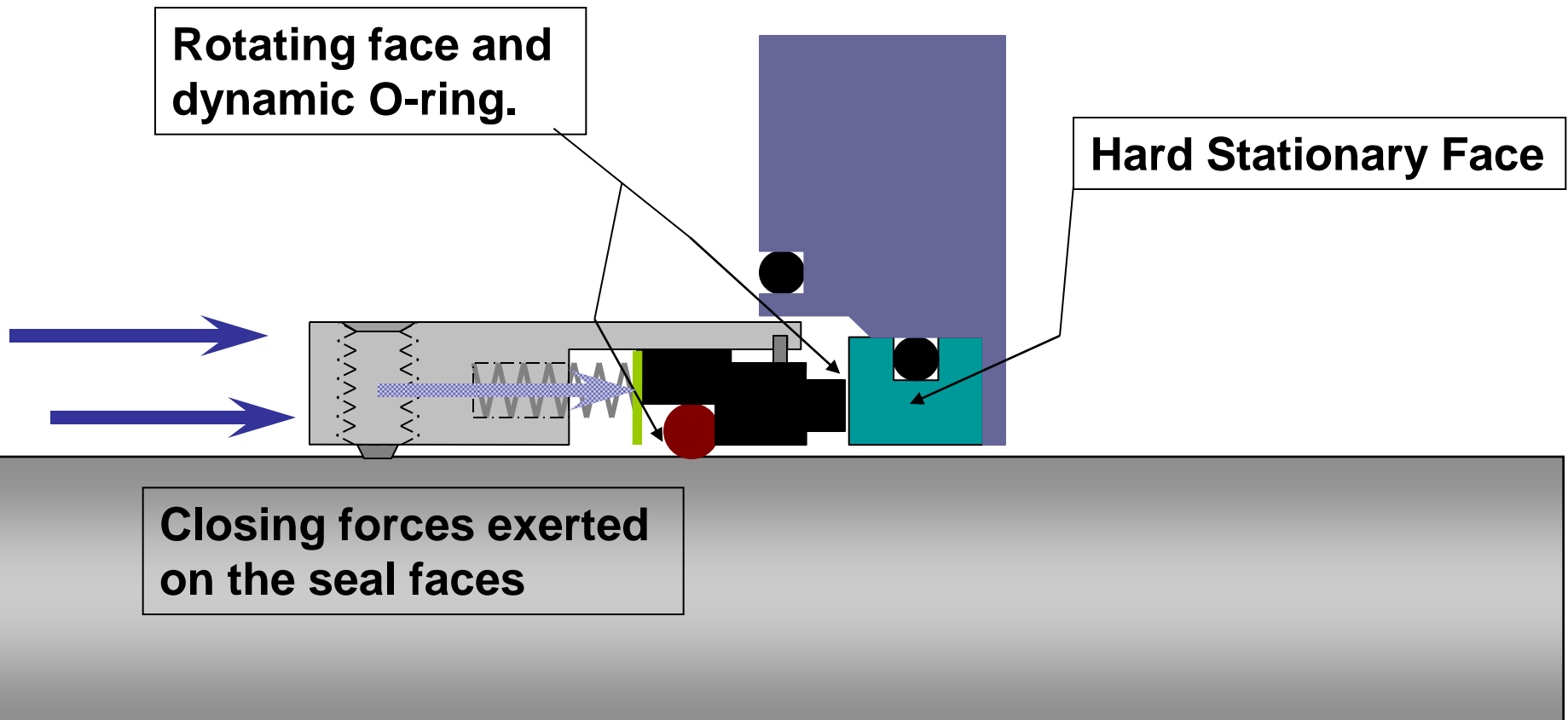
Both pusher and non-pusher types can be either shaft mounted or cartridge assemblies.

The basic difference between pusher and non-pusher types have to do with the dynamics of the shaft packing or O-ring and whether or not it moves as the seal wears.

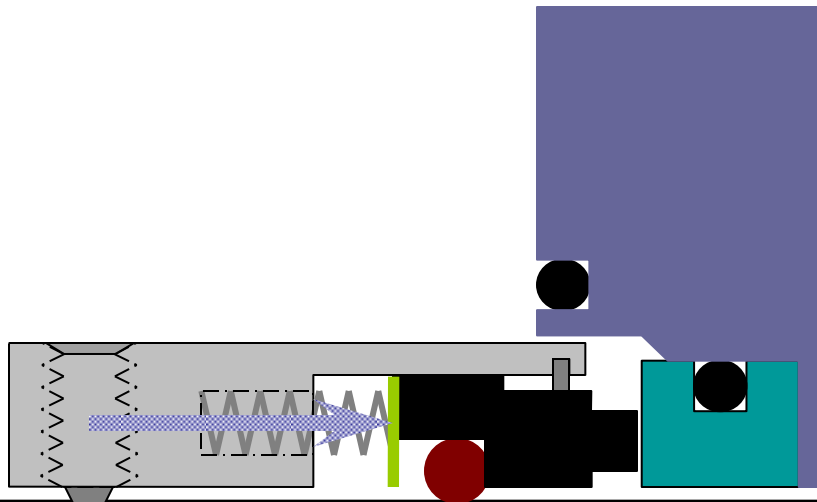
# PUSHER VS. NON-PUSHER

As the seal faces wear down over time, they must be closed to compensate for lost face material. If the shaft O-ring must move when this compensation takes place, it is pushed forward by the components of the seal and by stuffing box pressure. If the seal is configured with a “dynamic” O-ring of this type the seal is called a pusher type.

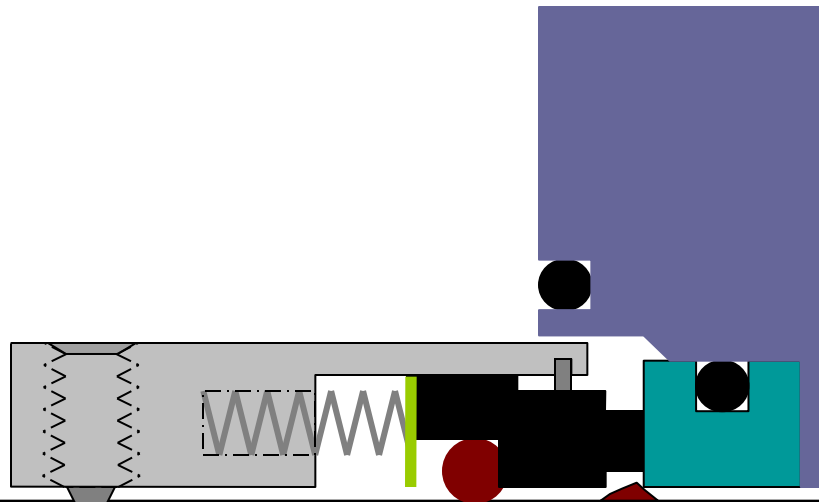
Illustrated here is a common pusher seal. As the seal springs and other pressures in the stuffing box are exerted on the seal, closure of the faces is achieved.



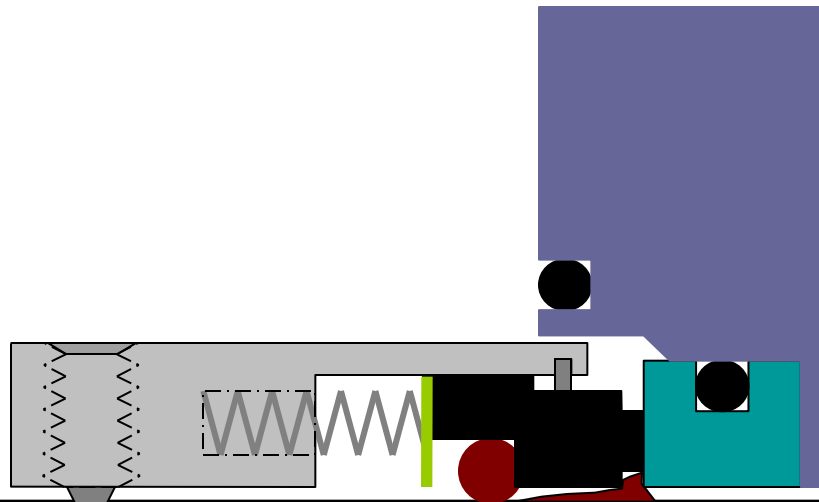
As the softer carbon face wears down, the rotating face must move to maintain face closure.

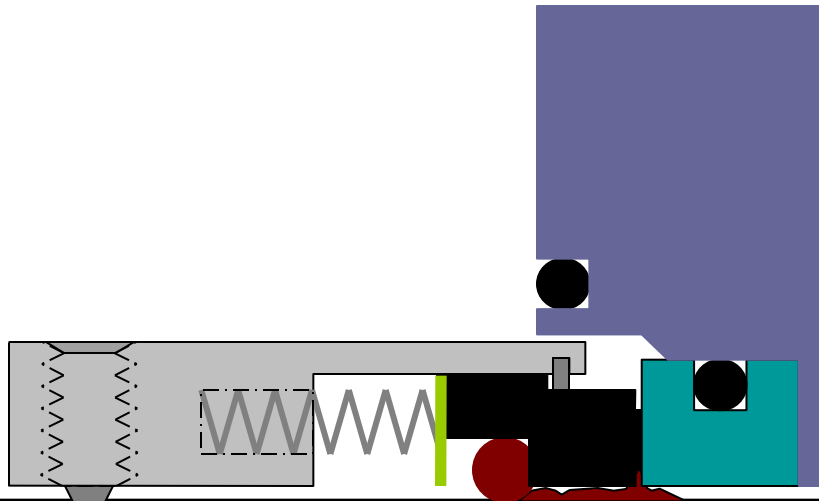


Minute particles of carbon and solids from the process liquid that migrate across the seal faces build up on the shaft.



This build up will ultimately cause the seal to “hang up” and in most cases, failure will occur well before the seal is actually “worn out”.







# PUSHER VS. NON-PUSHER

There are seal types that have no dynamic O-rings. All O-rings are “static” and the seal components compensate for face wear without “pushing” any sealing points.

One of these types is called a “Bellows Seal”. The bellows can be constructed of metal, rubber or PTFE. The RS-1 seen earlier in this presentation is an “Elastomer (or Rubber) Bellows Seal”.

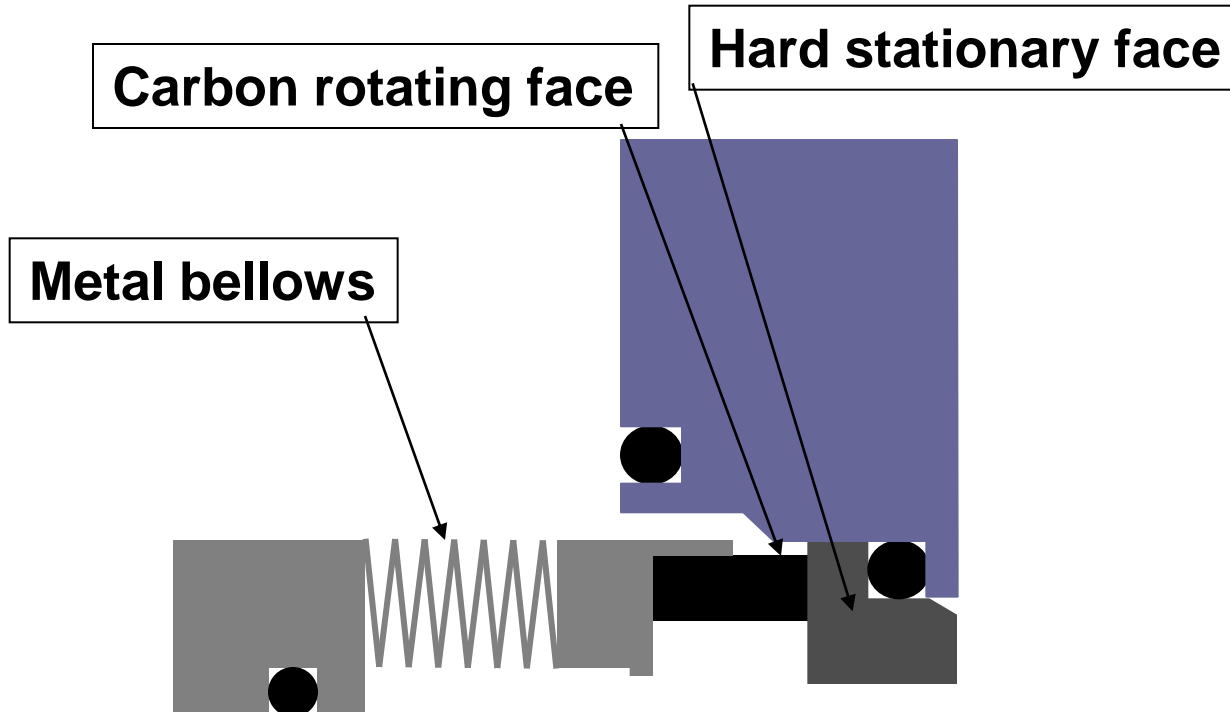
Let's consider the metal variety.

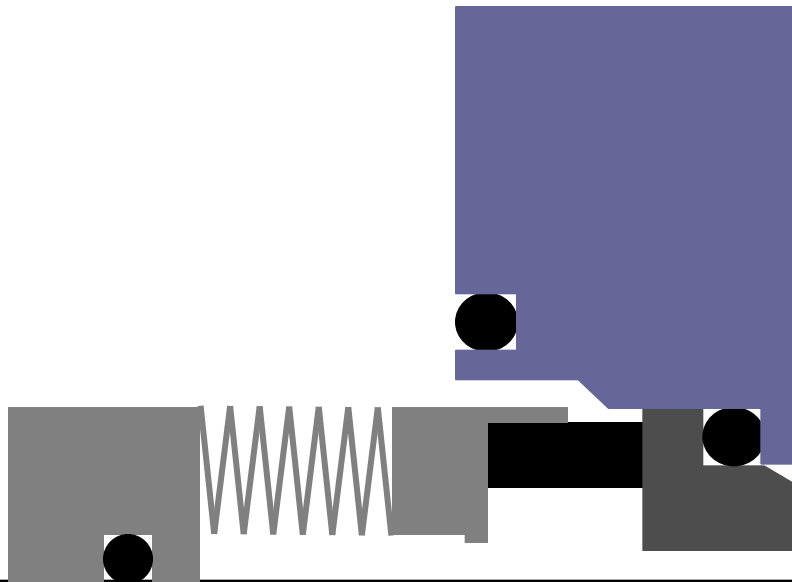
# METAL BELLOWS

Metal bellows are constructed by welding “leaflets” into a series of “convolutions”. This series of convolutions is referred to as the “Bellows Core”.

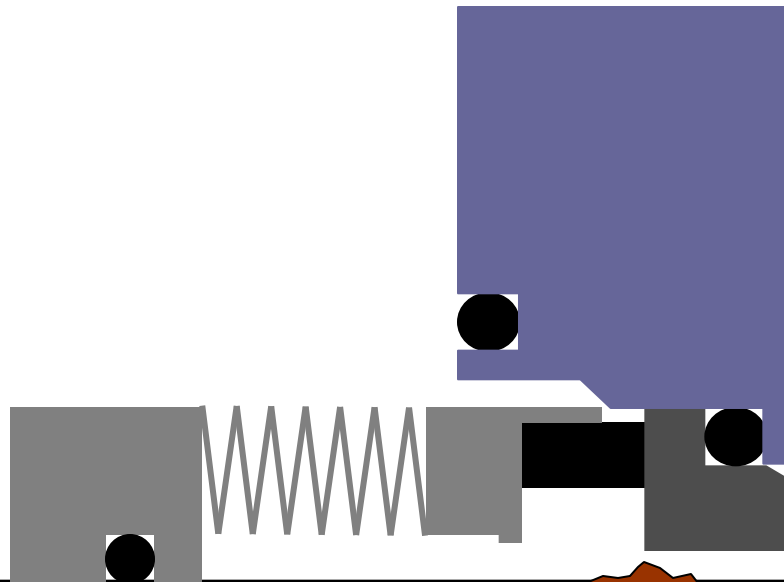
Now take a look at how a bellows seal compensates for face wear.

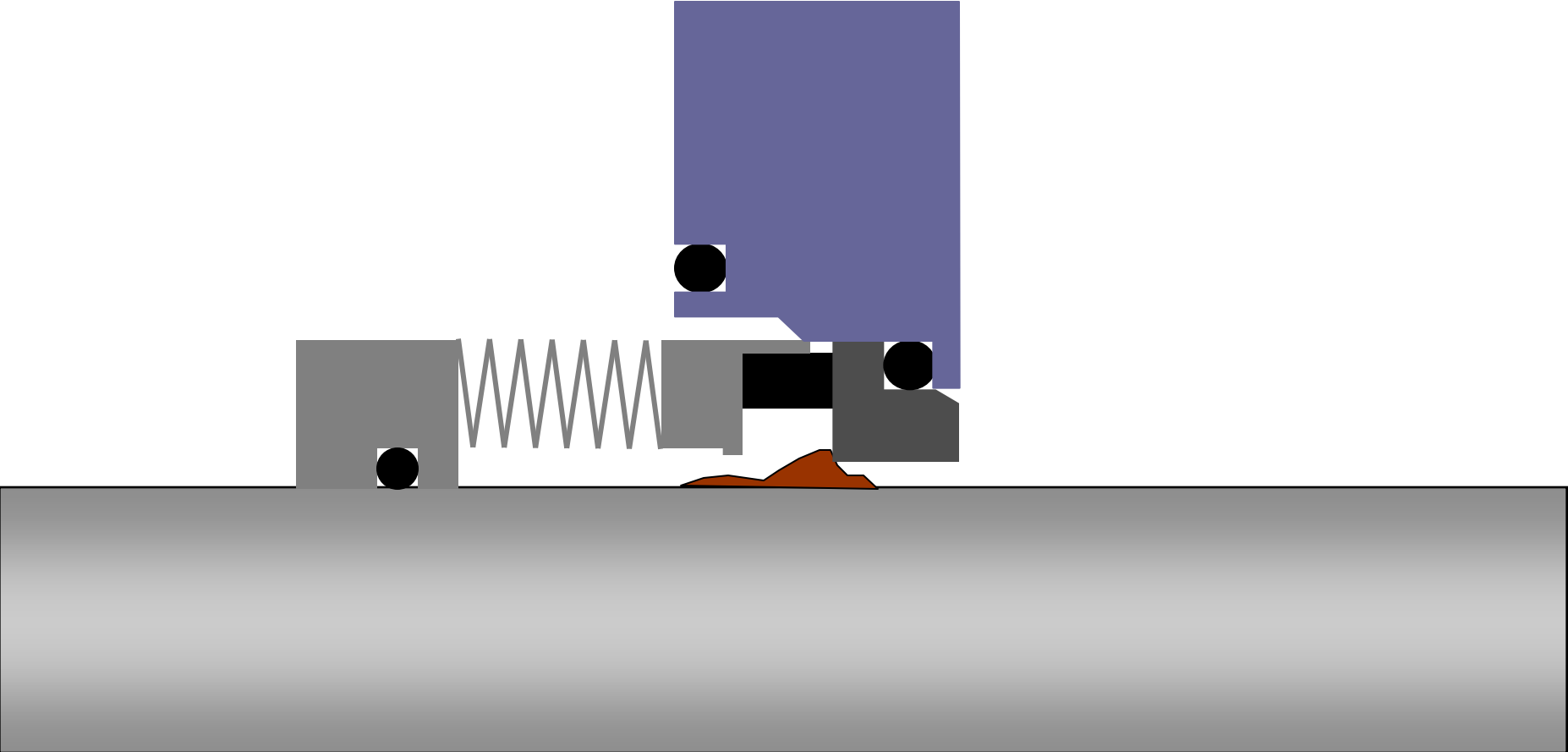




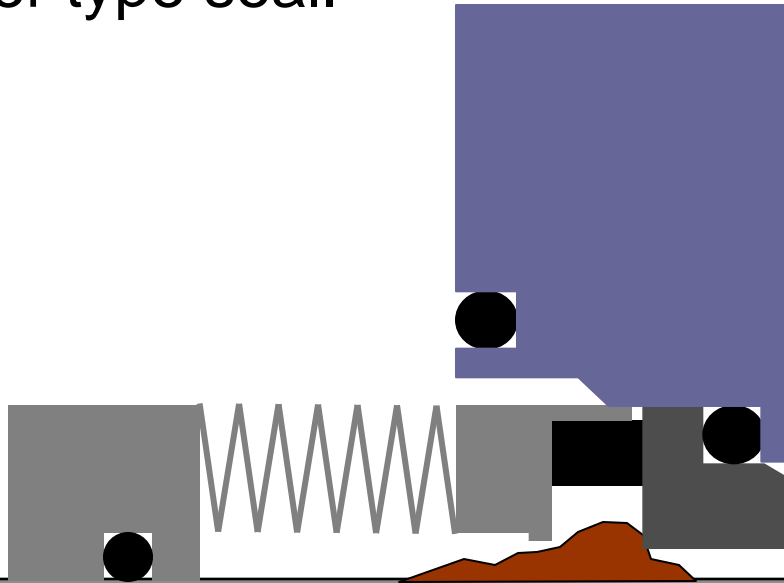


**The bellows core expands to compensate for face wear.**





Debris can build up without causing hang up.  
This feature is probably the most notable  
selling point when comparing a bellows seal  
to a pusher type seal.



# BALANCED VS. NON-BALANCED

When speaking of “Balance” in reference to mechanical seals, we are not talking about Mechanical or Rotational Balance. Instead, we are referring to Hydraulic Balance.

Since mechanical seals are subject to stuffing box pressure, this pressure is utilized to achieve and maintain seal face closure in a non-balanced seal.



# BALANCED VS. NON-BALANCED

If stuffing box pressure is very high, typically over 100psi., then the closing force may be too great to allow the “Boundary Layer Liquid” that lubricates the faces to be sufficient and the faces will wear prematurely.

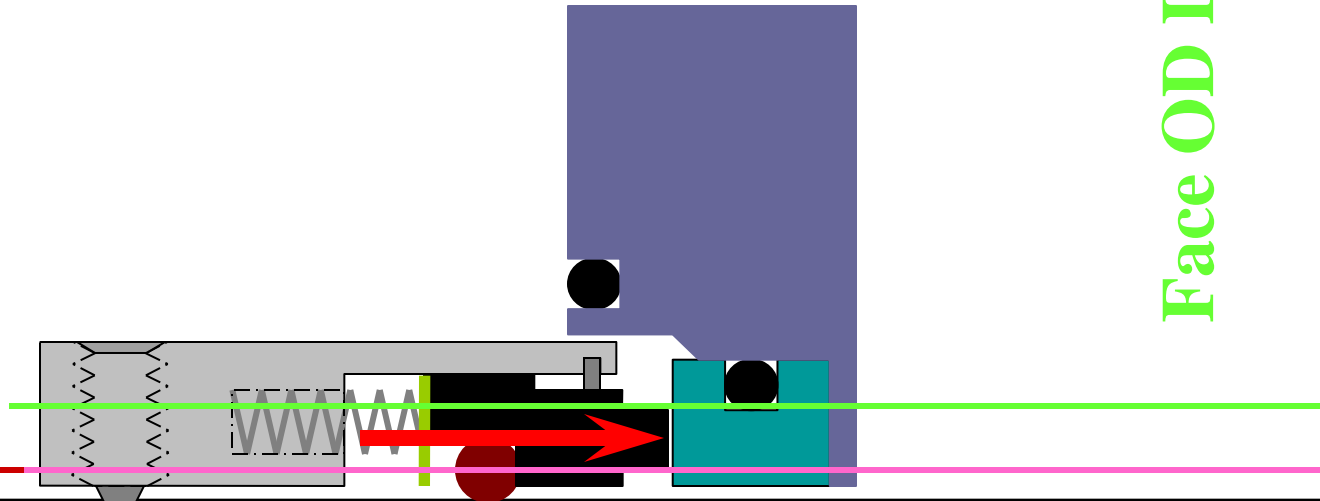
A balanced seal compensates for higher pressures by locating the seal faces such that stuffing box pressure has less effect on face closure.

A non-balanced seal has faces located outside the “Balance Diameter” of the seal. Stuffing box pressure is applied to the faces virtually evenly.

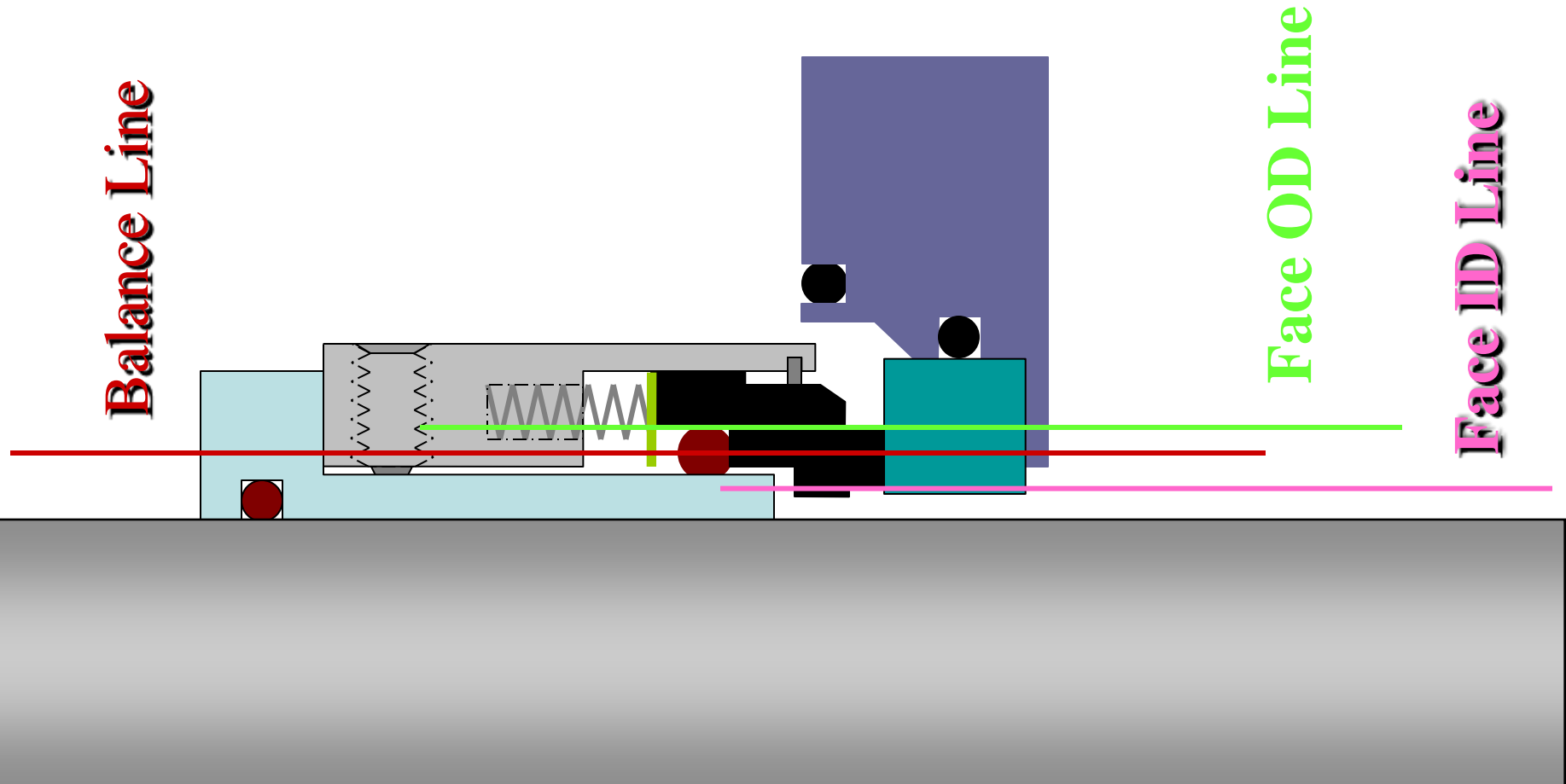
**Balance Line**

**Face OD Line**

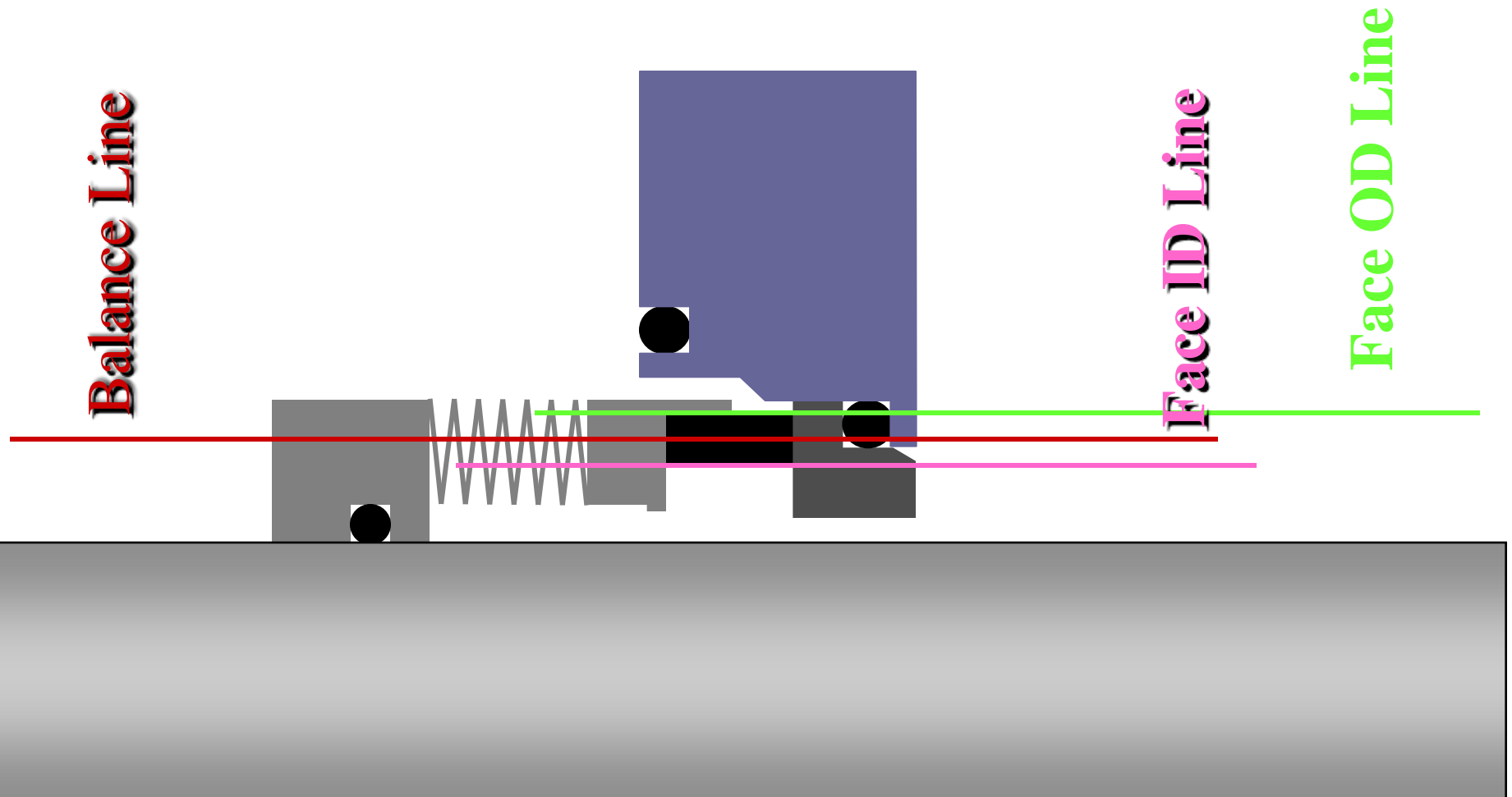
**Face ID Line**



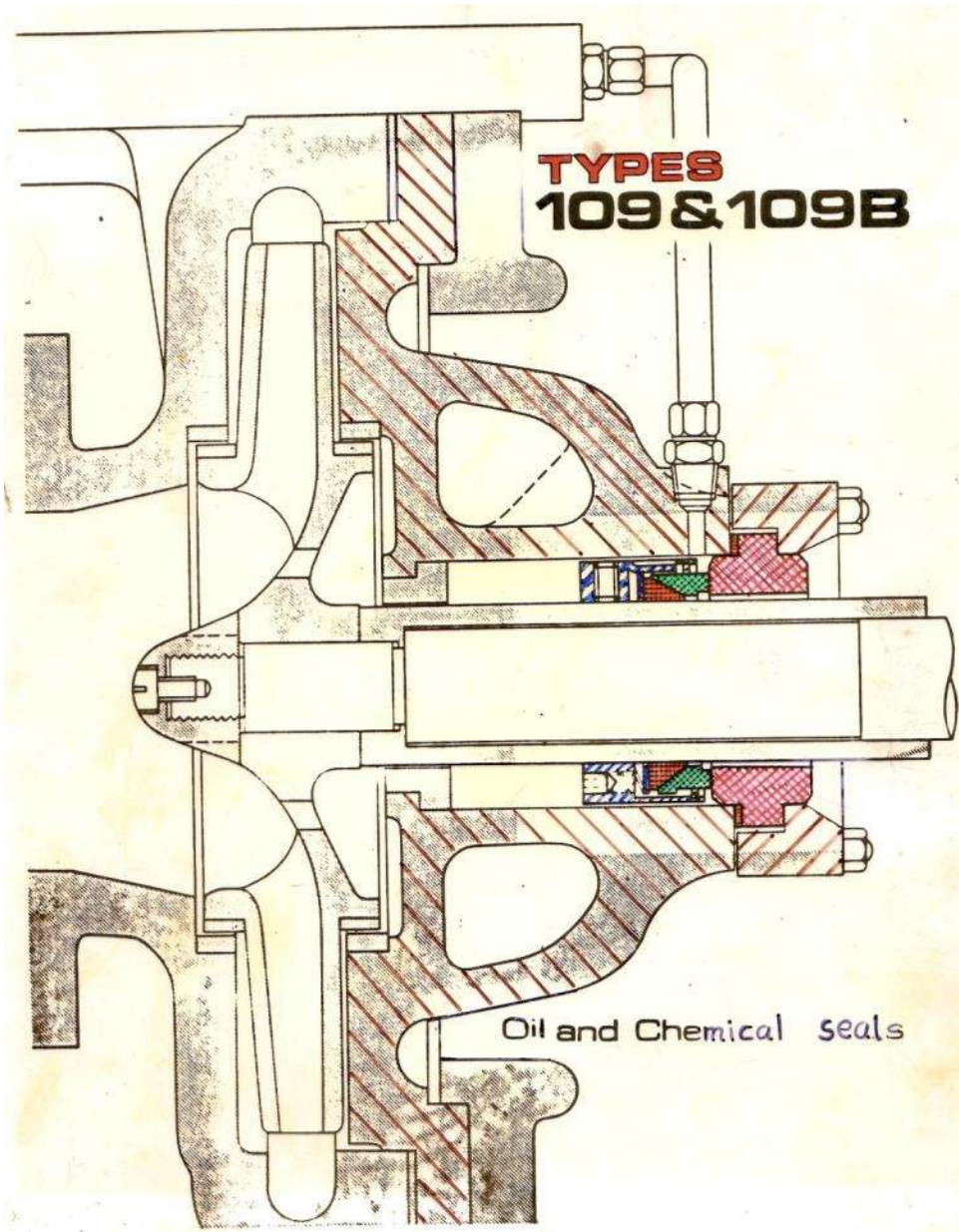
The faces of a balanced seal are located so that a portion of the face contact occurs inside the balance diameter resulting in reduced closing force due to stuffing box pressure.

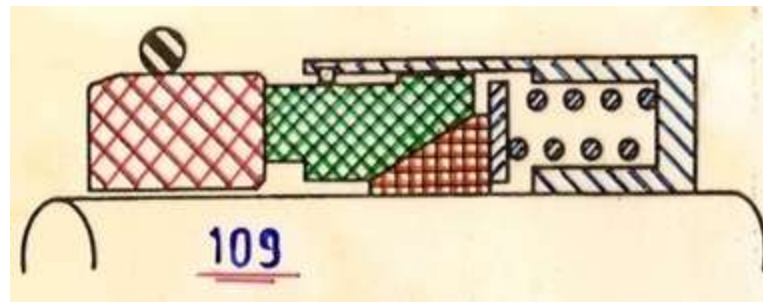


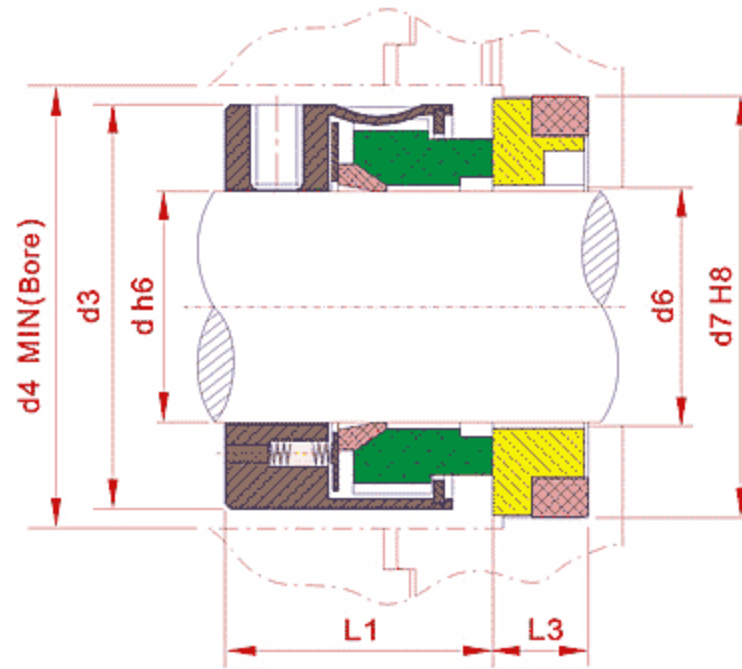
Most metal bellows seals are balanced.



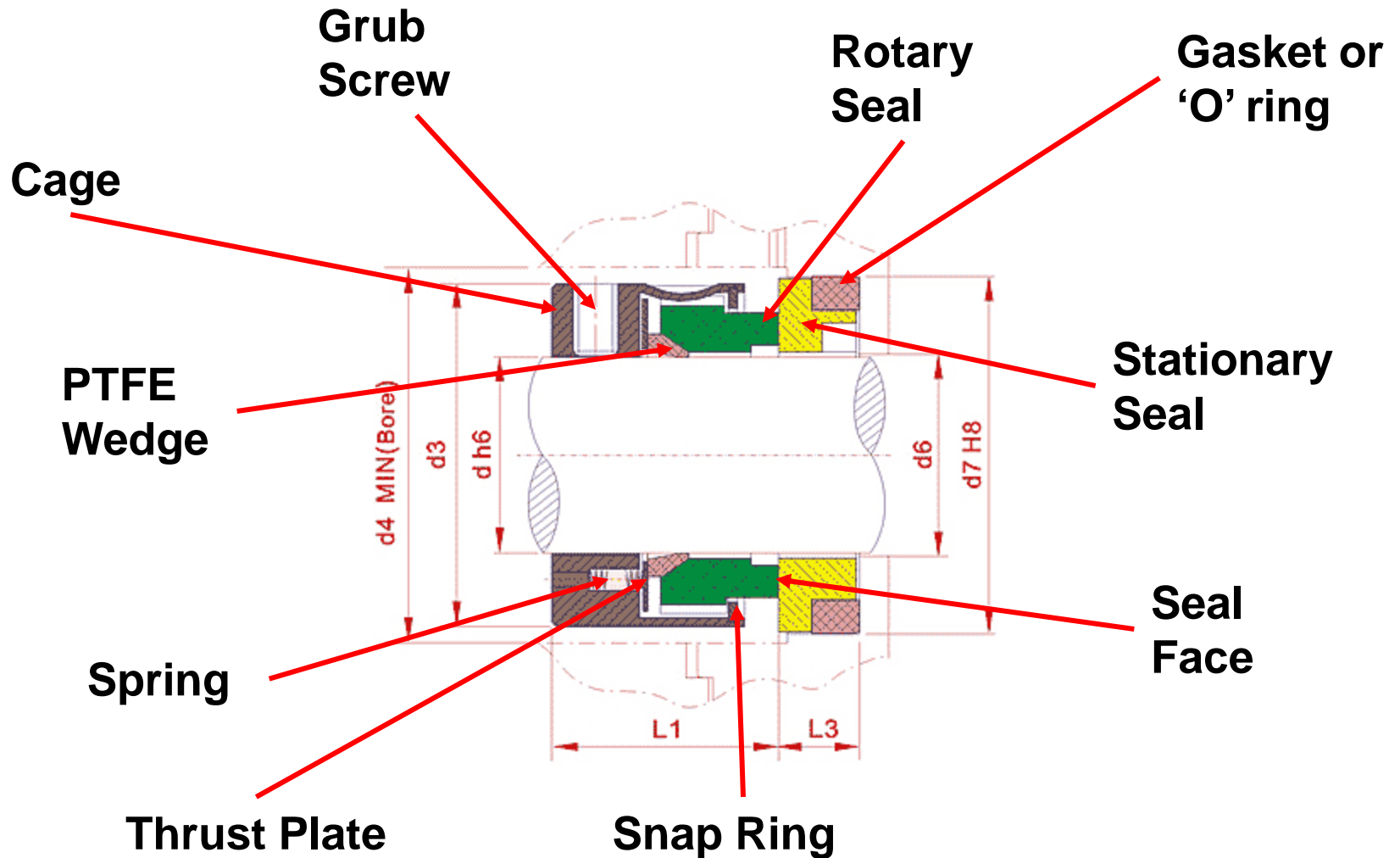
# Typical arrangement of the Crane109 Mechanical Seal and Parts







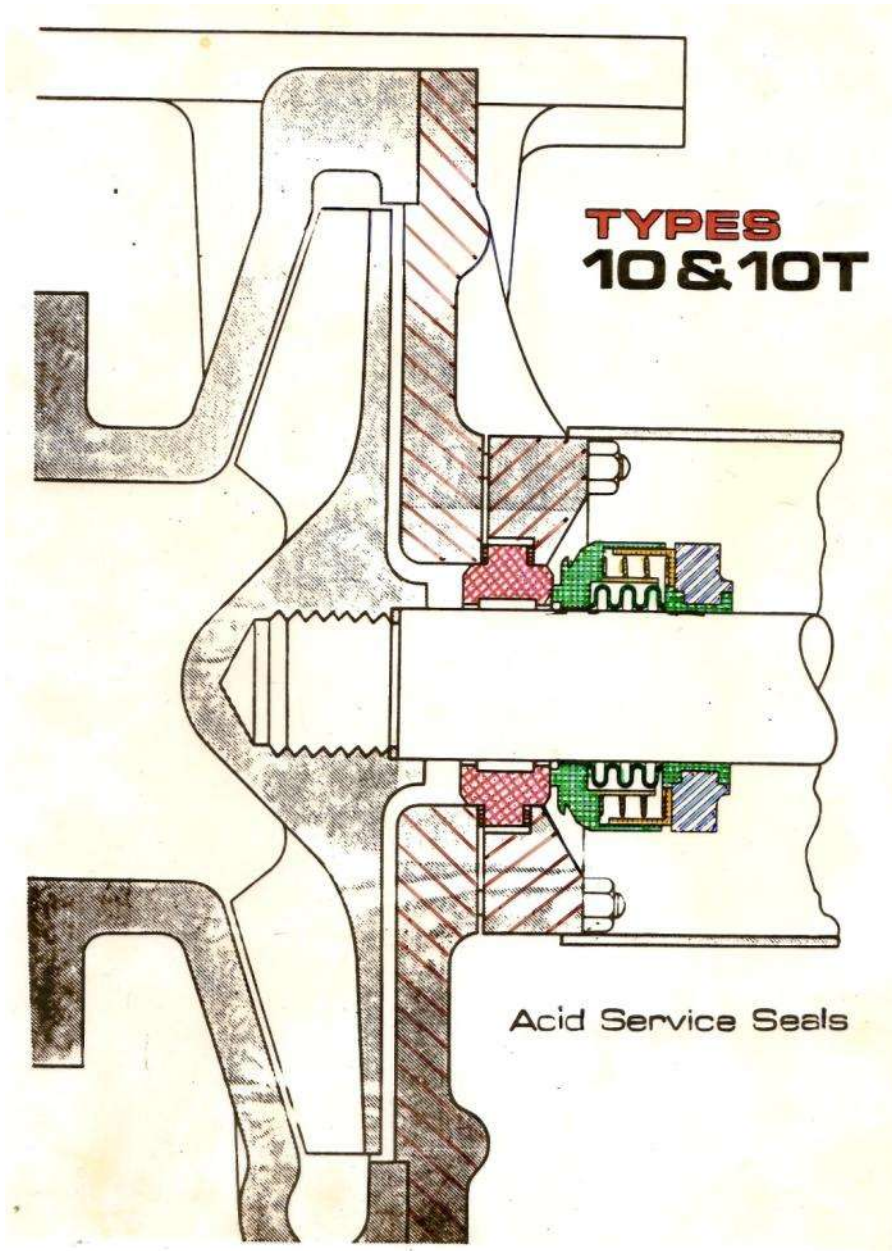




**109 Mech Seal  
Parts**

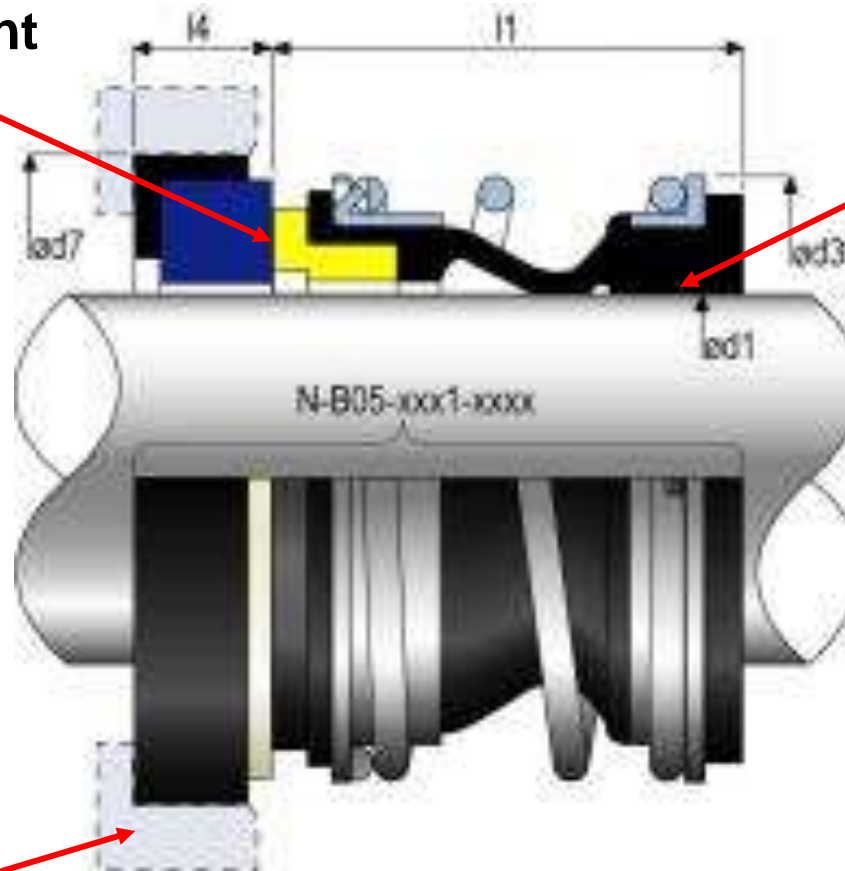


# Typical arrangement for other Crane Mechanical Seal and Parts

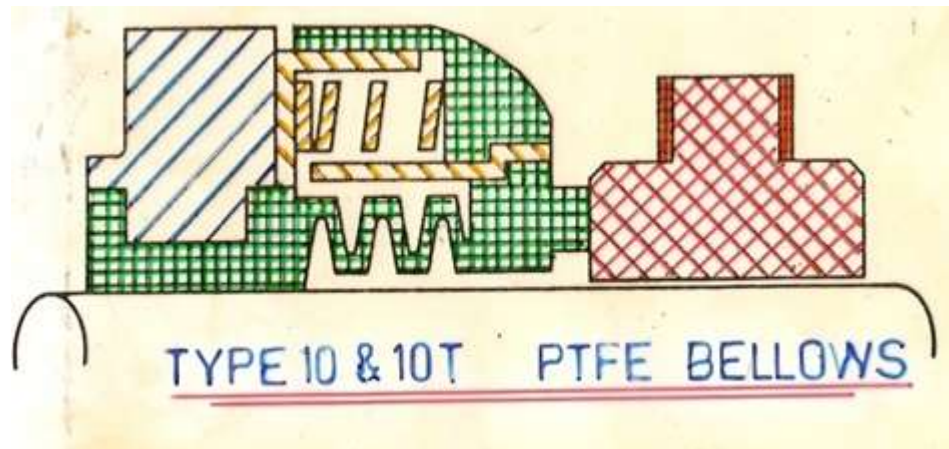


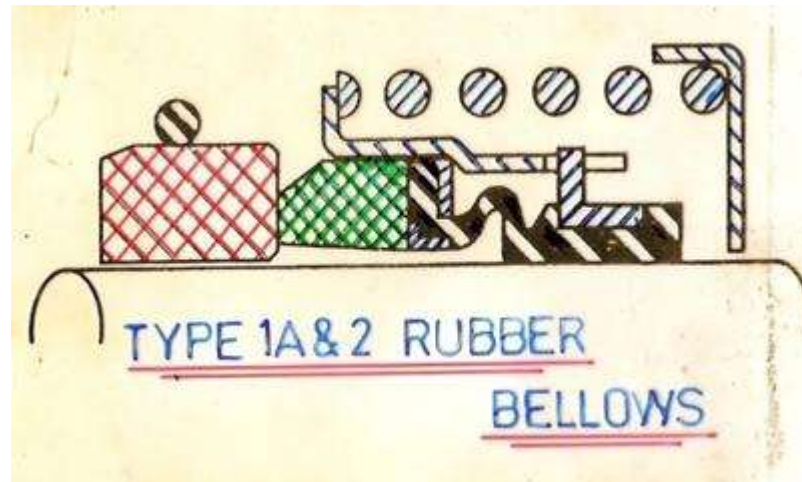
**Primary  
Sealing Point**

**Tertiary Sealing Point**



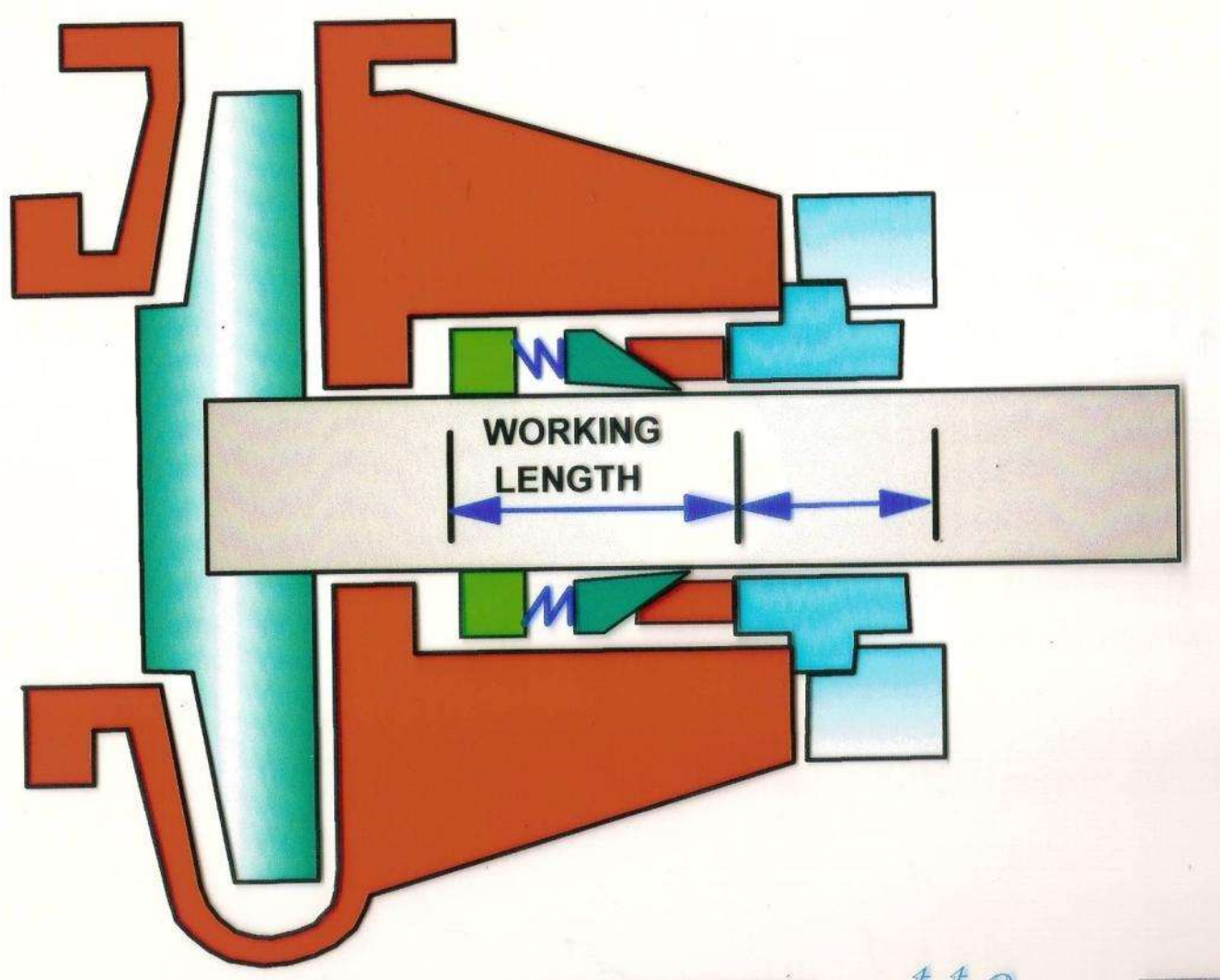
**Secondary  
Sealing Point**



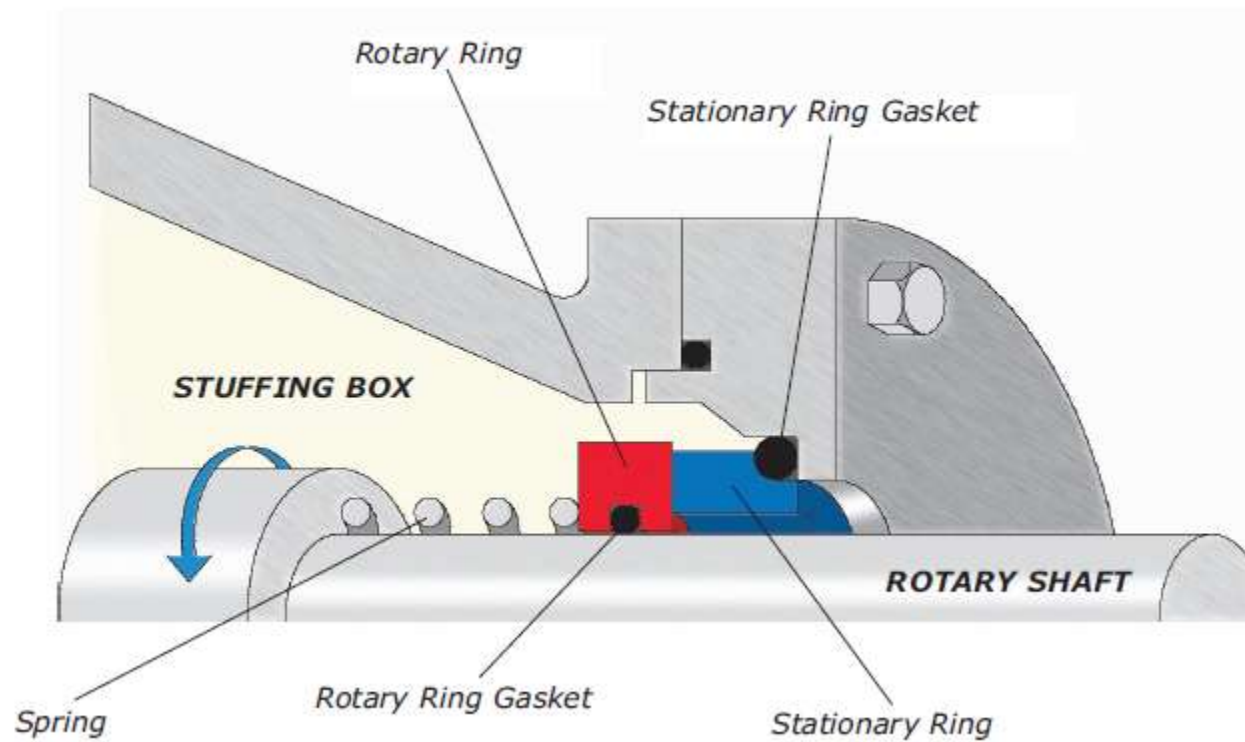








# Spring Type

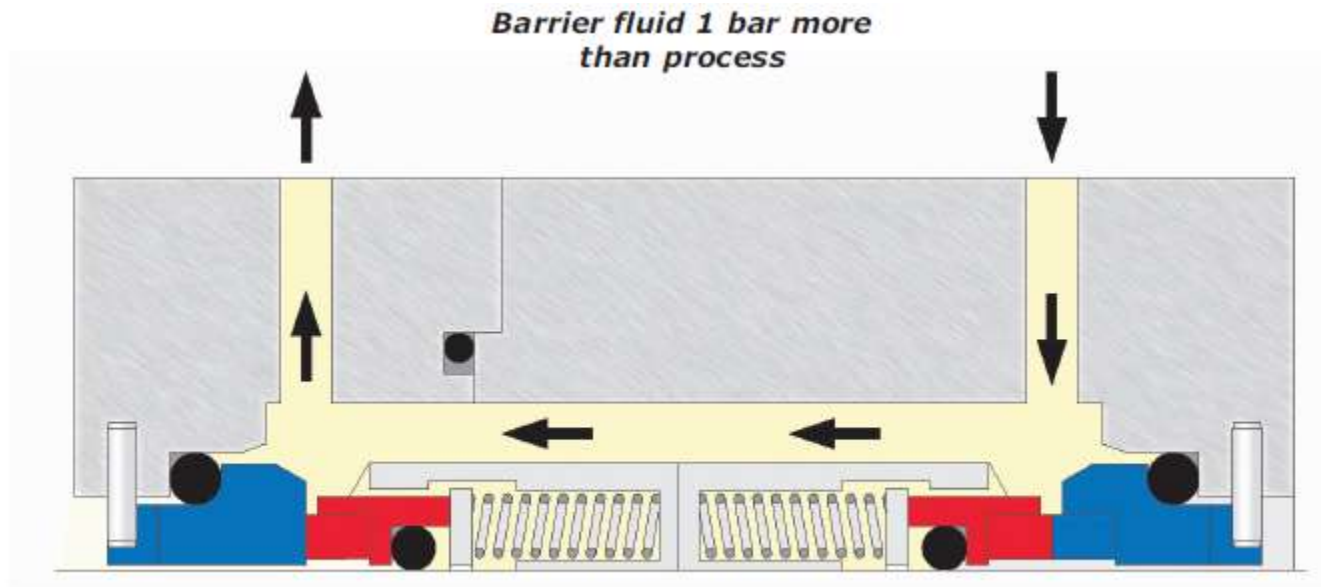


# SINGLE VS. MULTIPLE

Most rotating equipment is equipped with a single seal. This is what we have been examining thus far. Single shaft mounted seals, cartridges seals, balanced seals etc.

Some applications call for a multiple seal configuration. These are typically dual seal arrangements but can also be a series of three or more. For our purposes we will examine dual seal arrangements since that really covers 99% of multiple seal applications.

# Back to Back



# DUAL SEALS

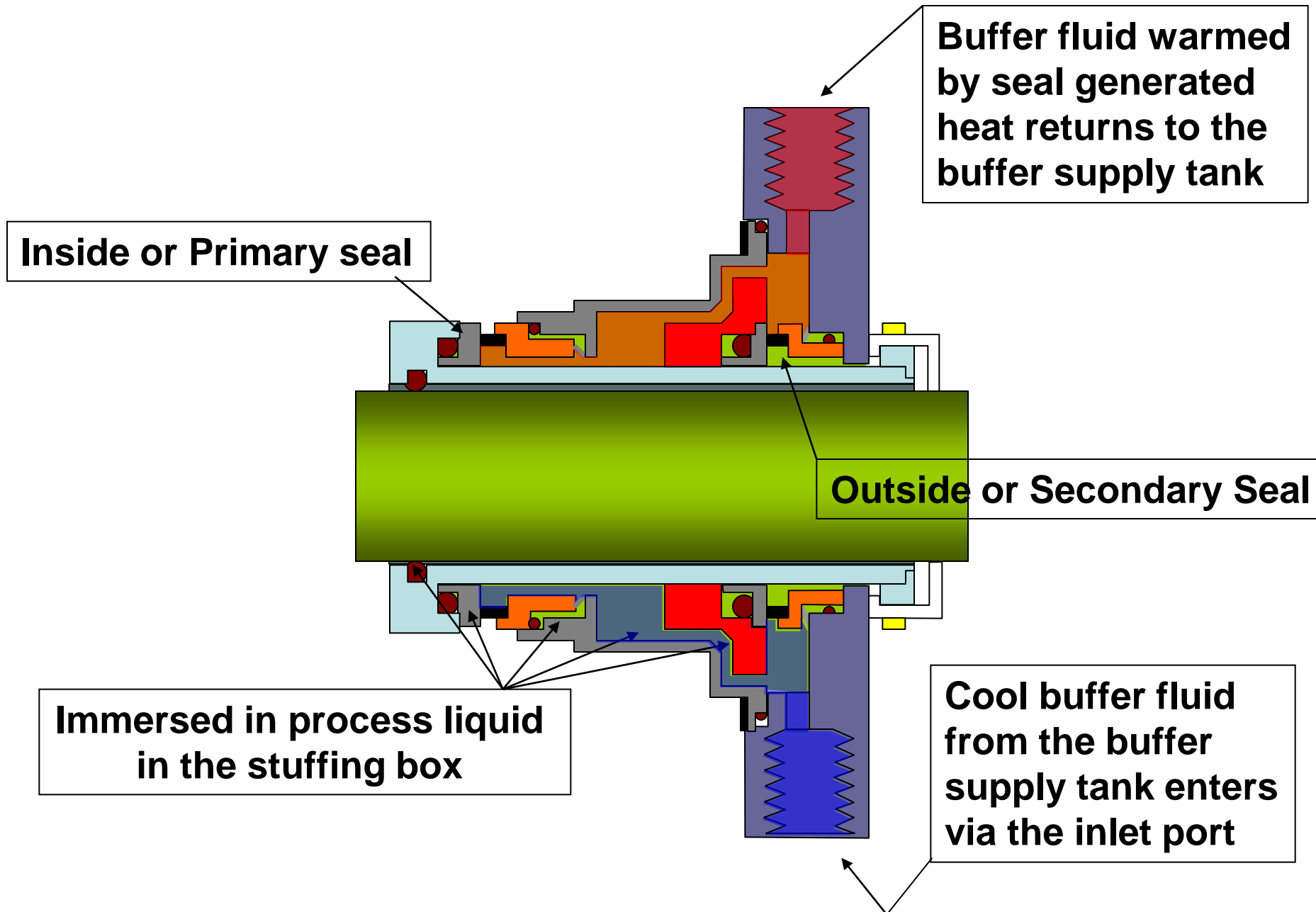
Dual seals can be either pressurized or non-pressurized. This is in reference to the artificial environment that is provided to exist “between” the seals.

A non-pressurized dual seal, also known as a “Tandem” arrangement, means that the inner, or primary seal is functioning as would a single seal. It is subject to stuffing box conditions, i.e. stuffing box pressure, process liquid to lubricate the faces and usually immersion of seal components in the process liquid. The secondary, or outside seal runs in a non-pressurized “Buffer” liquid that is supplied from an outside source, typically a nearby supply tank.

# DUAL SEALS

In a non-pressurized dual arrangement, the outside seal is primarily there as a containment device in the event that the inside or primary seal is lost. A “Back up” or safety mechanism if you will.

Let's look at a Dual Cartridge Seal.



# DUAL SEALS

Since the outside or secondary seal runs in a non-pressurized clean lubricating liquid, it will generally last for an extended period of time. When the inside or primary seal fails, the leakage through the faces will be contained by the secondary seal until the pump can be shut down for seal replacement.

Failure indication and shutdown devices can be attached to the buffer supply so that the pump operators know when the primary seal has failed.



# DUAL SEALS

When pumping volatile liquids, hazardous, corrosive, abrasive, etc. it is sometimes necessary to insure that the process liquid does not enter the atmosphere or the artificial environment created for the seal or even the seal faces.

Pressurizing the artificial environment, 20 to 30 psi. above the pump stuffing box pressure will prevent process liquid from crossing the primary seal faces. Instead, boundary layer film liquid is supplied to the primary seal by the artificial environment or “Barrier”.

# DUAL SEALS

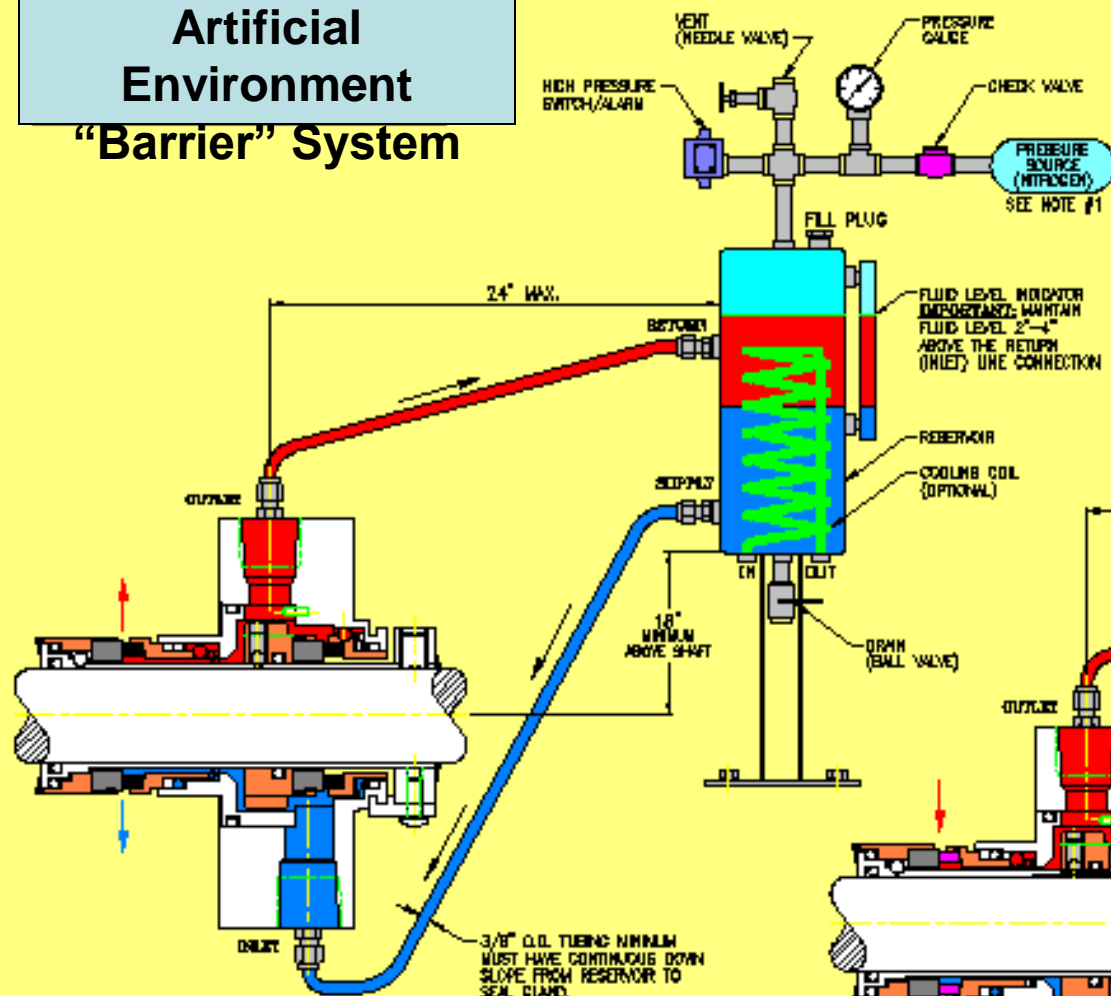
The arrangement of seals can be the same as a non-pressurized in most cases. The difference is in how the seals perform.

In a pressurized dual seal, the outboard or secondary has the tougher job of the two. It operates sealing high barrier pressure while the inboard or primary seal has clean lubricating liquid applied at differential pressure of only 20 to 30 psi.

Now let's look at the environmental controls for operating dual seals.

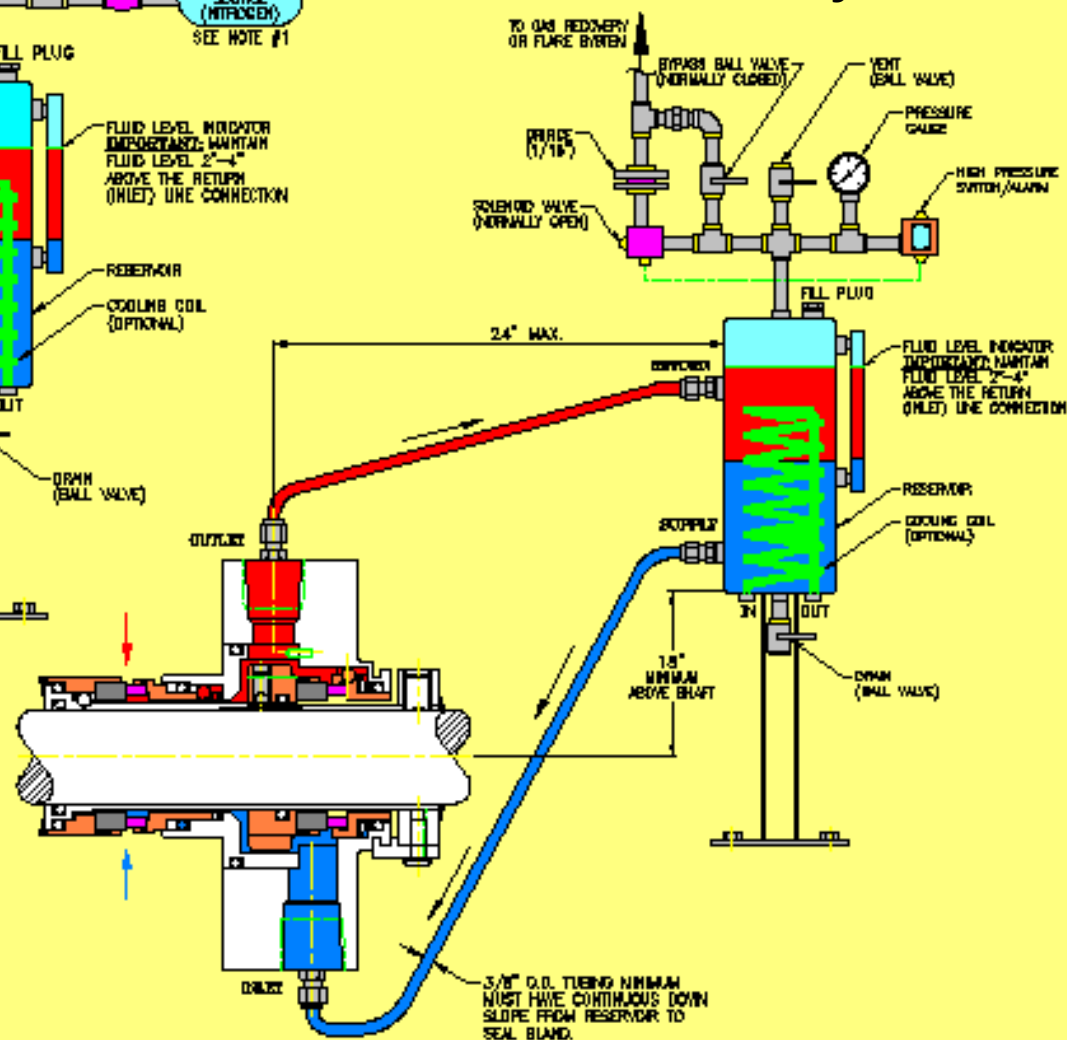
# Pressurized Dual Seal Artificial Environment

## "Barrier" System

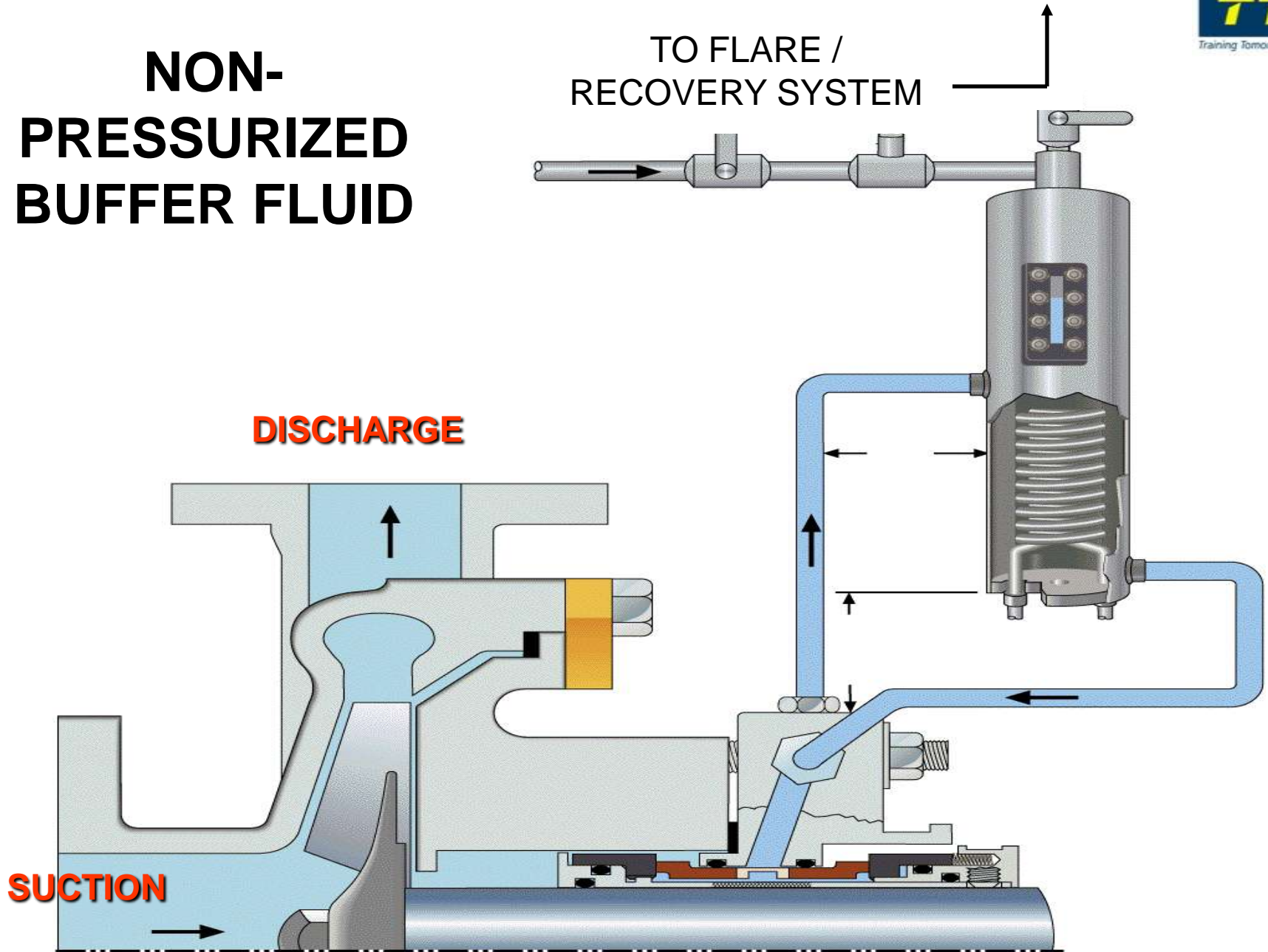


# Non-Pressurized Dual Seal Artificial Environment

## "Buffer" System

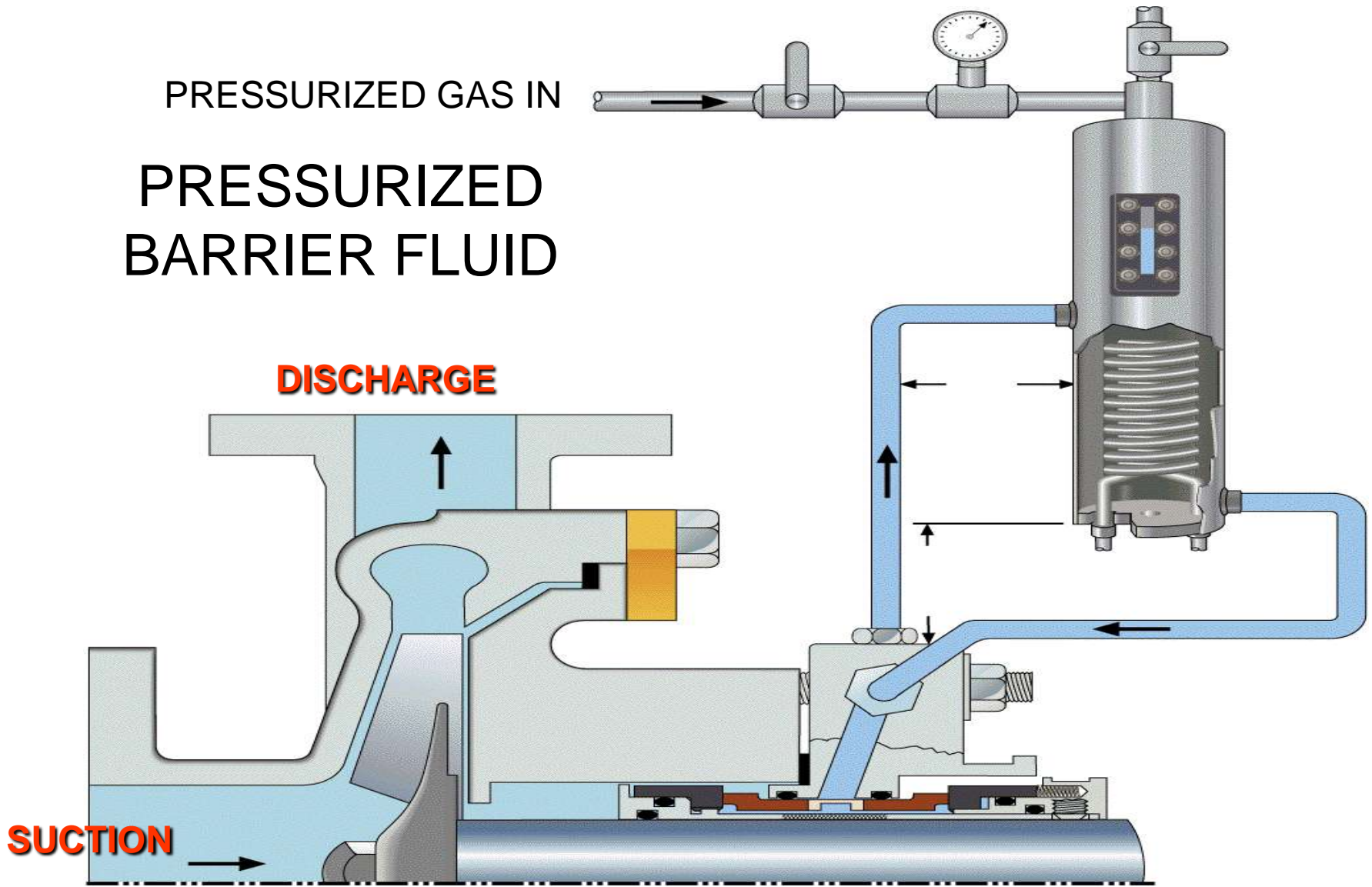


# NON- PRESSURIZED BUFFER FLUID



PRESSURIZED GAS IN

PRESSURIZED  
BARRIER FLUID



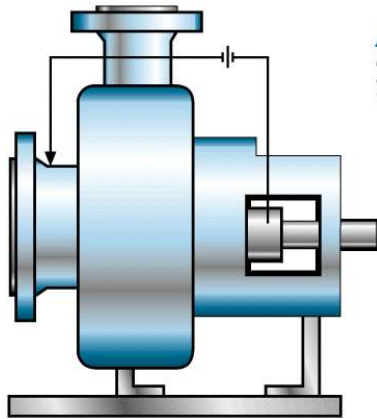
# DUAL SEALS

There are many more types of environmental control arrangements that are required. We have only covered the basics in this presentation. For more detailed information you need to contact a Mechanical Sealing Technologies Representative.

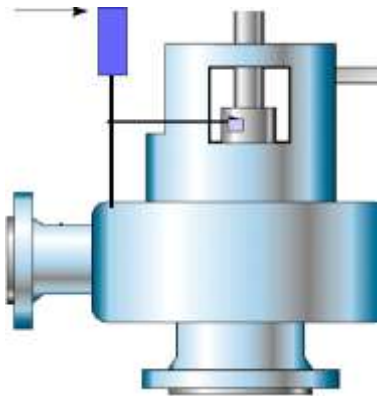
# VERTICAL SEALS

Other types of seal configuration is a vertical setup where this introduces another issue of trapping gas at the seal faces that can cause these faces to run dry with no lubrication film as show in the following slides.

# Correct Vent Arrangement

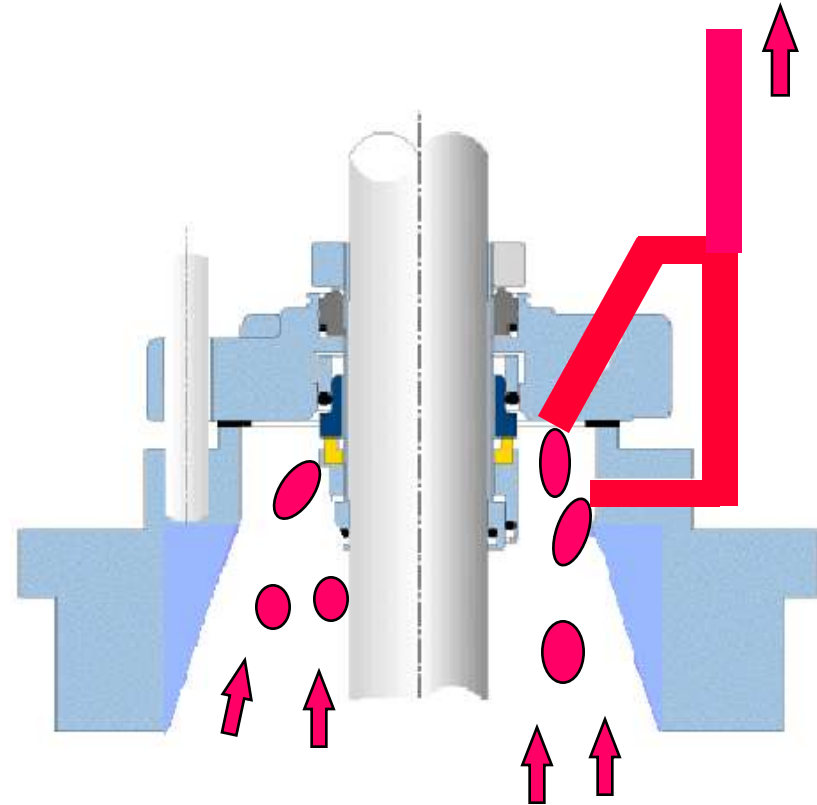


**API PLAN 13**



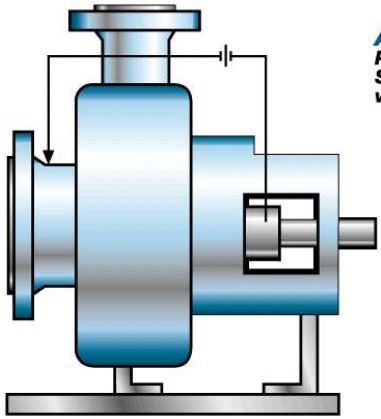
**CASING VENT**

To suction or casing vent



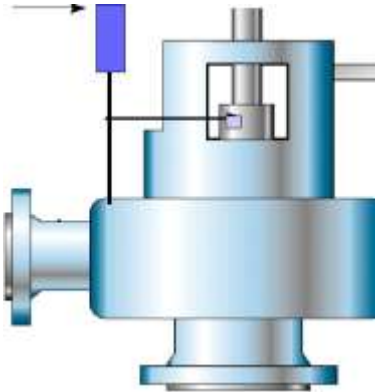


# Incorrect Vent Arrangement

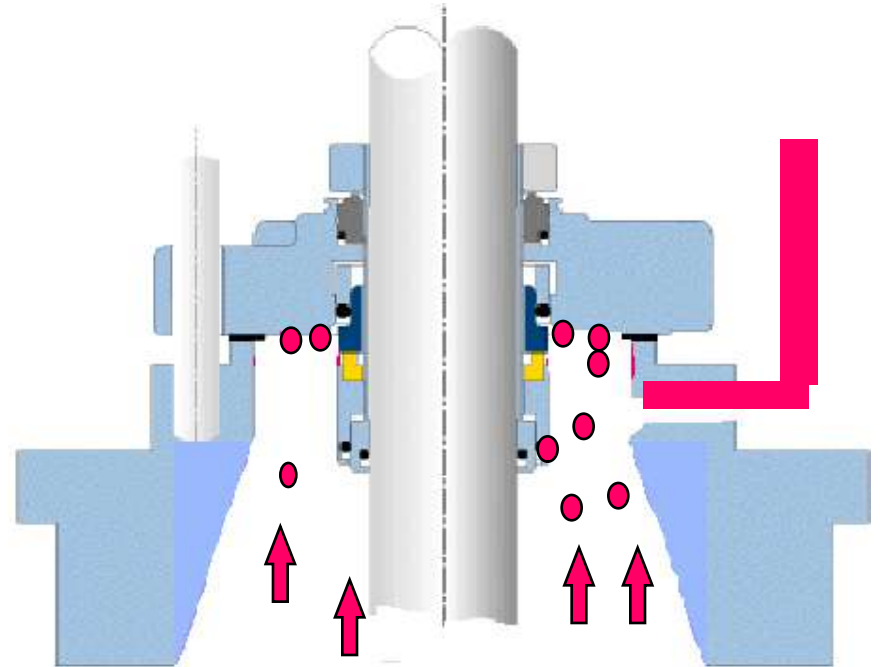


FSV

**API PLAN 13**



**CASING VENT**



# SPLIT SEALS

Some types of machinery are cumbersome to maintain. Large shafts, heavy components, and immovable drivers are some of these concerns.

Often, a typical mechanical seal is impractical to use by the nature of it's installation requirements.

In these cases it is frequently beneficial to use a Split Seal.

# SPLIT SEALS

In a Split Seal, all components are literally cut or split in half and they are assembled onto the equipment without removal or disassembly of the major equipment components.

Obviously, these seals are prone to leak more readily than non-split seals so they are generally applied to processes where some leakage is acceptable. Even with some leakage, they will out perform common packing.

Split Seals are often used on mixers, agitators and large volume, large shafted pumps.

# SPLIT MECHANICAL SEAL

The split radially as shown in this photo.

All internal components are also split and they are assembled onto the equipment shaft without removing the equipment from it's operating position or tearing down it's major components.





# SPLIT SEALS

Aside from the fact that the components are split, split seals operate virtually the same way that most single cartridge or shaft mounted seals operate.

By nature of their split design, their application is limited to lower pressures and non-volatile liquids.

Now let's move onto our final discussion topic, Gas Buffer Seals.

# GAS BUFFER SEALS

The final seal type that we will look at during this course is the Gas Buffer Seal.

Gas Buffer Seals are the latest advancement in sealing technology. There are as many different types as there are Sealing Product Manufacturers.

# GAS BUFFER SEALS

They were designed to facilitate capabilities similar to a dual seal without requiring elaborate environmental controls or in the case of pressurized dual seals, without liquid contamination of the process liquid.

We will briefly discuss the features of this type of Seal.

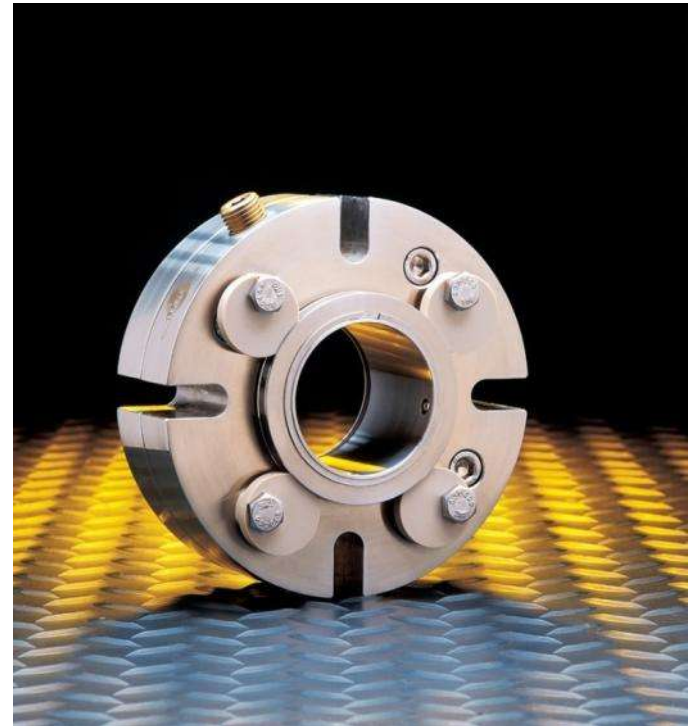


# DUAL CO-AXIAL GAS SEAL

The DCG Seal is a cartridge arrangement that contains a “Gas Lift-Off Seal”.

In a Gas Lift-Off seal, the faces theoretically never contact. There is no fluid film between the faces and since they never contact, there is no need for it.

A cut-away drawing of this seal will follow.



# DUAL CO-AXIAL GAS SEAL

This control panel is used to adjust the gas flow (Nitrogen, Clean Plant Air, CO<sub>2</sub>, etc.) that is inject into the seal gland port at 25 to 30 psi. over stuffing box pressure. The gas flows through holes in the carbon stationary, separating the faces.

As the seal operates, an envelope of gas surrounds the seal faces keeping process liquid out.



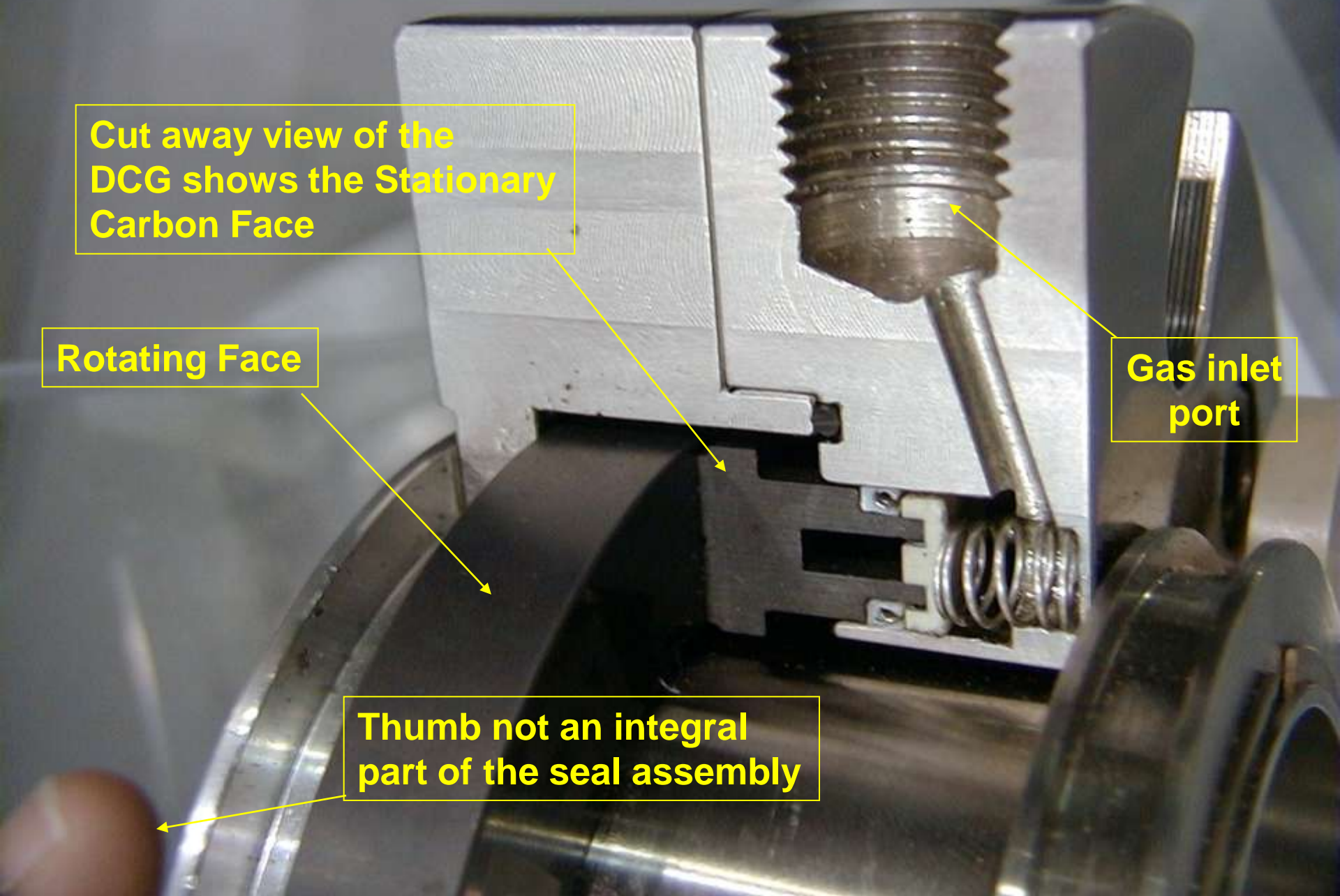
# DUAL CO-AXIAL GAS SEAL

Cut away view of the DCG shows the Stationary Carbon Face

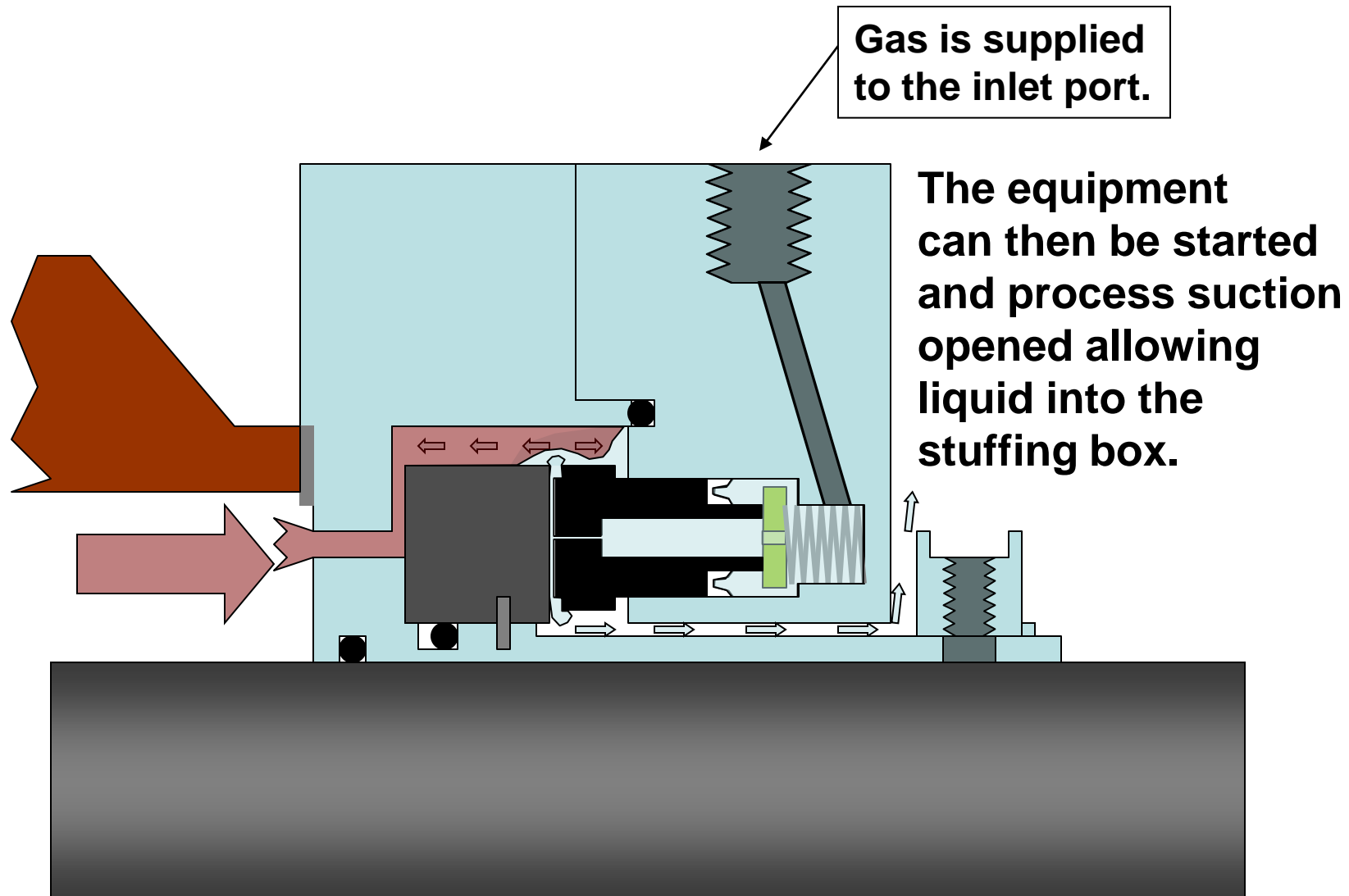
Rotating Face

Gas inlet port

Thumb not an integral part of the seal assembly



# DUAL CO-AXIAL GAS SEAL



The End  
Any Questions ?