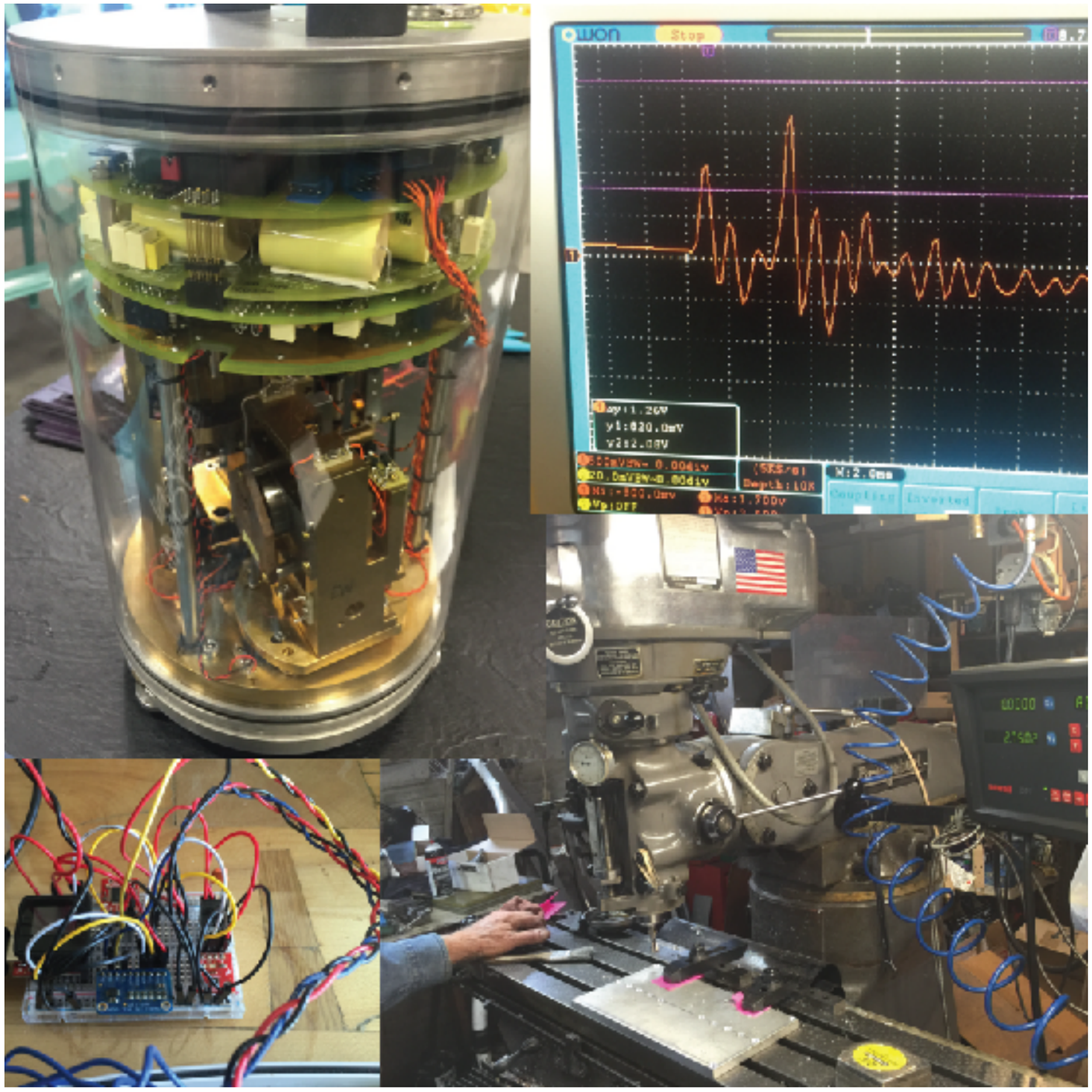
Seals and Adhesives

J.R. Leeman and C. Marone

Techniques of Geoscientific Experimentation

October 4, 2016



WhatsApp increases group chat size limit to 256 people

Bigger groups are now available to all WhatsApp users on iOS and Android

Doug Bolton | @DougieBolton | Friday 5 February 2016 | 17 comments

WhatsApp increases group chat size limit to 256 people

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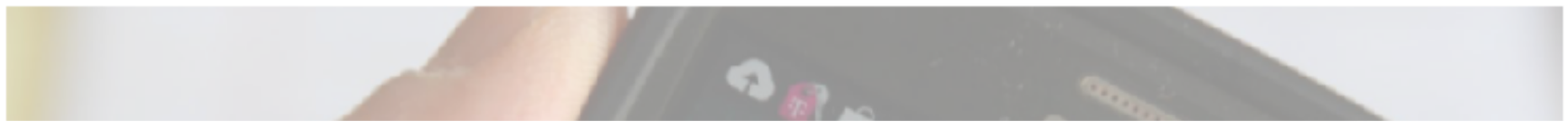
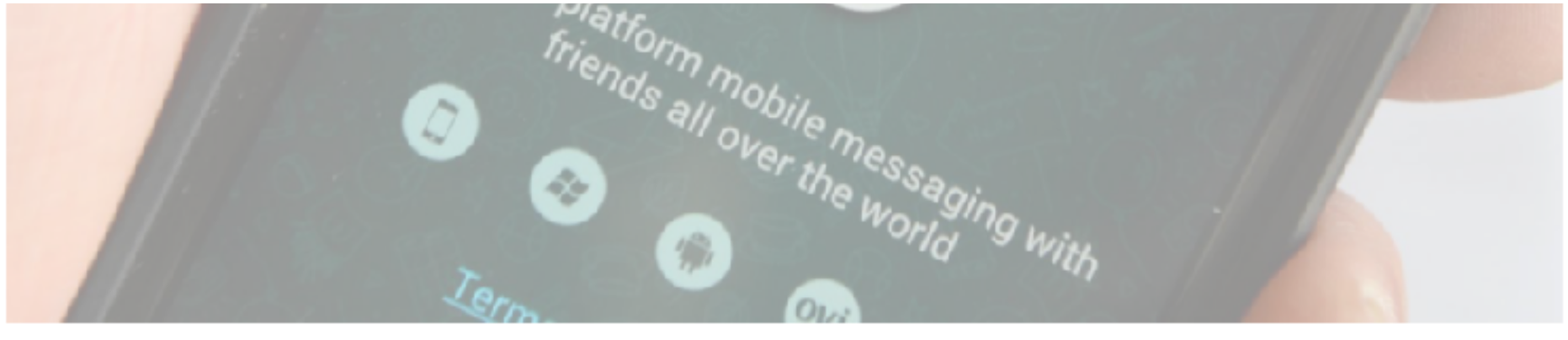
2K shares



A previous version of this article said it was "not clear why WhatsApp settled on the oddly specific number." A number of readers have since noted that 256 is one of the most important numbers in computing, since it refers to the number of variations that can be represented by eight switches that have two positions - eight bits, or a byte. This has now been changed. Thanks for the tweets. DB




M
Maker Faire


wasp
WORLD'S ADVANCED SAVING PROJECT
DELTA WASP 3MT


CIRCUIT
CLASSICS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WAZER


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WAZER


handibot
Henry
handibot
ShopBot


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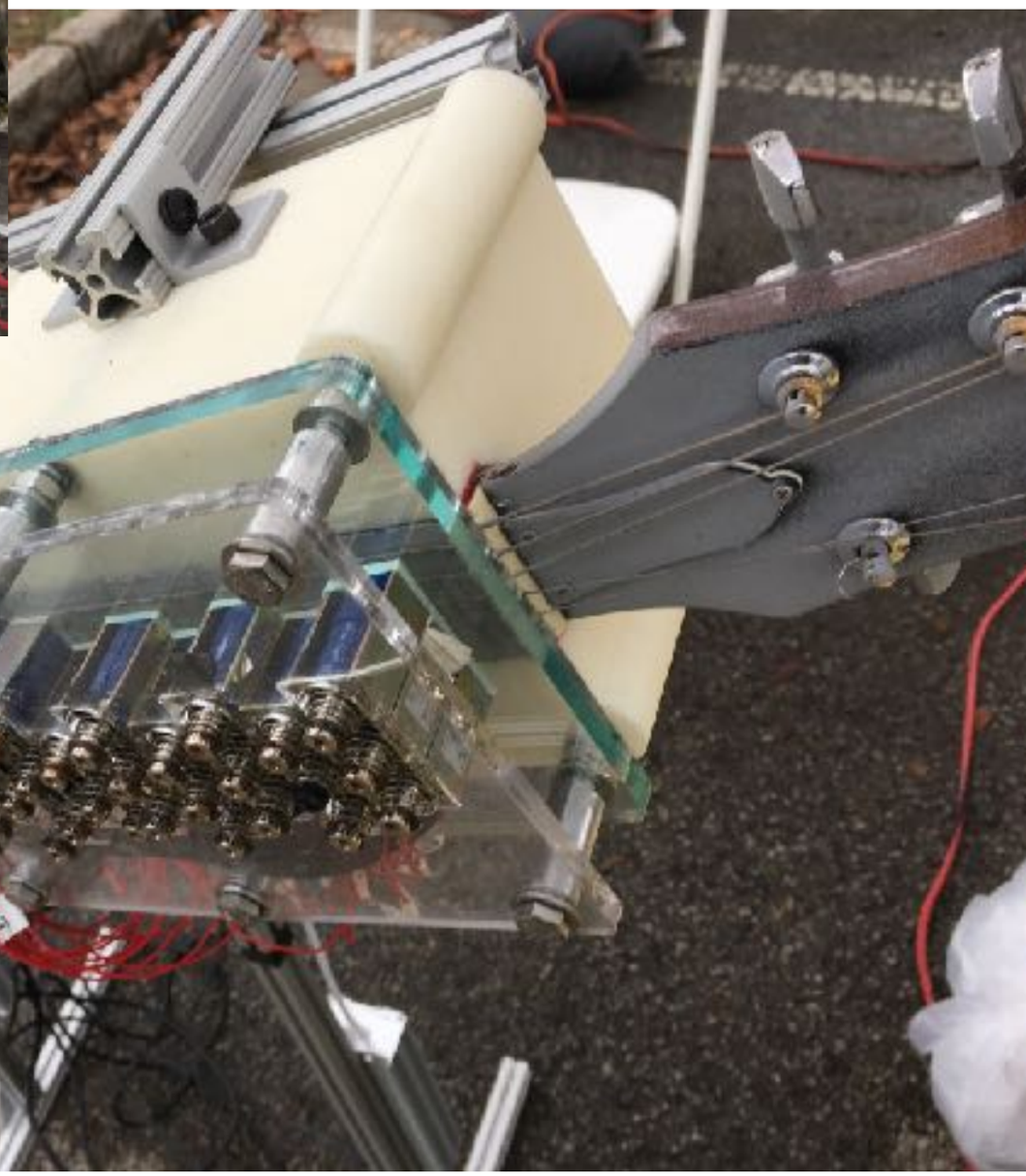


Dover
Robotics
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XBee


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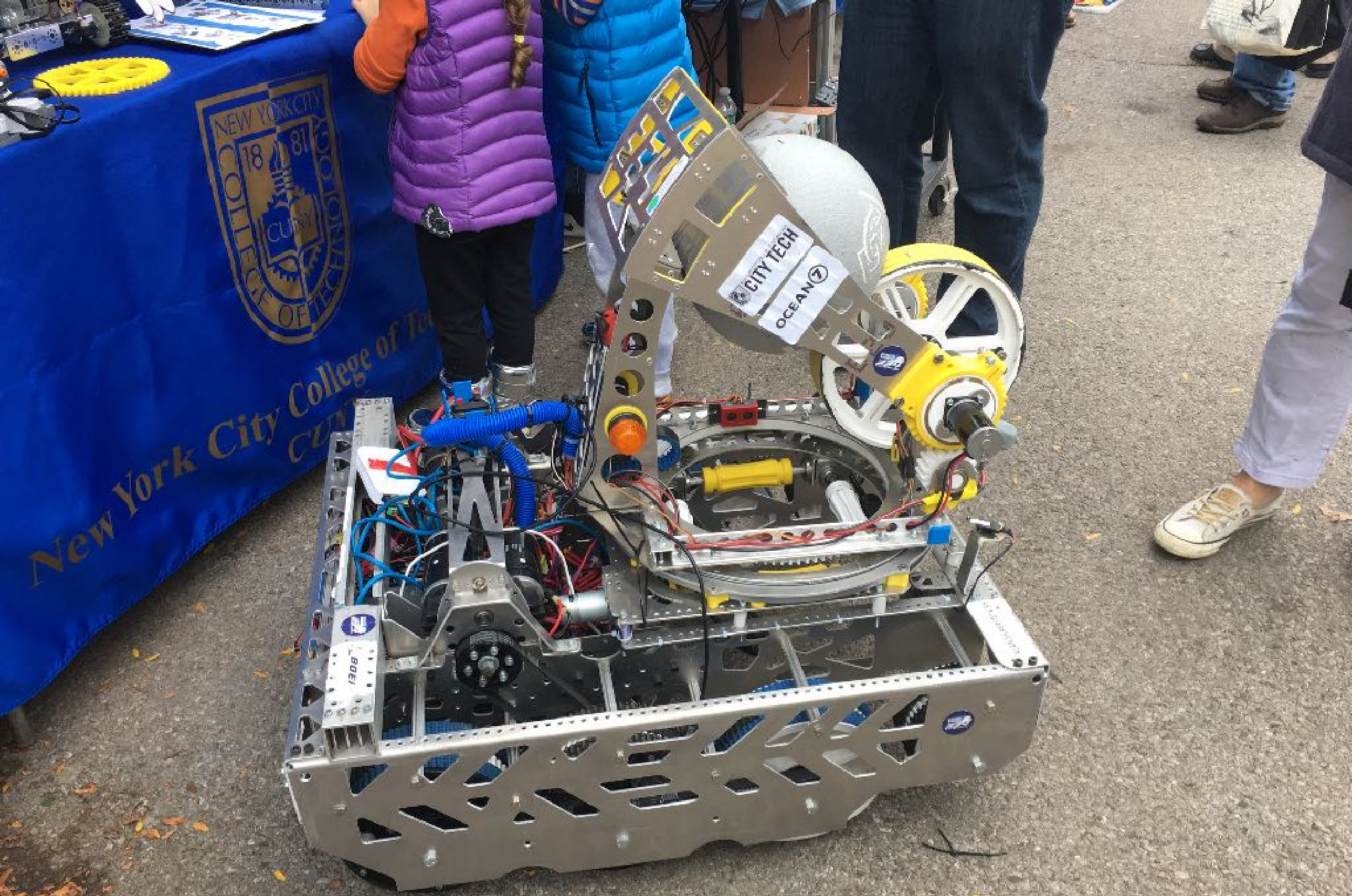
NEW YORK CITY
COLLEGE OF TECHNOLOGY
CITY TECH
OCEAN
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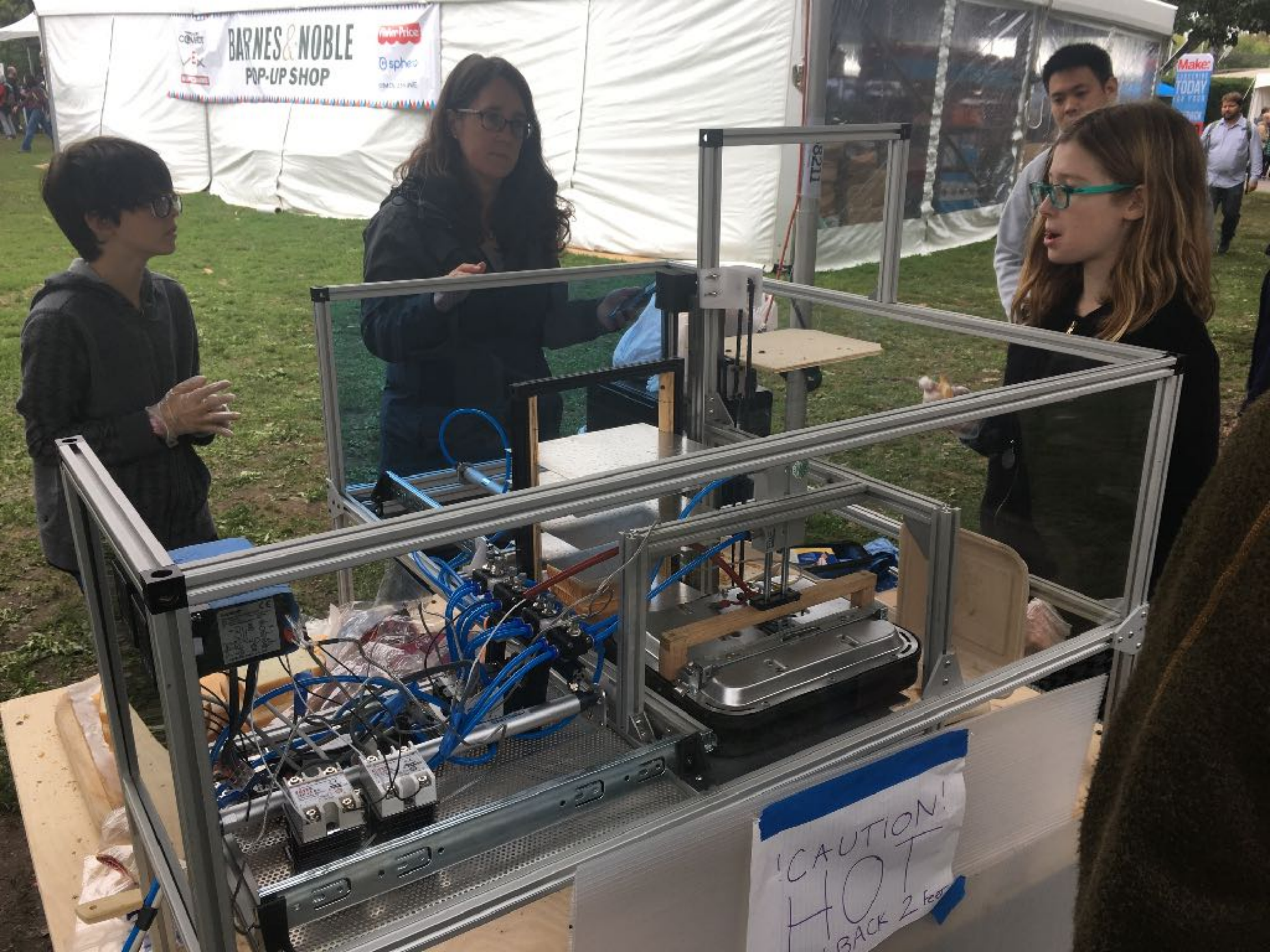
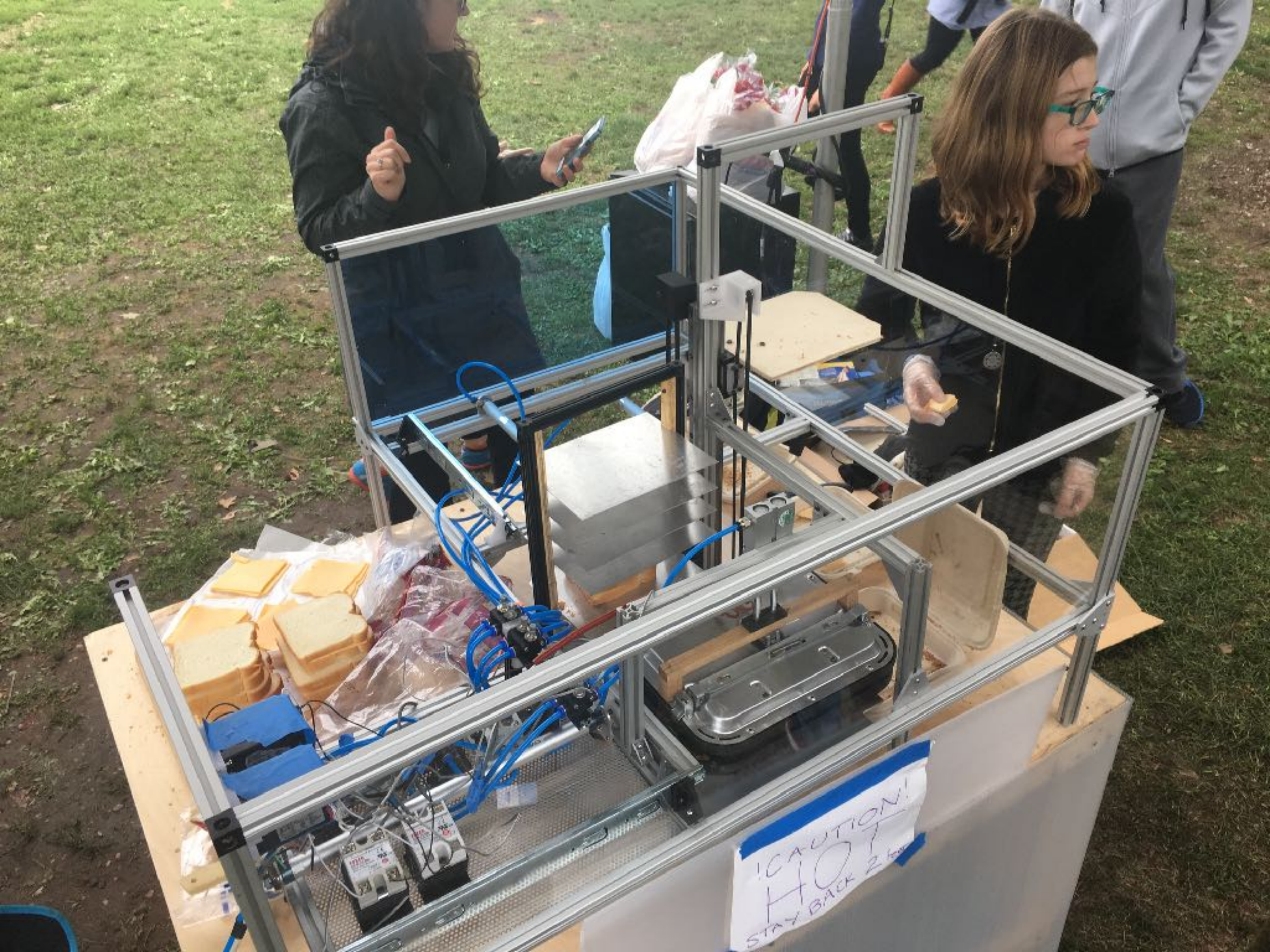
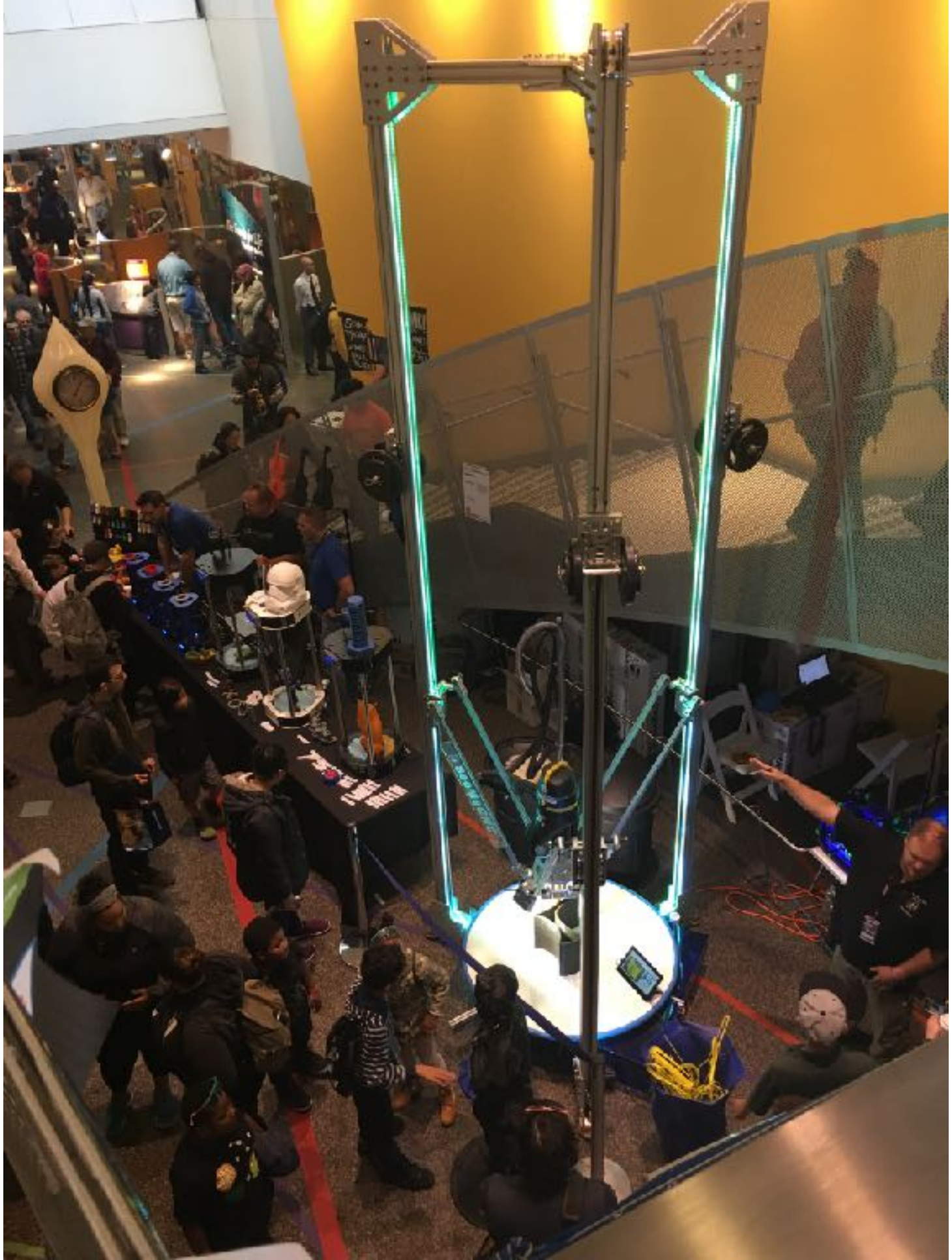
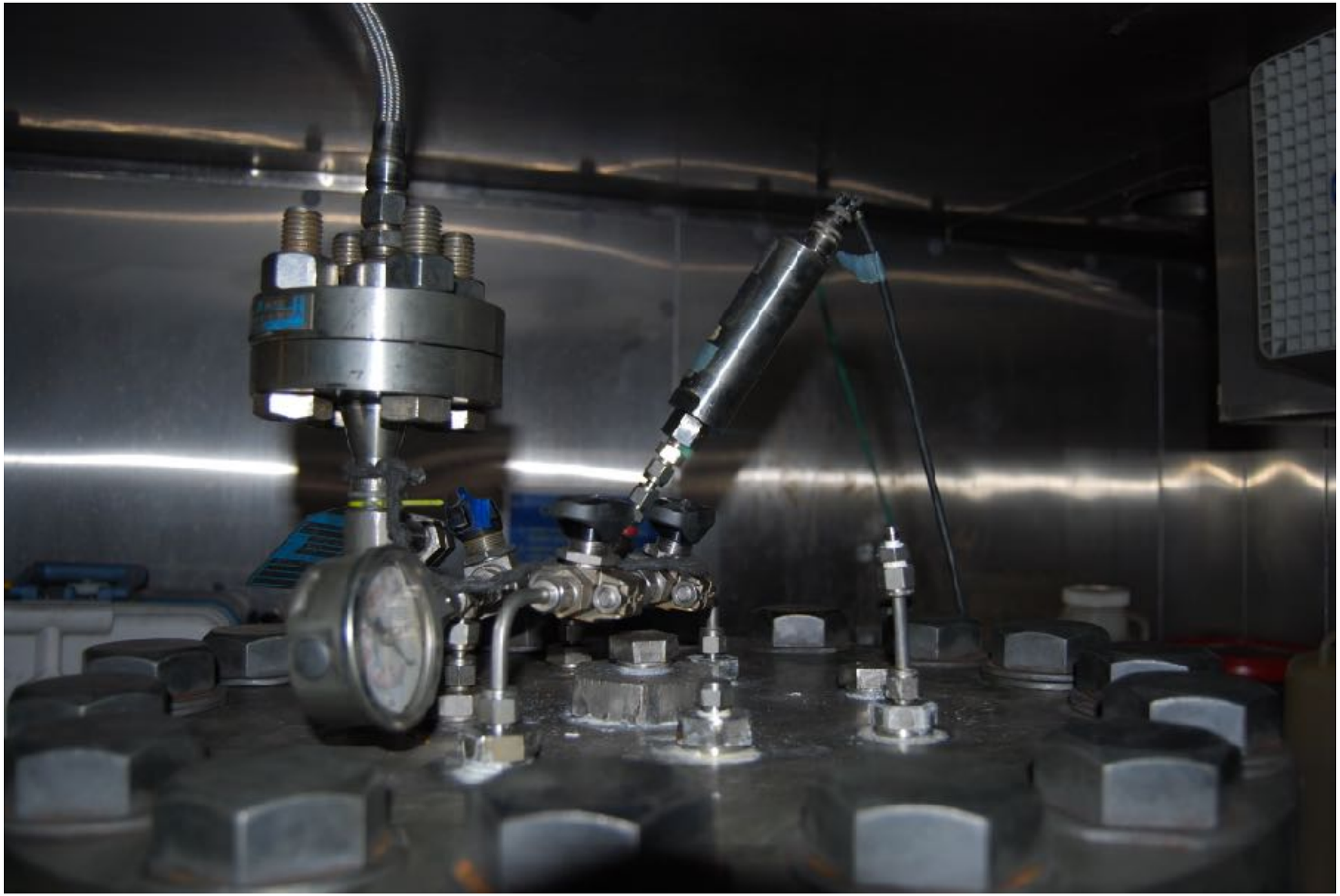

BARNES & NOBLE
POP-UP SHOP
Fisher-Price
sphero
Make:
TODAY
'CAUTION!
HOT
BACK 2 feet


!CAUTION!
HOT
STAY BACK 2




M
Maker Faire

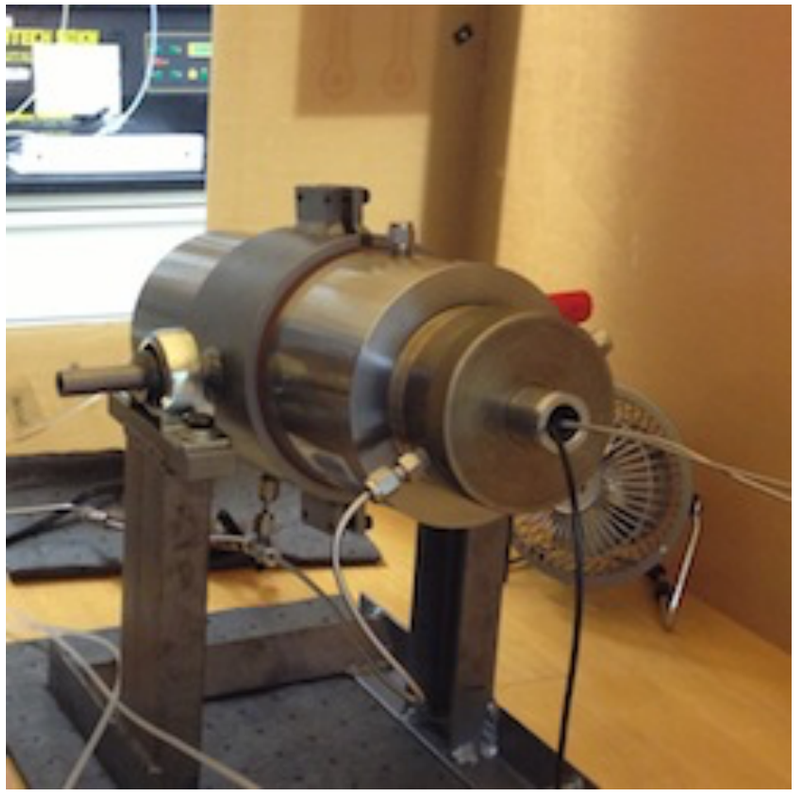
Sealing and adhesives are used everywhere in the lab and field

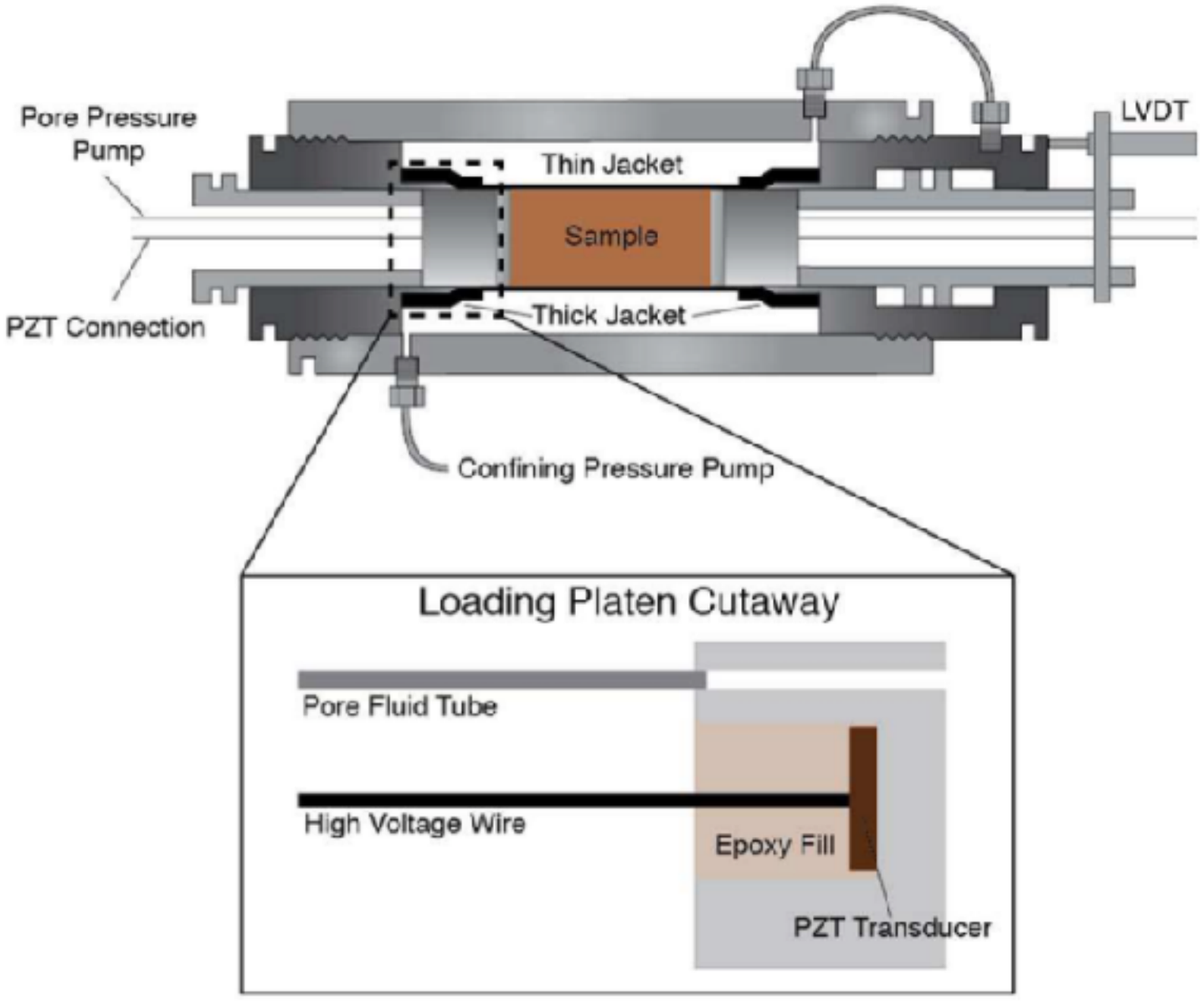


Seals have several common use cases

- Seal working fluid into its desired location
- Prevent the escape of lubricant
- Prevent contamination
- Prevent ingress of dirt
- Prevent ingress of water

Sealing fluid into its working area is common in fluid pressure vessels





It’s also common in hydraulic cylinders

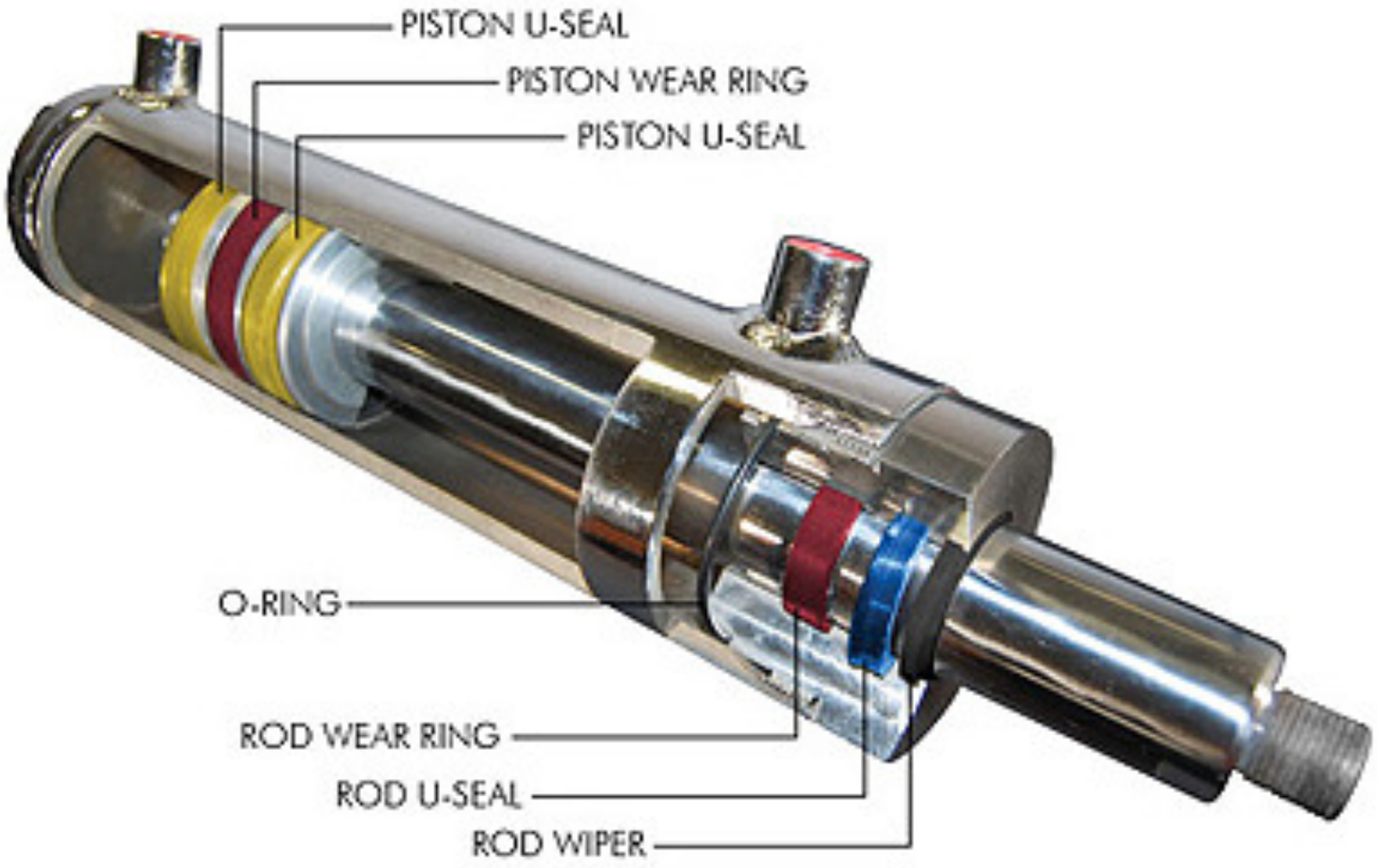


Image: indiamart.com

Preventing the escape of lubricant is important for many dynamic devices

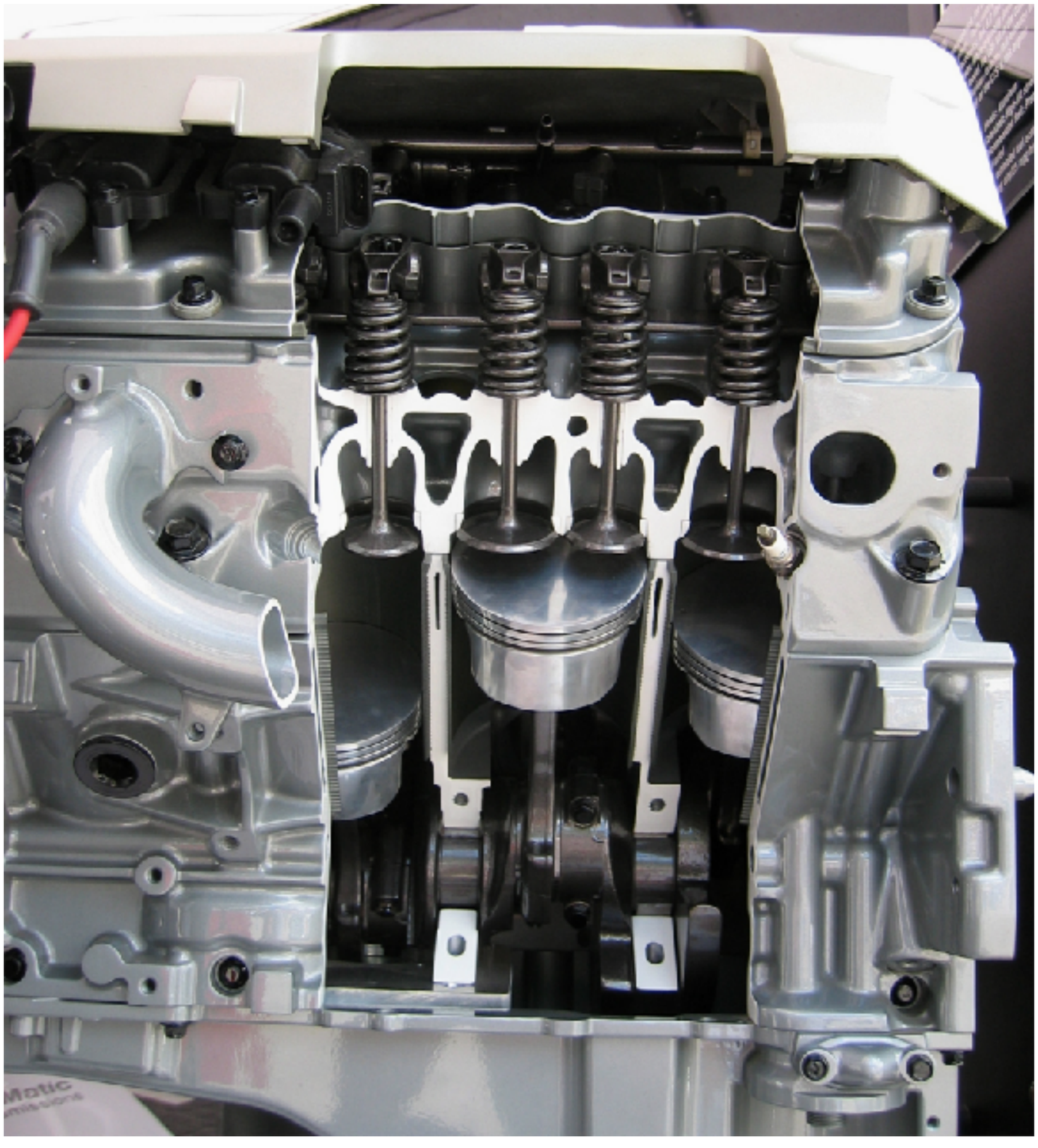


Image: cadillacfaq.com

Contamination prevention is important in food and sample applications

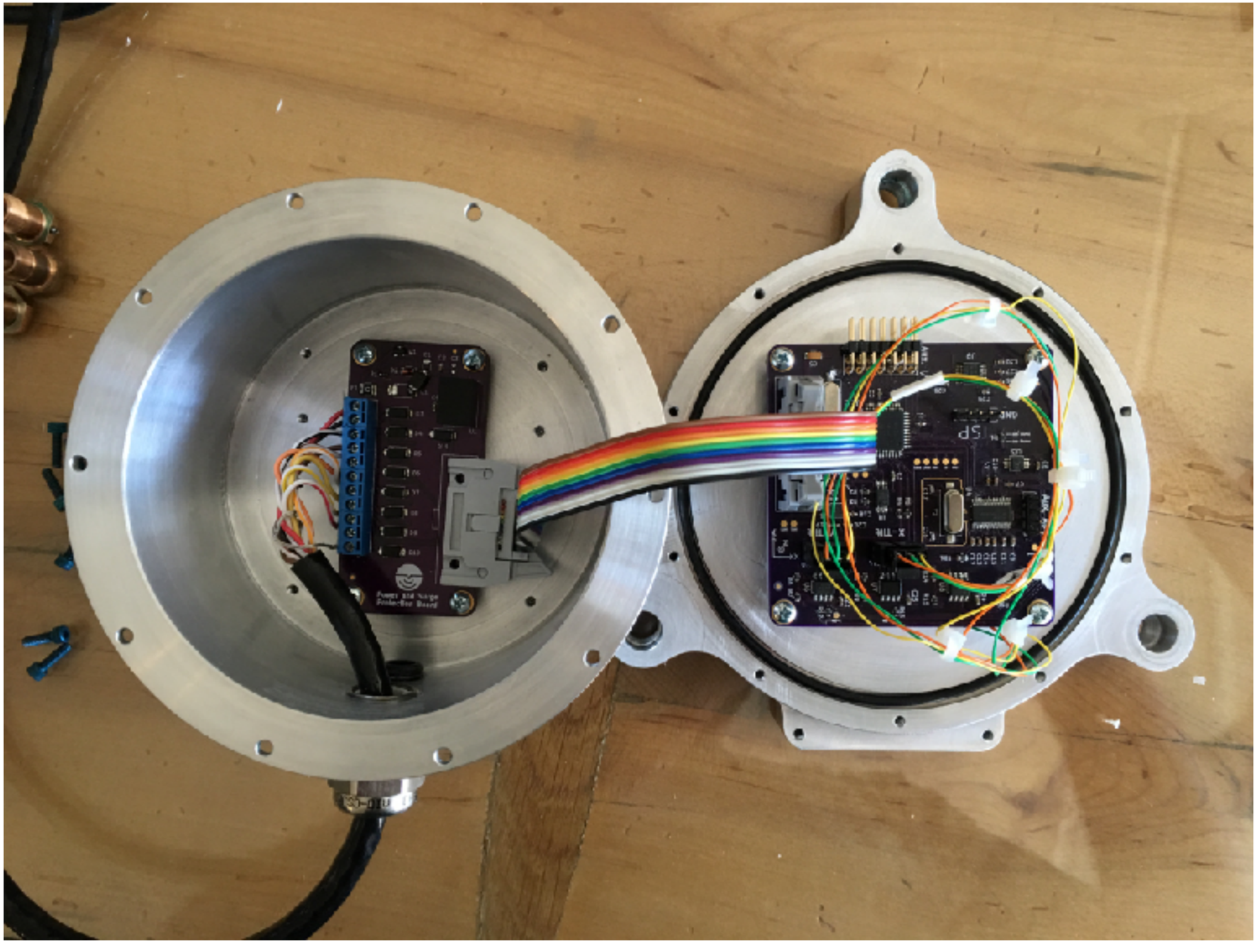
Image: diytrade.com

Image: portal.utpa.edu

Instruments are plagued by abrasive dust and particles

Image: marinewarehouse.net

Environmental protection is one of the largest concerns for field instruments



Ingress protections standards describe what equipment is designed to endure

Sample IP Rating

IP	6	8
“Ingress Protection”	First Digit: Solids Protection	Second Digit: Liquids Protection

Image: dsmt.com

Ingress protections standards describe what equipment is designed to endure

First Digit: Solids

The first digit indicates the level of protection that the enclosure provides against access to hazardous parts (e.g., electrical conductors, moving parts) and the ingress of solid foreign objects.

Level	Object Size Protected Against	Effective Against
0	–	No protection against contact and ingress of objects
1	>50 mm	Any large surface of the body, such as the back of the hand, buy no protection against deliberate contact with a body part
2	>12.5 mm	Fingers or similar objects
3	>2.5 mm	Tools, thick wires, etc.
4	>1 mm	Most wires, screws, etc.
5	Dust Protected	Ingress of dust is not entirely prevented, but it must not enter in sufficient quantity to interfere with the satisfactory operation of the equipment; complete protection against contact
6	Dust Tight	No ingress of dust; complete protection against contact

Image: dsmt.com

Ingress protections standards describe what equipment is designed to endure

Second Digit: Liquids

Protection of the equipment inside the enclosure against harmful ingress of water.

Level	Protected Against	Effective Against
0	Not protected	–
1	Dripping water	Dripping water (vertically falling drops) shall have no harmful effect.
2	Dripping water when tilted up to 15°	Vertically dripping water shall have no harmful effect when the enclosure is tilted at an angle up to 15° from its normal position.
3	Spraying water	Water falling as a spray at any angle up to 60° from the vertical shall have no harmful effect.
4	Splashing water	Water splashing against the enclosure from any direction shall have no harmful effect.
5	Water jets	Water projected by a nozzle (6.3mm) against enclosure from any direction shall have no harmful effects.
6	Powerful water jets	Water projected in powerful jets (12.5mm nozzle) against the enclosure from any direction shall have no harmful effects.
7	Immersion up to 1 m	Ingress of water in harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time (up to 1 m of submersion).
8	Immersion beyond 1m	The equipment is suitable for continuous immersion in water under conditions which shall be specified by the manufacturer. Normally, this will mean that the equipment is hermetically sealed. However, with certain types of equipment, it can mean that water can enter but only in such a manner that it produces no harmful effects.

Image: dsmt.com

You can and should test your designs

Gaskets are a simple seal that can be made from a variety of materials

Image: builtej.com

You can make your own gaskets easily with simple hand tools

Image: dansmc.com

Image: mgexp.com

RTV silicone can be used in a pinch and/or high temp applications

Image: youtube.com

O-rings are one of the most common seals used

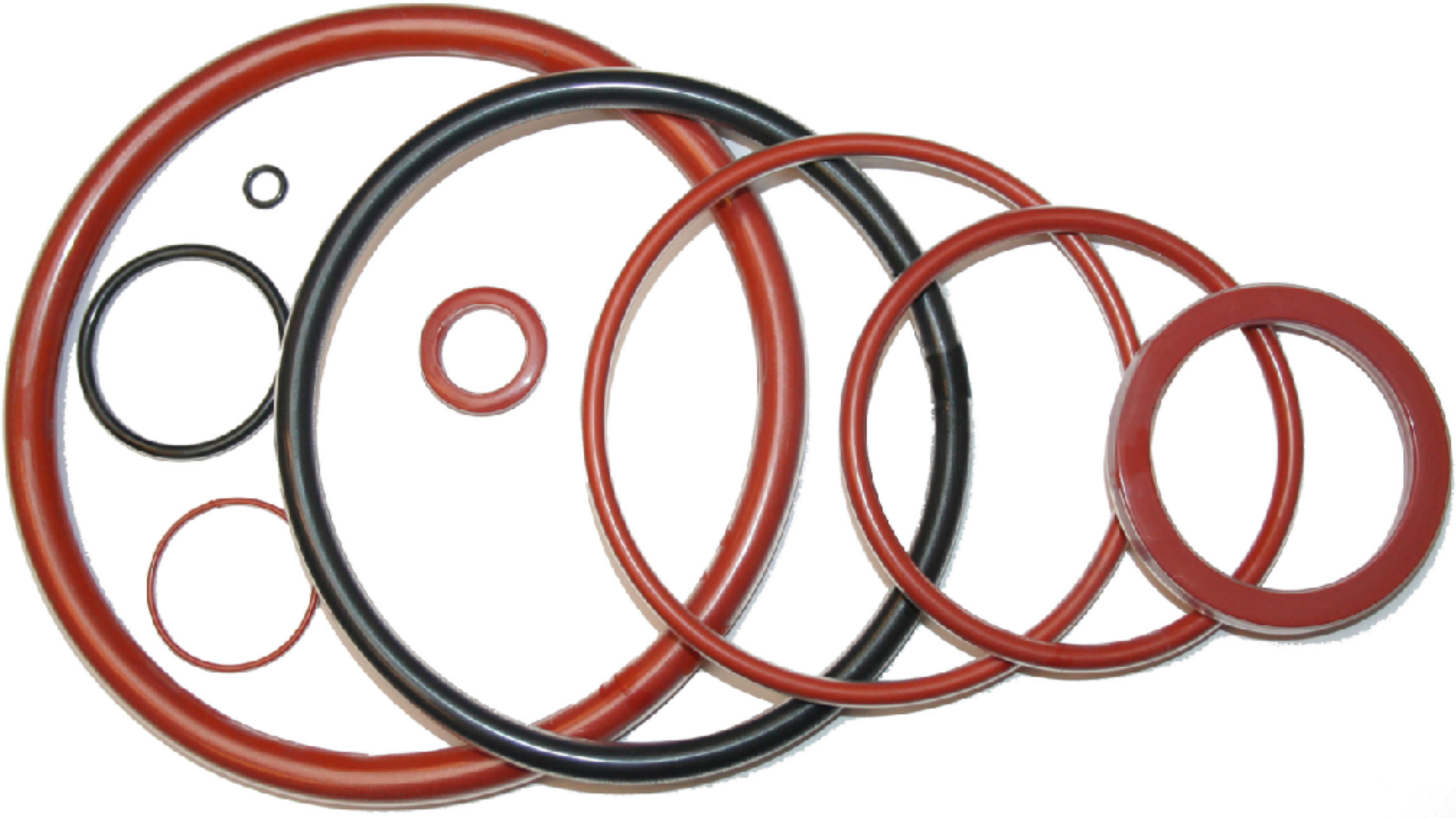


Image: directindustry.com

There are a wide variety of cross-sections available


Multipurpose O-Rings


Colored O-Rings


Ultra-Compressible O-Rings


Abrasion-Resistant O-Rings


X-Profile O-Rings


Square-Profile O-Rings


Refrigerant-Resistant O-Rings


Extreme-Chemical O-Rings


Extreme-Pressure Metal O-Rings


UL-Recognized O-Rings


Food-and-Beverage O-Rings


Metal-Detector-Grade O-Rings


Clean Room O-Rings


Mil. Spec. O-Rings


O-Rings for Straight Thread Tube Fittings


Backup Rings


Made-to-Order O-Rings


Multipurpose O-Ring Cord Stock


Colored O-Ring Cord Stock


Ultra-Compressible O-Ring Cord Stock


Abrasion-Resistant O-Ring Cord Stock


X-Profile O-Ring Cord Stock


Square-Profile O-Ring Cord Stock


Refrigerant-Resistant O-Ring Cord Stock


Extreme-Chemical O-Ring Cord Stock


Food-and-Beverage O-Ring Cord Stock


O-Ring Cord Joining Kits


O-Ring Cord Splicing Kits


O-Ring Size-Identification Tools


O-Ring Assortments


Metric O-Ring Assortments


Backup Ring Assortments

Image: mcmaster.com

There are several common O-ring applications

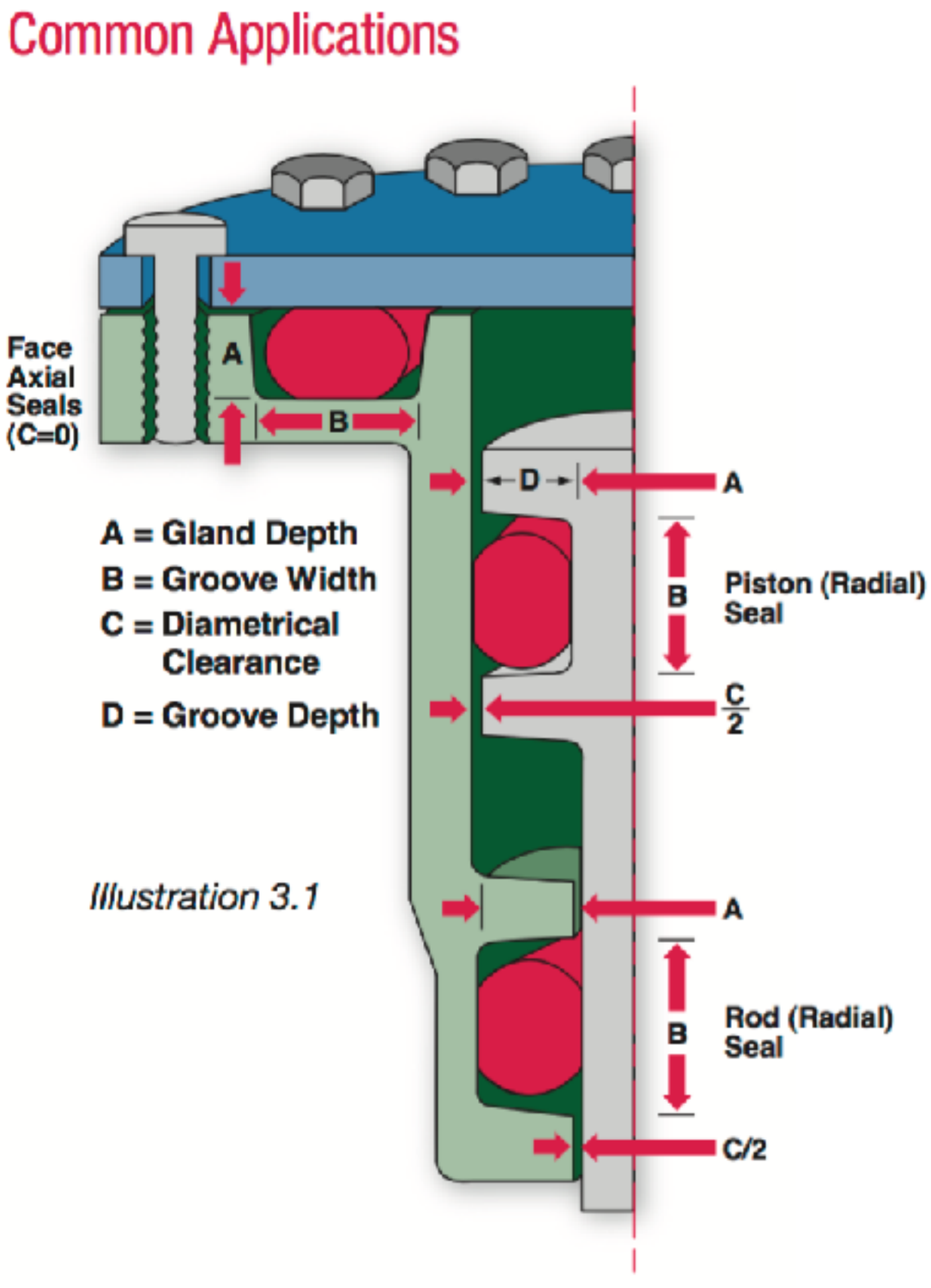


Image: applerubber.com

Internal Pressure

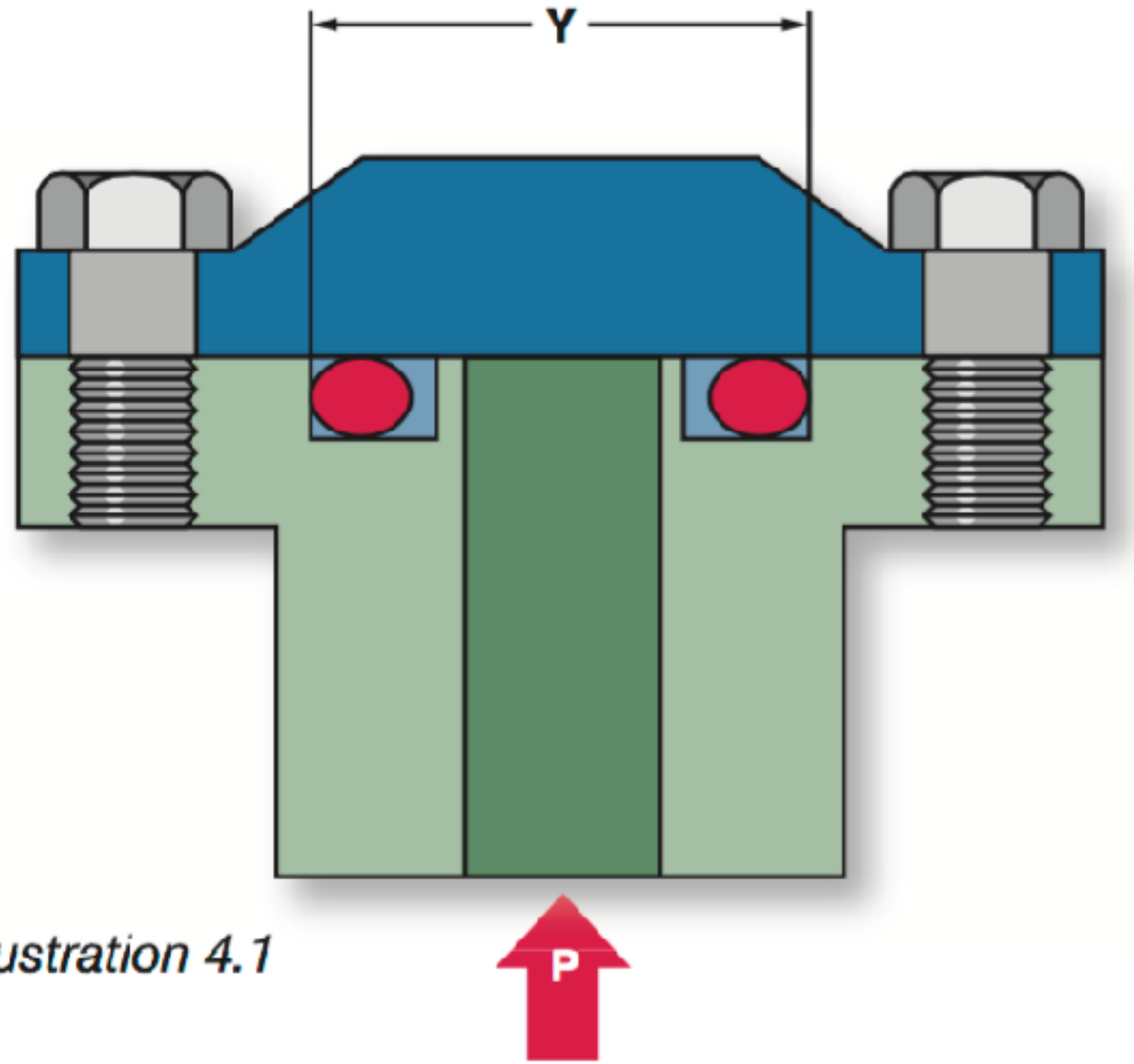
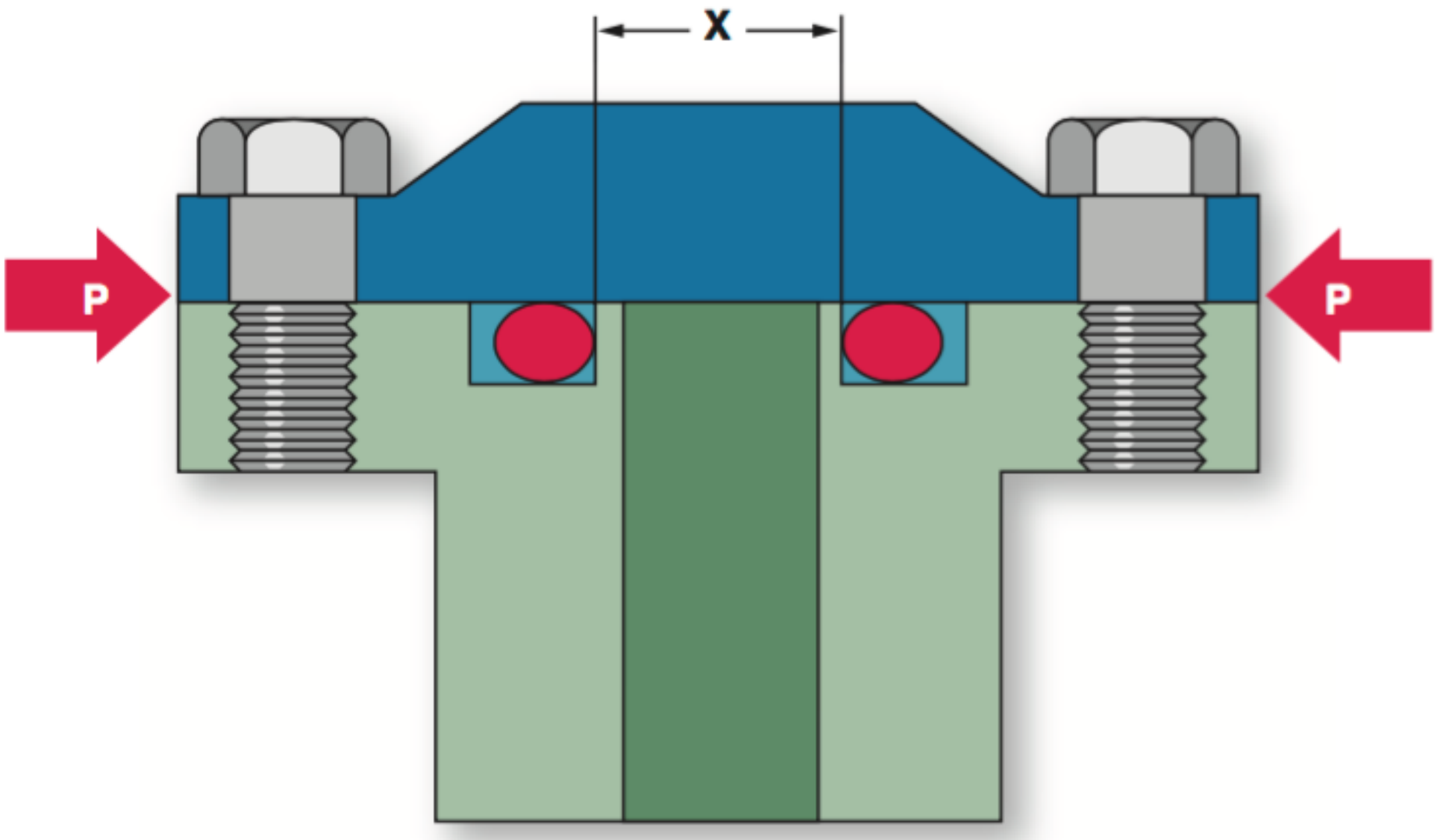


Illustration 4.1

Y Min. = O-Ring Mean I.D. - 1% UP TO .060 **Y Max.** = O-Ring Mean O.D.

Image: applerubber.com

External Pressure



X Min. = O-Ring Mean I.D. **X Max.** = O-Ring Mean I.D. + 1% UP TO .060

Illustration 4.2

Image: applerubber.com

Static Crush Seal

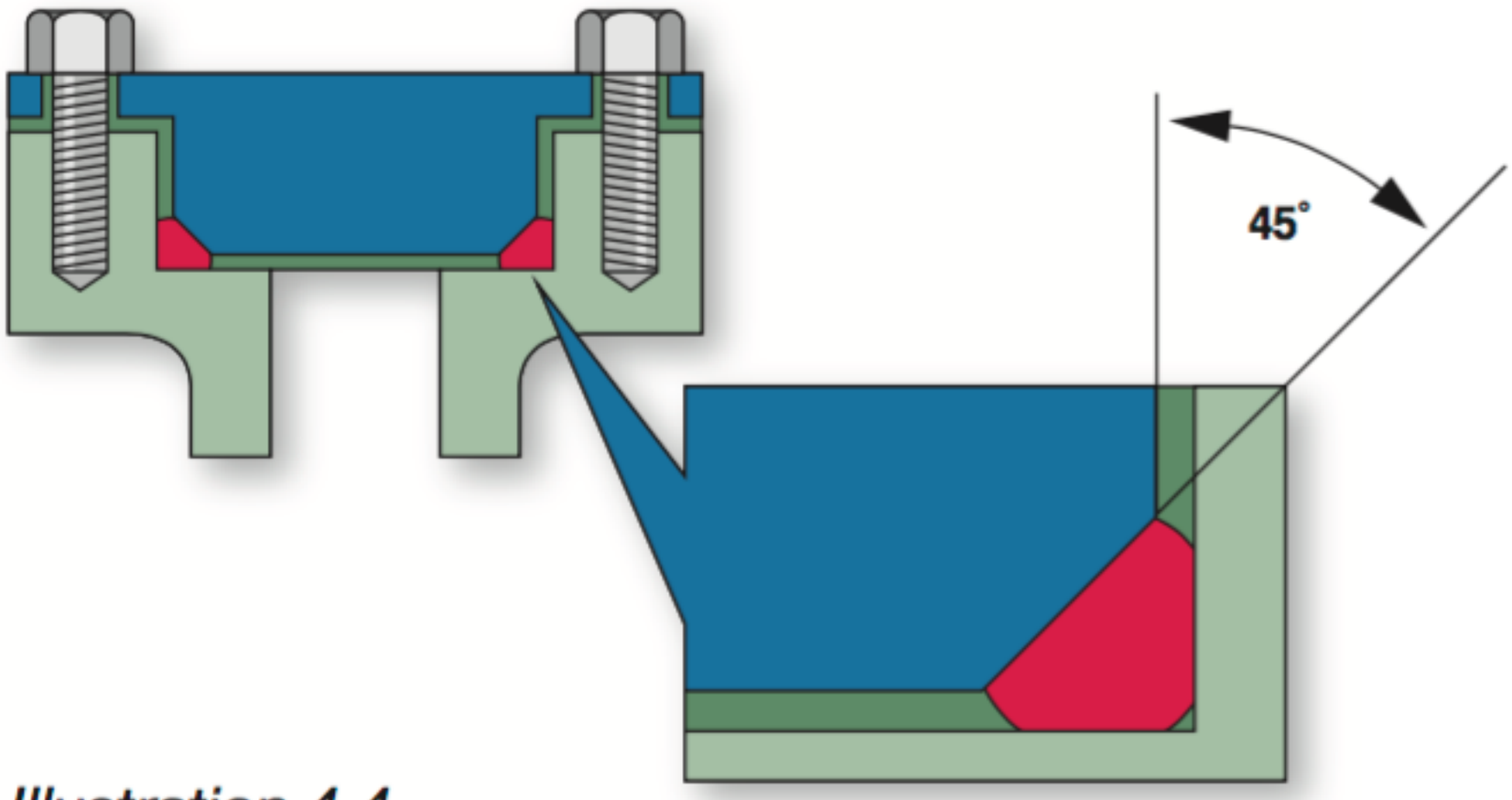


Illustration 4.4

Image: applerubber.com

Radial Seal

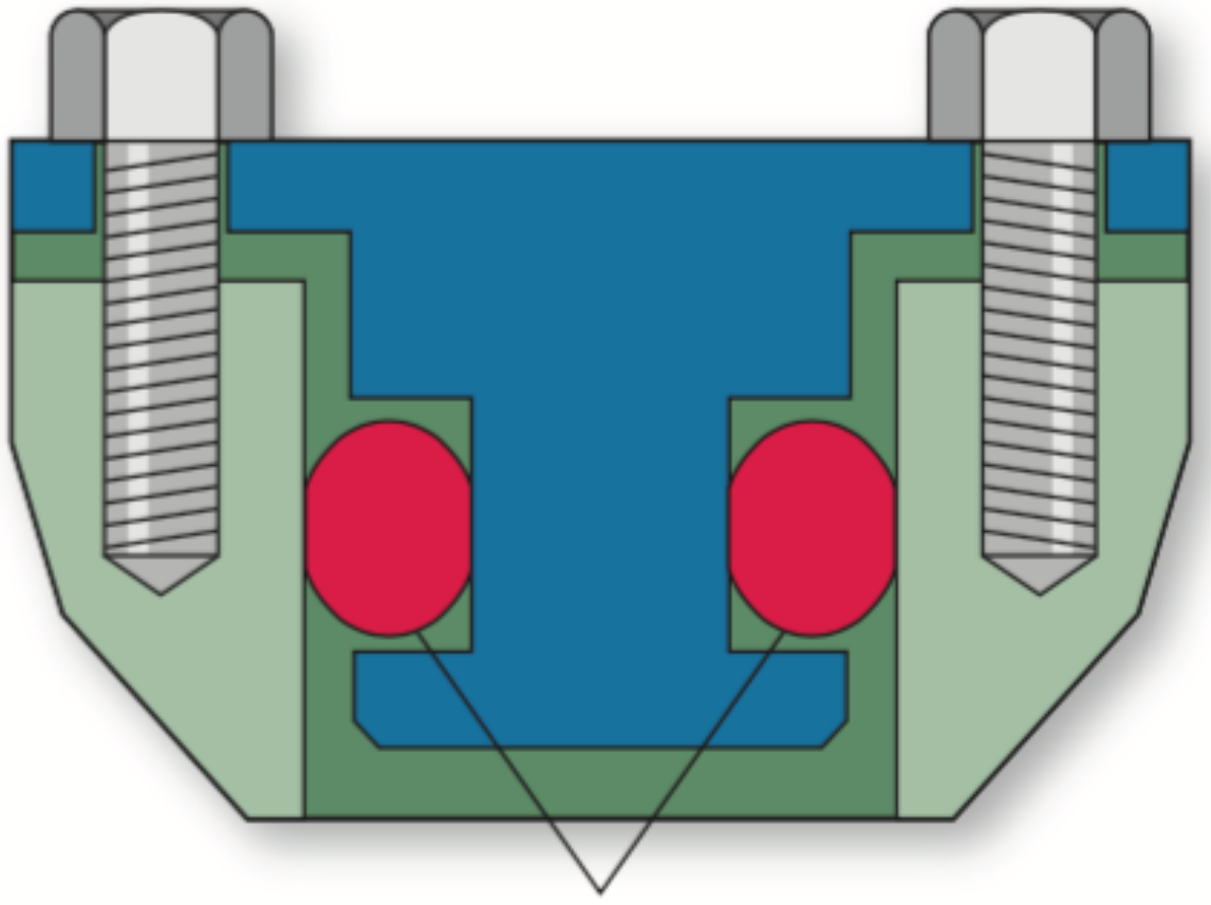


Illustration 4.3

Image: applerubber.com

Dovetail Gland

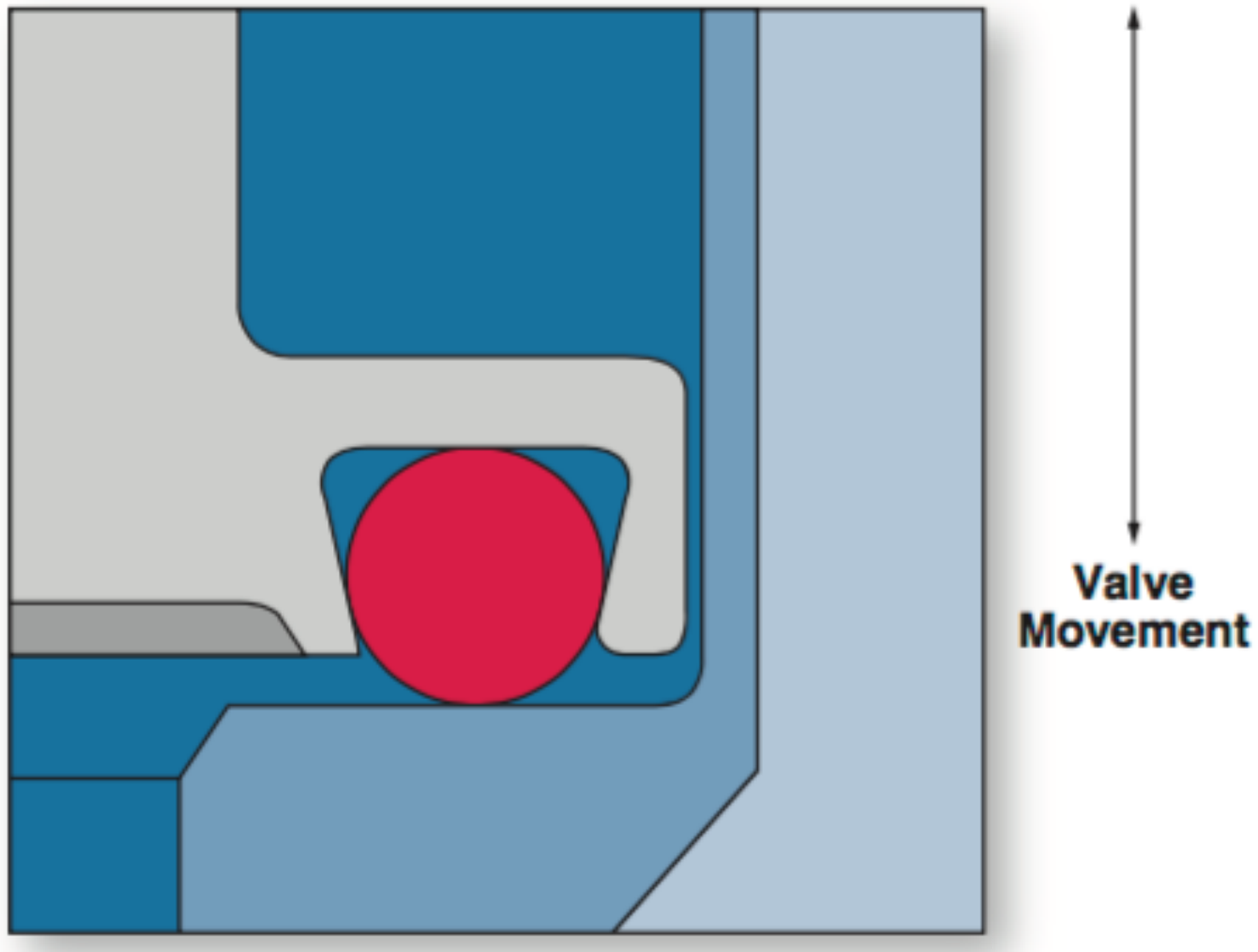


Illustration 4.5

Image: applerubber.com

Rotary Seal

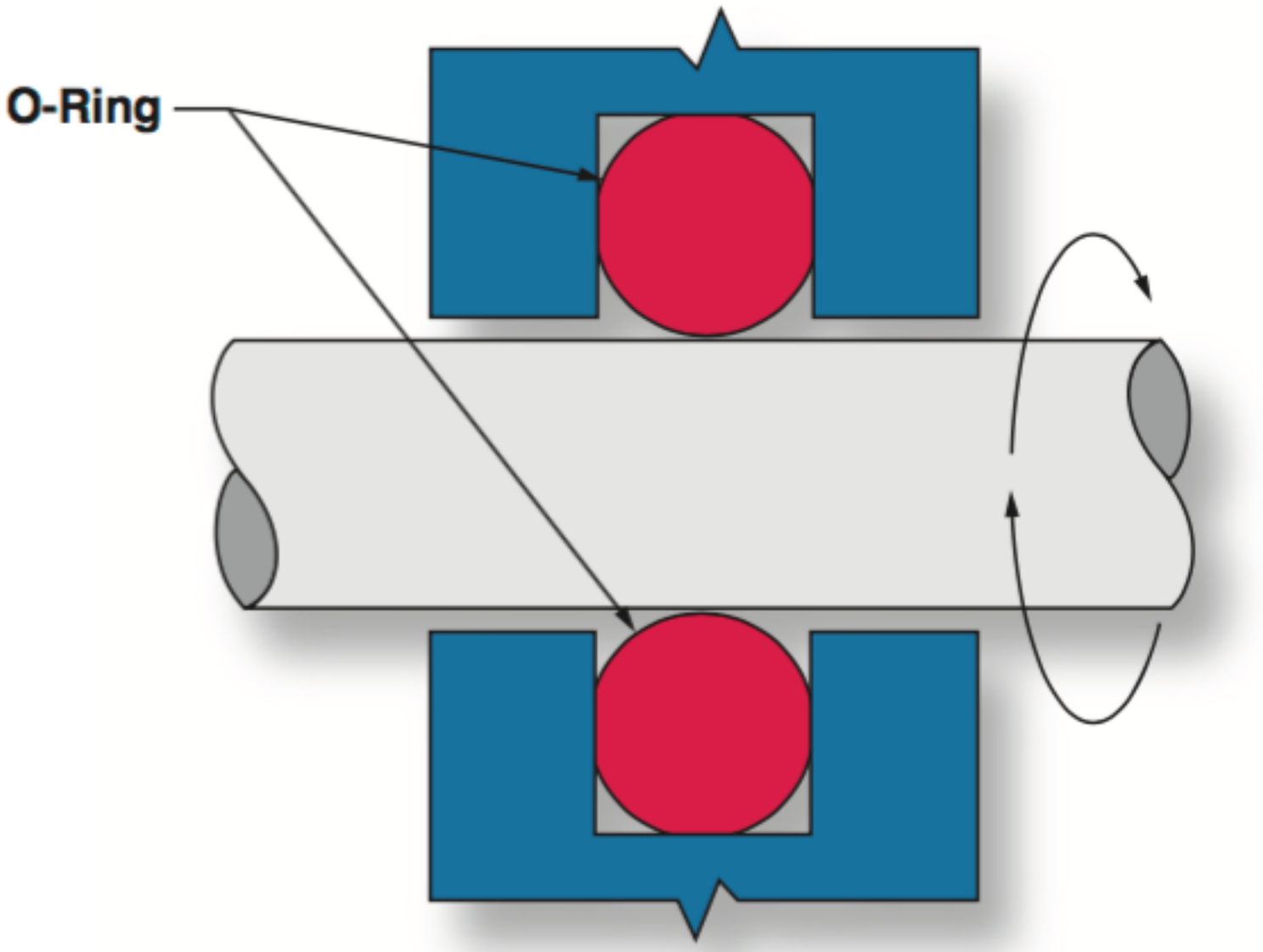
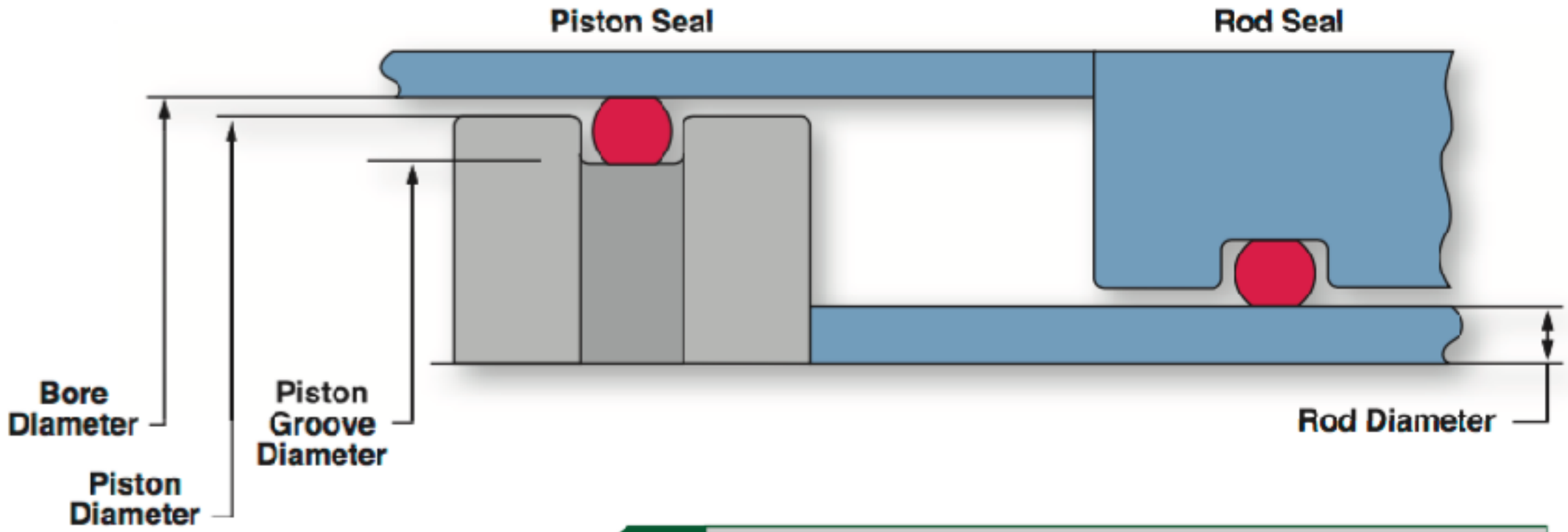


Illustration 4.7

Image: applerubber.com

Reciprocating Seals

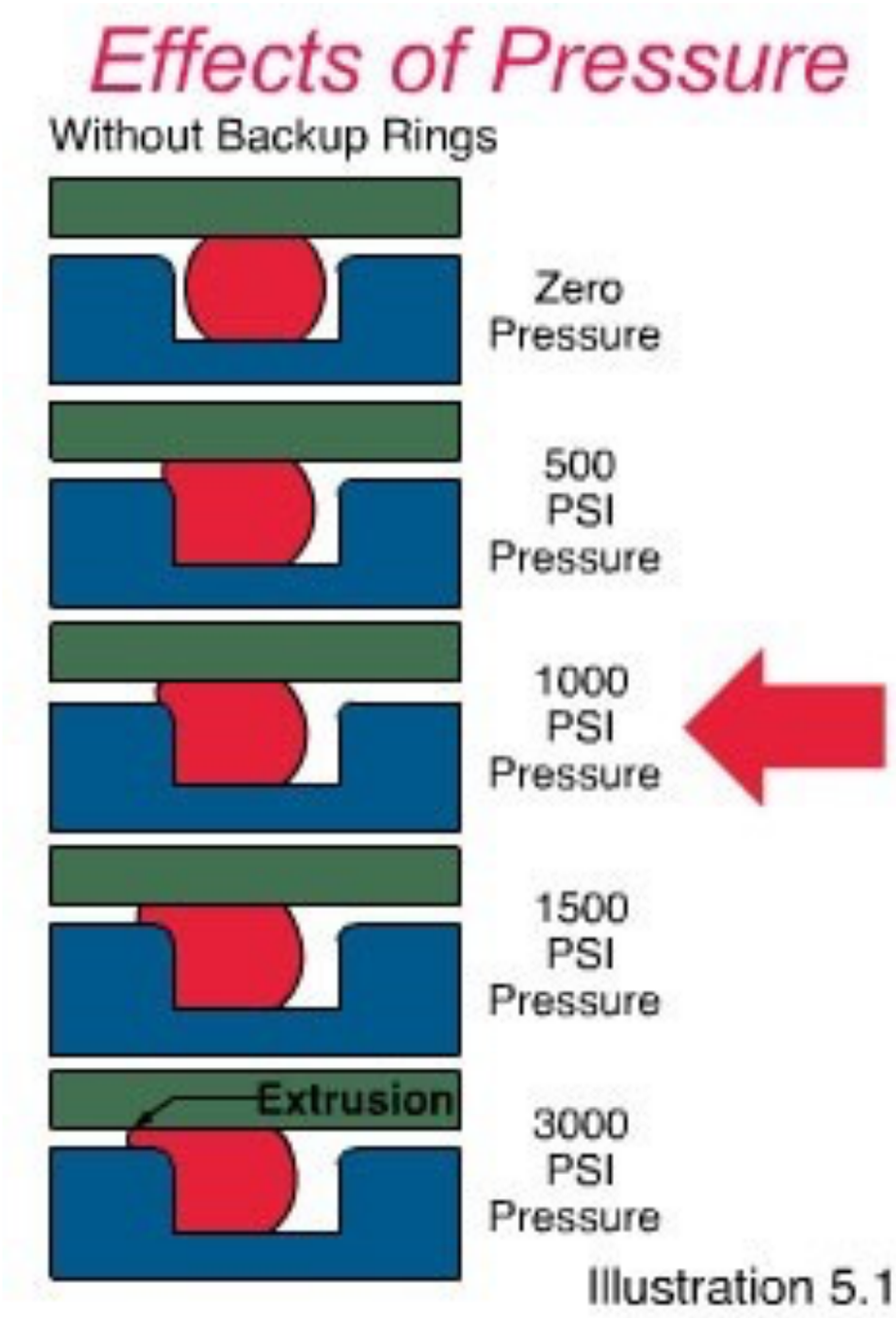


Rule of Thumb

For reciprocating seals – passing O-rings over ports is not recommended. Nibbling and premature wear and seal failure will result.

Image: applerubber.com

Backup rings are used to prevent main ring extrusion



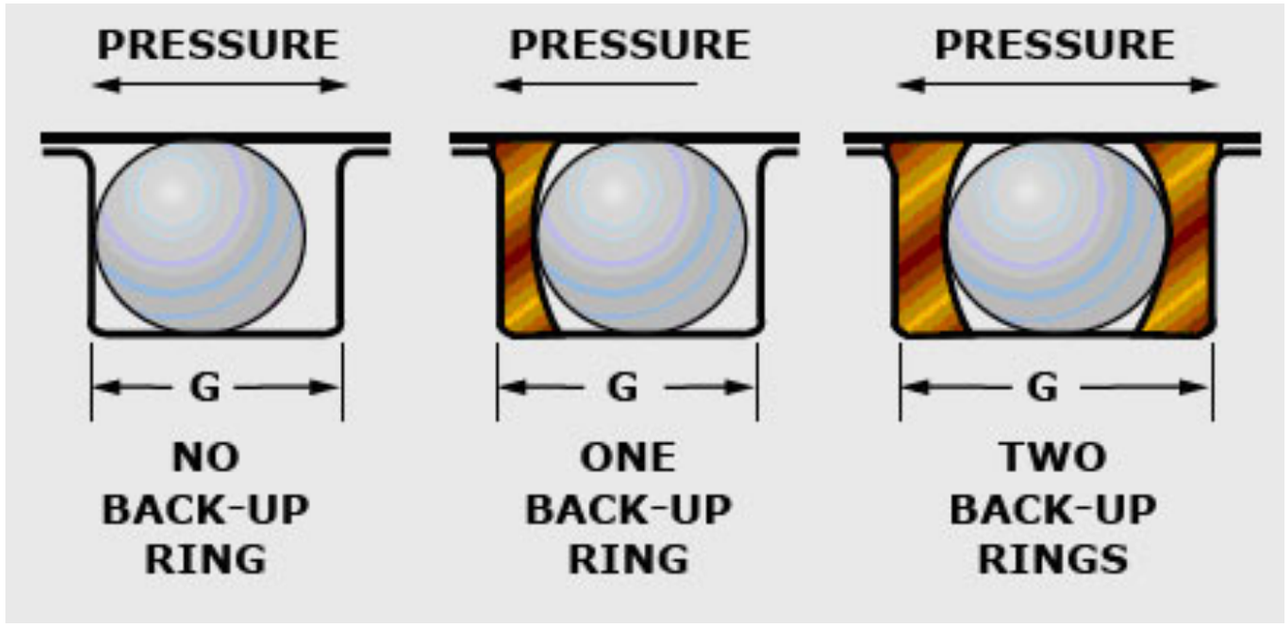


Image: applerubber.com

Metal sealing rings are used as well

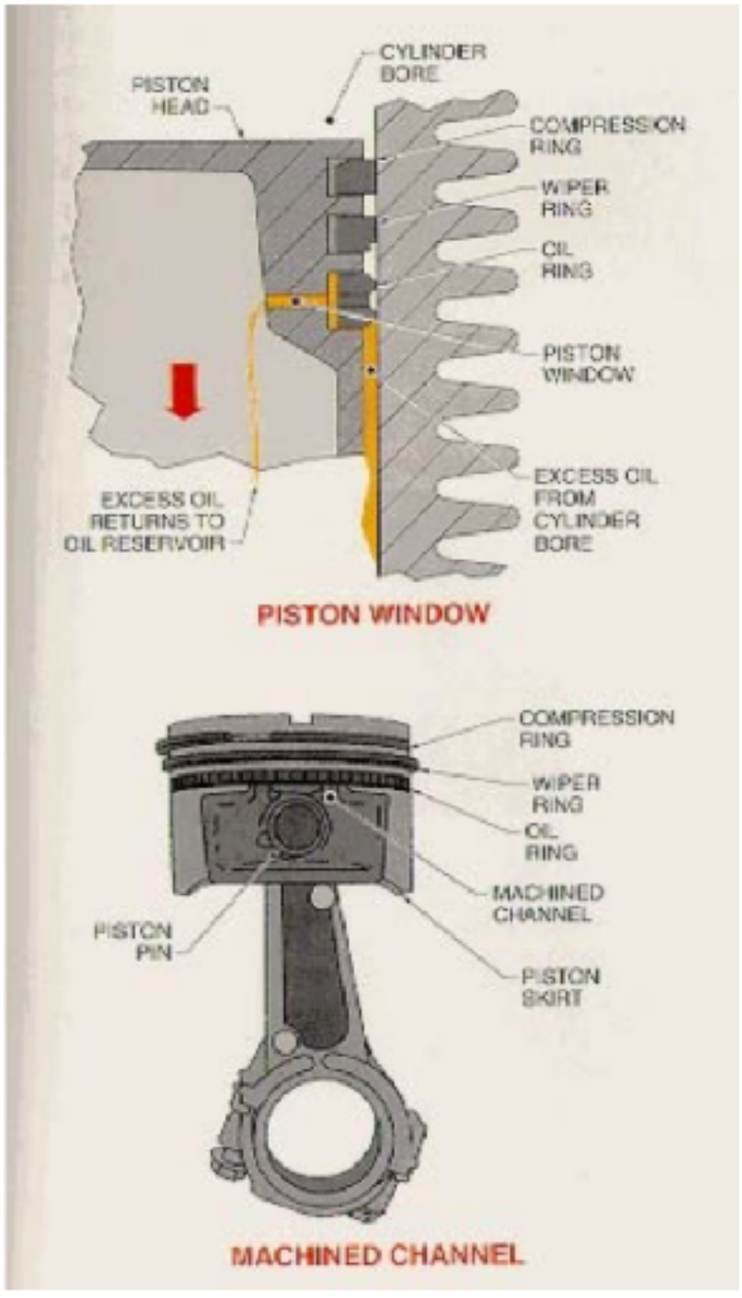


Image: https://www.engineersaustralia.org.au/sites/default/files/shado/Learned%20Groups/National%20Committees%20and%20Panels/Engineering%20Design/Part%203.pdf

Crushable washers are another common seal

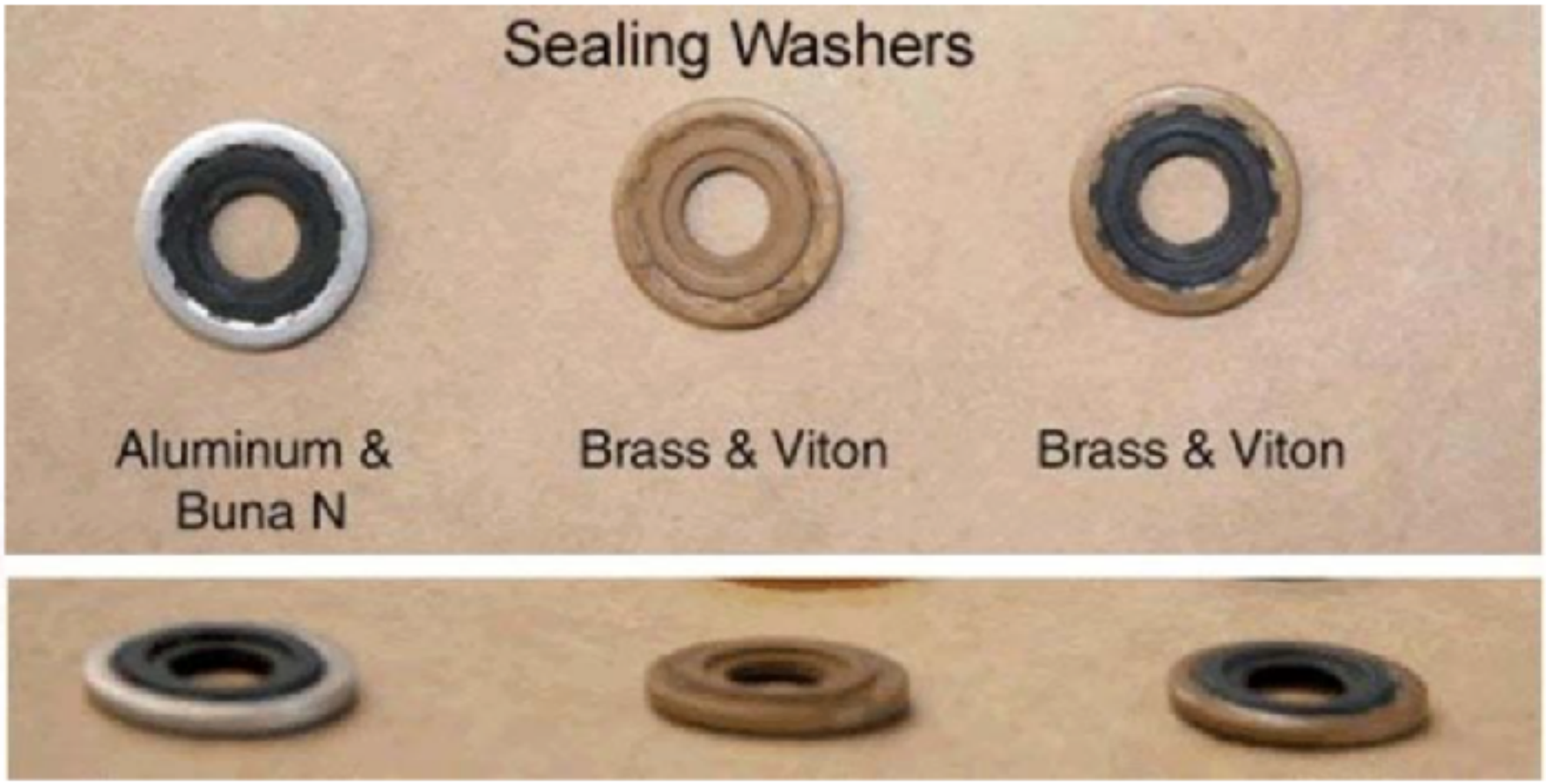
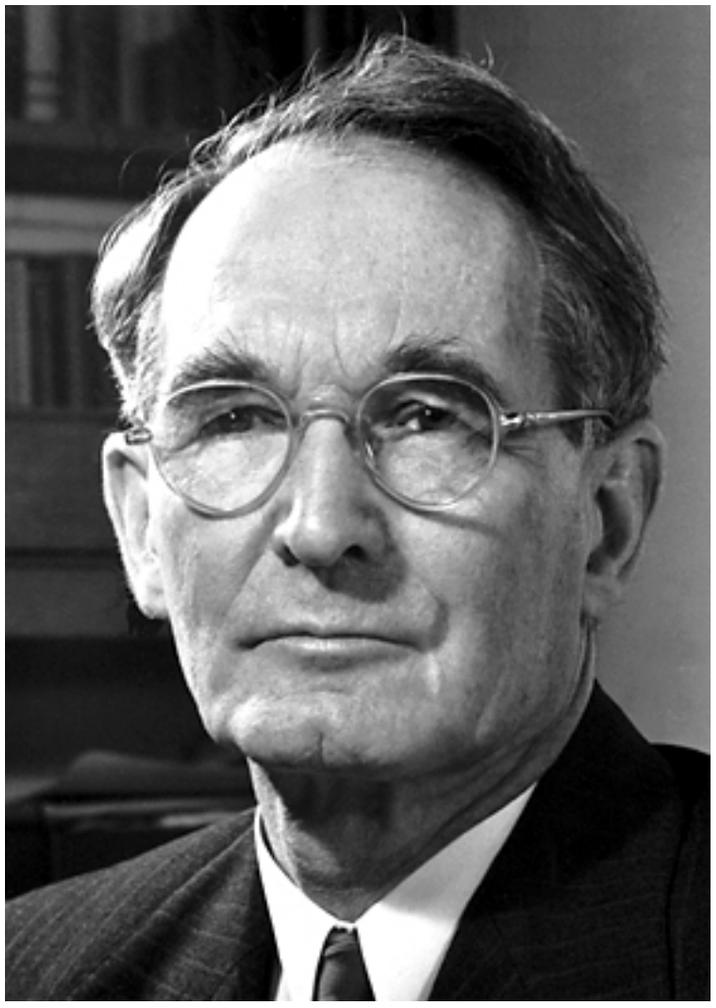
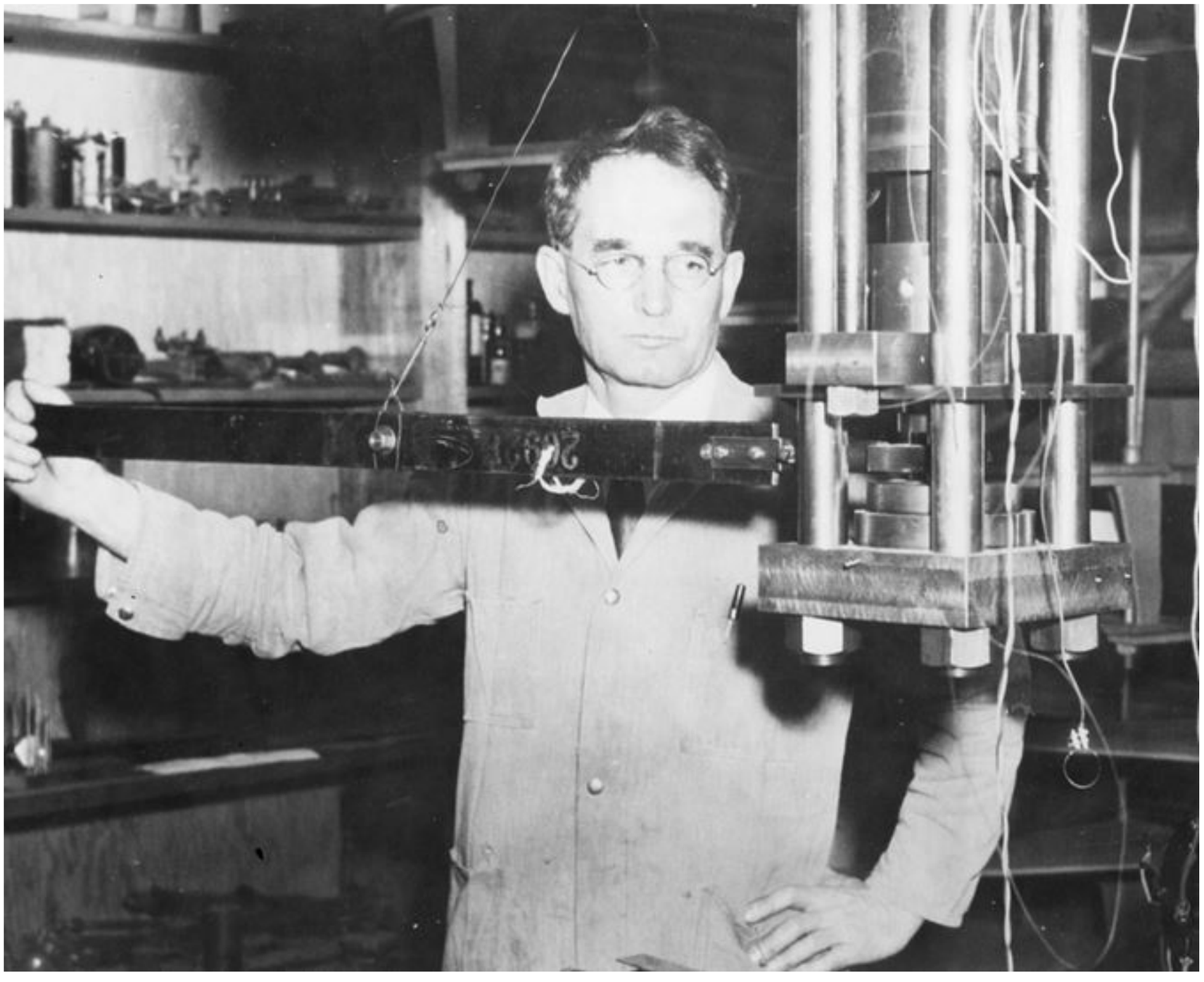


Image: https://www.engineersaustralia.org.au/sites/default/files/shado/Learned%20Groups/National%20Committees%20and%20Panels/Engineering%20Design/Part%203.pdf

Bridgman… that name should ring a bell

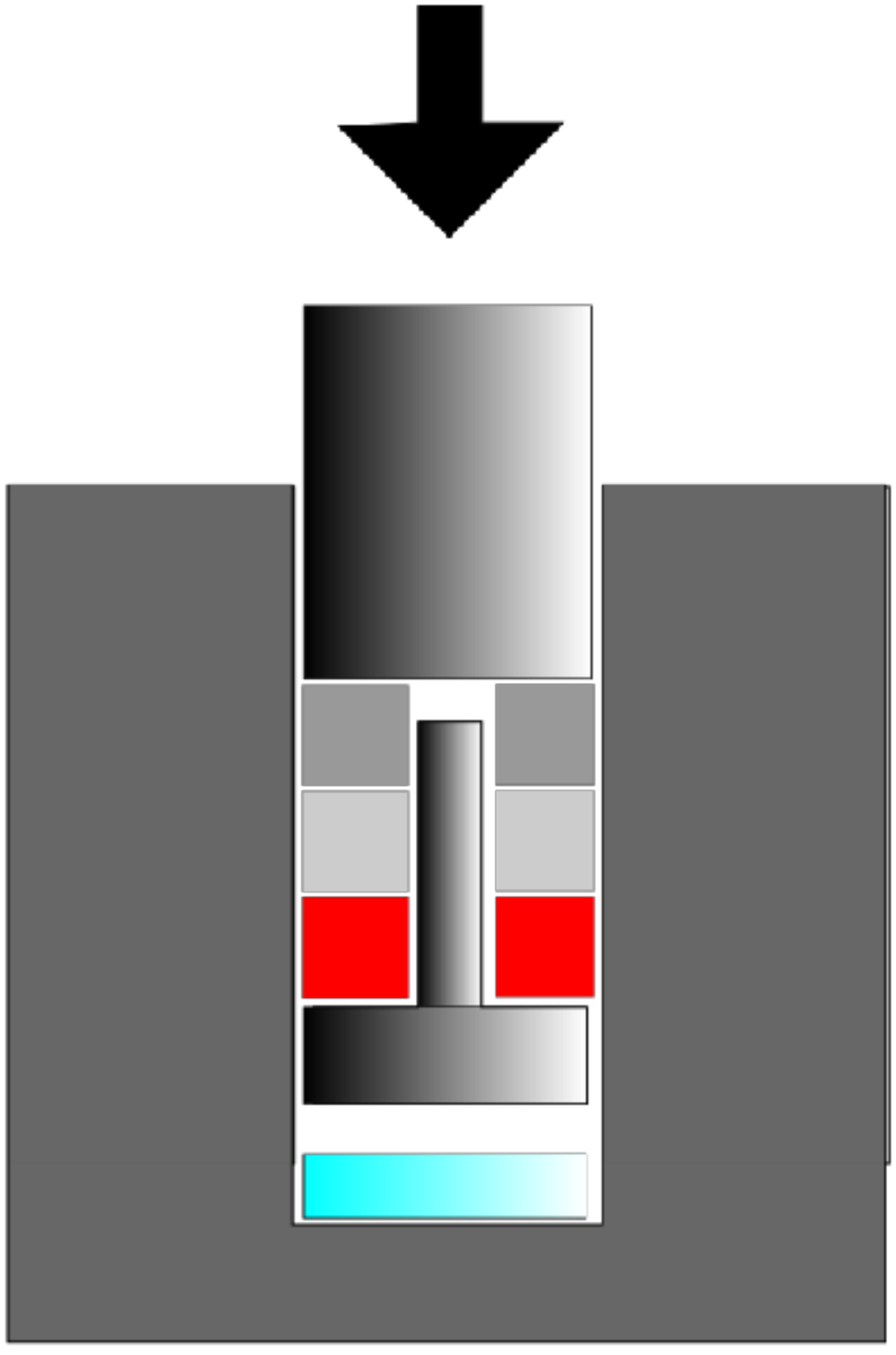


Percy Williams Bridgman
(1882-1961)



~1915 (mountainmystery.com)

The Bridgman unsupported seal, good to 40,000 MPa!



Bridgman, P. W. (1914). "The technique of high pressure experimenting". *Proceedings of the American Academy of Arts and Sciences*. **49**: 627–643. doi:10.2307/20025490.

Image: wikipedia.com

U-Cup seals are good to dynamic seals at high pressure

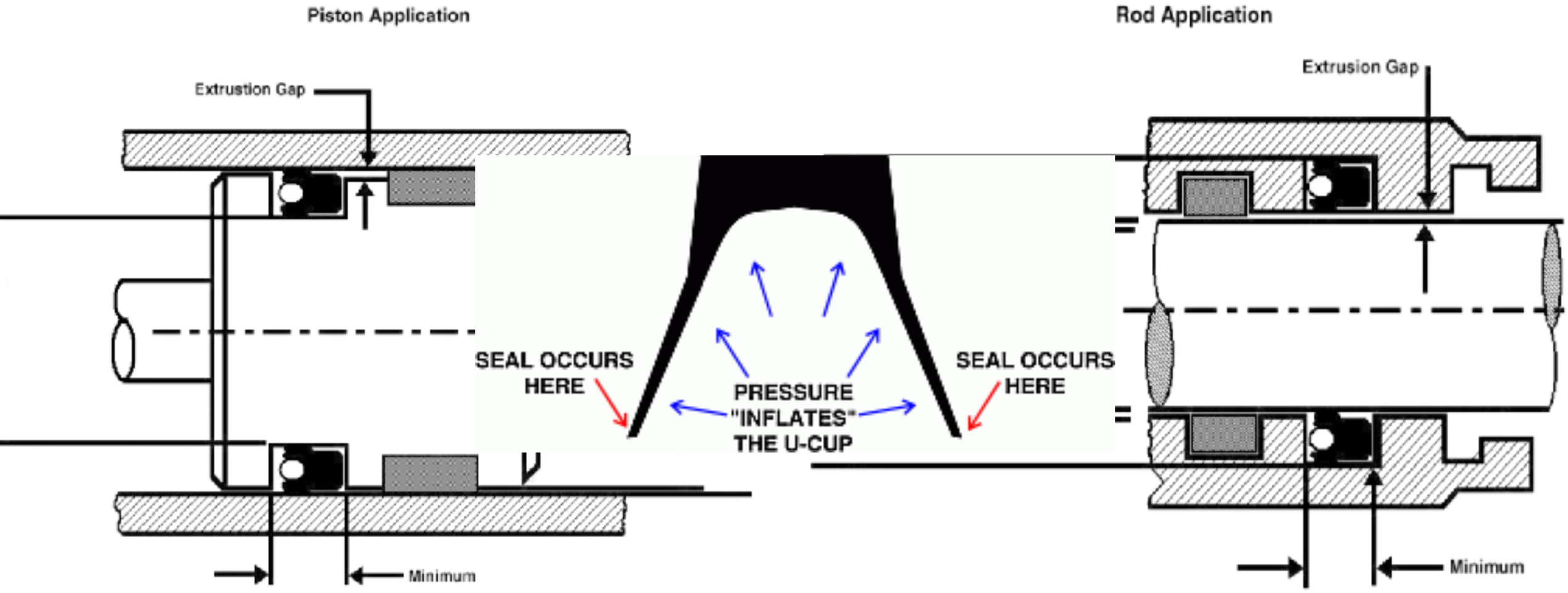


Image: pastomatic.com

Many varieties are available

U-Cup Seals

Piston Cup Seals

Place one of these seals in the groove found around a piston in hydraulic and pneumatic cylinders.

O-Ring Supported U-Cup Seals

These seals are as wide as they are high for uniform contact.

Heavy Duty O-Ring Supported U-Cup Seals

Also called Type B seals, these are taller than standard O-ring-supported U-cup seals for better stability, plus they have beveled lips for a tighter seal.

Rod Wiper Seals

Also known as double-lip and 8800 type wipers, these Buna-N seals have an outer lip that scrapes the shaft and an inner lip that acts as a pressure seal. They are commonly used with JIC cylinders that have rubber rod seals.

Heavy Duty Rod Wiper Seals

Commonly called U-type wipers, these are solid polyurethane for abrasion and tear resistance.

Oil-Resistant Shaft Seals

Commonly used in oil-lubricated applications, these seals have a spring that keeps the lip engaged to prevent leaks.

Double-Lip Oil-Resistant Shaft Seals

Stretch-Fit Oil-Resistant Shaft Seals

These all-rubber seals stretch to assist installation in motors, pumps, and gearboxes, then they bounce back to shape.

Chemical-Resistant Shaft Seals

Made from PTFE, these seals are chemically inert, except to molten alkali metal and fluorines. They have a slippery surface that prevents sticking and keeps friction at a minimum.

Stackable Chemical-Resistant Shaft Seals

Begin with a male and female adapter, then stack as many V-rings between them as you need. Each V-ring adds a layer of sealing force.

Heavy Duty Chemical-Resistant Shaft Seals

Resistant to steam and most chemicals, these heavy duty graphite-reinforced PTFE seals offer excellent wear resistance.

Heavy Duty Double-Lip Oil-Resistant Shaft Seals

These seals are built to handle moderate pressure changes better than the standard double-lip shaft seals.

Low-Pressure Grease-Resistant Shaft Seals

Typically used in low-pressure, grease-lubricated applications, these springless seals do not have the strength to seal oil.

Oil-Resistant Pump Shaft Seals

Flexible Oil-Resistant Pump Shaft Seals

An extended spring on these seals accommodates variations in seal cavity length and pump misalignment.

High-Speed Oil-Resistant Pump Shaft Seals

Able to handle speeds up to 15,000 fpm, these seals are built for high-speed pumps.

Image: sparkfun.com

Packed seals are an old, cheap, and common shaft seal

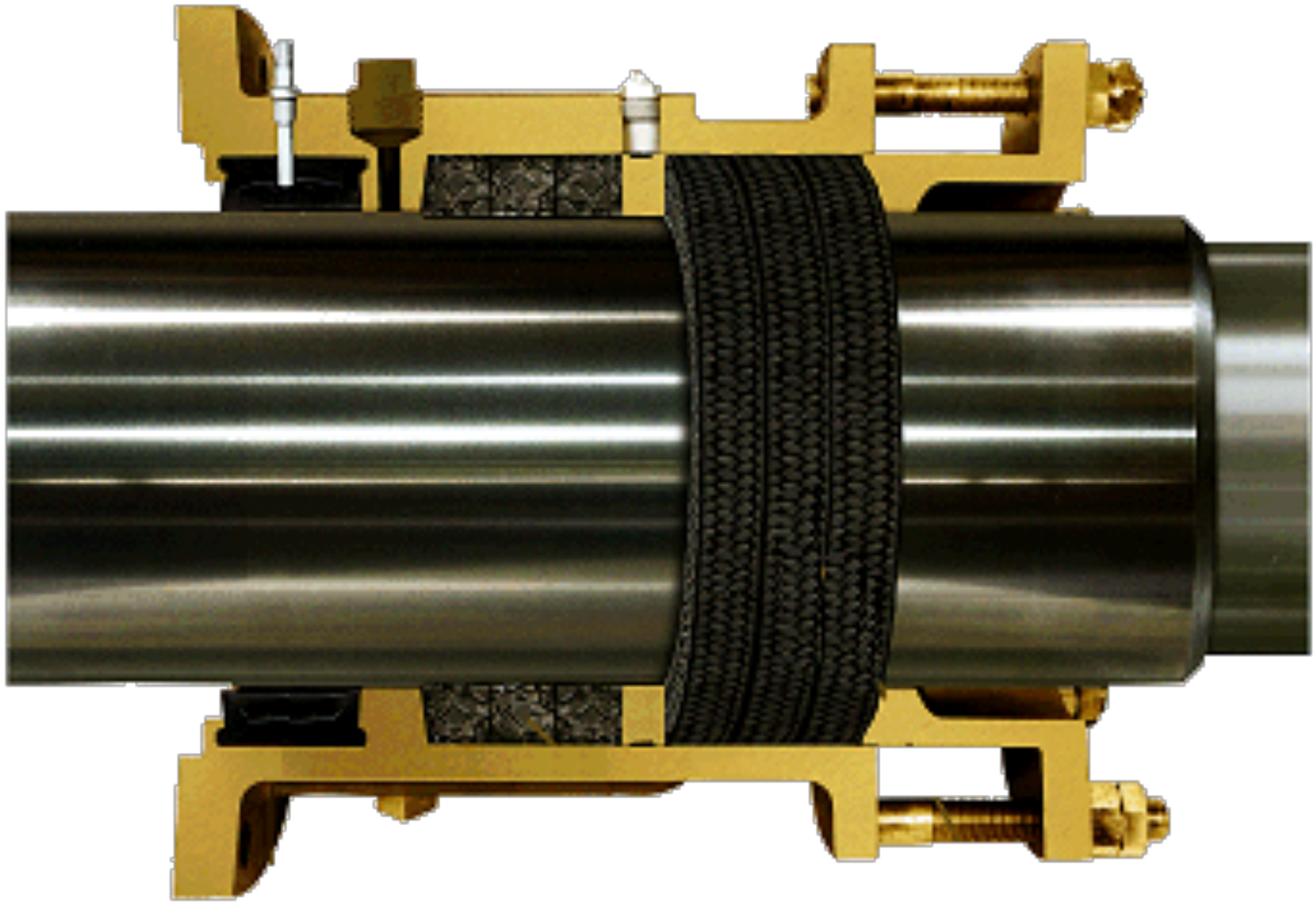


Image: cgedwards.com

Packing cord is available in many sizes and cross-sections

Compression Packing

Chemical-Resistant Packing Seals

These lubricated PTFE fiber seals stand up to most chemicals. Use them in pumps and valves.

Steam- and Chemical-Resistant Packing Seals

Fill irregularities in valve stem with these soft PTFE seals.

Abrasion- and Chemical-Resistant Packing Seals

Aramid and PTFE fibers are blended for seals that resist chemicals and abrasion. Use these seals in pumps.

Hard Chemical-Resistant Packing Seals

These seals are made of PTFE fiber without a lubricant, so they're harder than other chemical-resistant packing seals to handle high-pressure valve applications.

High-Speed Chemical-Resistant Packing Seals

Built for high-speed pump and valve applications, these super-tough seals are made of expanded-graphite yarn with carbon-yarn corners.

Heat-Shielding Chemical-Resistant Packing Seals

Also known as 100% GFO, these expanded PTFE seals contain graphite powder, which dissipates heat away from the shaft and allows pumps to run cool at high speeds.

Food-Grade Chemical-Resistant Packing Seals

Made of FDA-listed material for use with food and beverage, these PTFE seals are lubricated with mineral oil. Use them in pumps.

Steam-Resistant Packing Seals

Use these graphite-impregnated graphite seals for steam applications in pumps and valves.

Wire-Reinforced Steam-Resistant Packing Seals

The Inconel-wire reinforcement in these expanded-graphite yarn seals ensures they keep their shape longer than the High-Flexibility Steam-Resistant Packing Seals. Use them for steam applications in valves.

High-Speed Steam-Resistant Packing Seals

Made of graphite-impregnated carbon, these steam-resistant seals dissipate heat from the shaft to protect pumps and valves when operating at high speeds.

High-Flexibility Steam-Resistant Packing Seals

Offering excellent flexibility, these seals are made of expanded graphite yarn. Use them for steam applications in pumps and valves.

Oil- and Water-Resistant Packing Seals

Made of PTFE-impregnated synthetic fiber, these seals are for use in pumps.

Heat-Shielding Oil- and Water-Resistant Packing Seals

Synthetic yarn that's comparable in strength to aramid is combined with graphite for soft seals that dissipate heat away from the shaft to extend the life of pumps.

Low-Friction Oil- and Water-Resistant Packing Seals

These seals require lighter packing pressure than standard oil- and water-resistant packing seals, so they cause less friction and reduce shaft wear. They're made of graphite-impregnated aramid fiber and are for use in pumps and valves.

Ultra-Sealable Oil- and Water-Resistant Packing Seals

Our most compressible packing seals, these require less pressure than any other to make an effective seal. They're made of lubricated PTFE-impregnated aramid fiber and are for use in pumps.

Premium Steam- and Chemical-Resistant Packing Seals

Made of Gore-PTFE, these premium seals are soft, so they conform to fill irregularities caused by wear in valve stems.

Abrasion-, Oil-, and Water-Resistant Packing Seals

The most abrasion resistant of all our packing seals, these are made of PTFE-impregnated aramid fiber that has been saturated in a lubricant. They are for use in pumps.

Candle Wick Packing Seals

Super thin and flexible, these cotton yarn seals fit into tight spaces, such as in faucets.

Packing Seal Tape

For use in valves and pumps, this thin, flexible tape is made from high-purity graphite with no fibers or binders that could contaminate your process line.

Packing Seal Lubricating Rings

Install between layers of packing seals to ensure lubricants are distributed evenly. These lubricating rings are also known as lantern rings.

Image: mcmaster.com

Many experiments happen in vacuum systems which require special sealing techniques

Image: lesker.com

Copper gaskets on flat flanges is the most common

Image: eBay.com

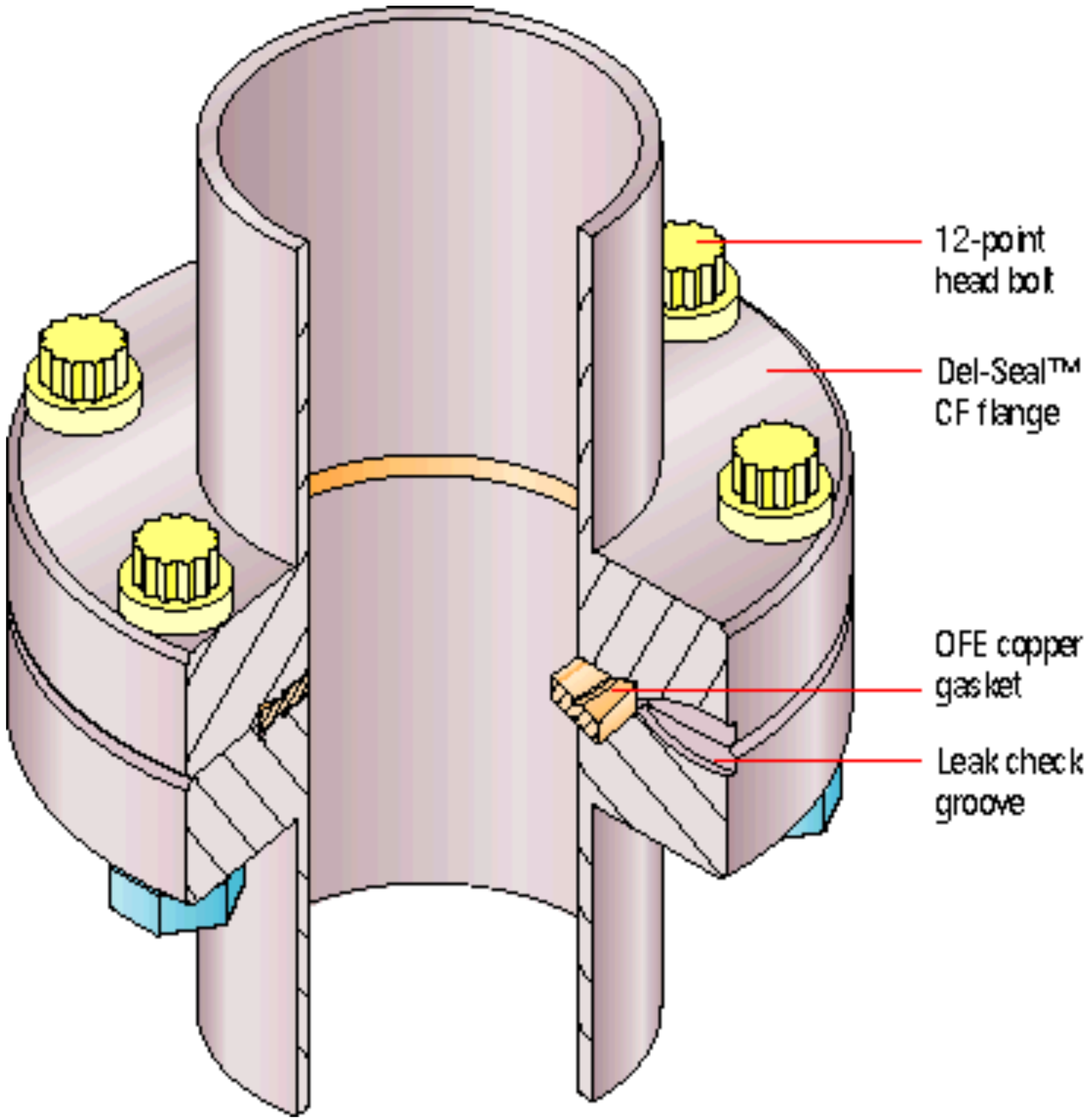


Image: mdcvacuum.com

Threaded seals are used for pressurized pipes and pathways

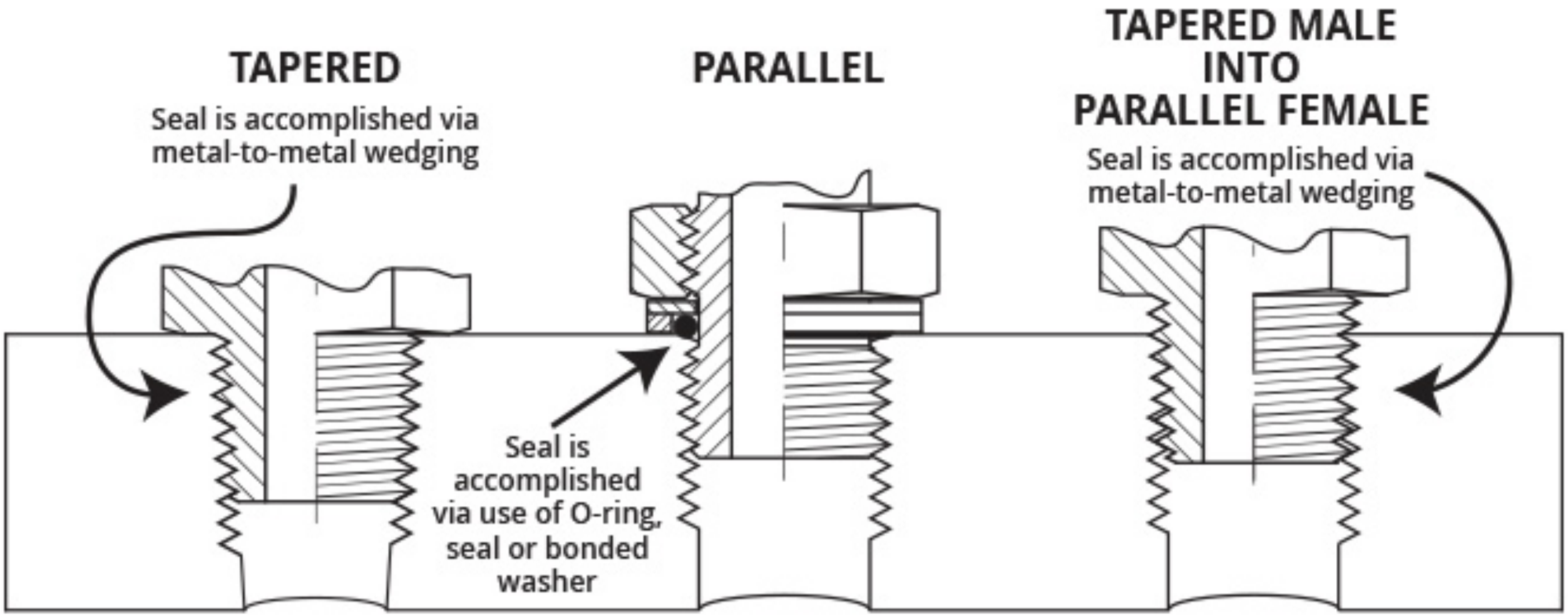


Image: adaptall.com

Teflon tape is a common seal

Image: wikipedia.com

Pipe dope is a gel alternative

Image: familyhandyman

Swagelok is a common ferruled pressure fitting

Image: swagelok.com

Fully insert the tube into the fitting and against the shoulder; rotate the nut finger-tight.

High-pressure applications and high safety-factor systems:
Further tighten the nut until the tube will not turn by hand or move axially in the fitting.

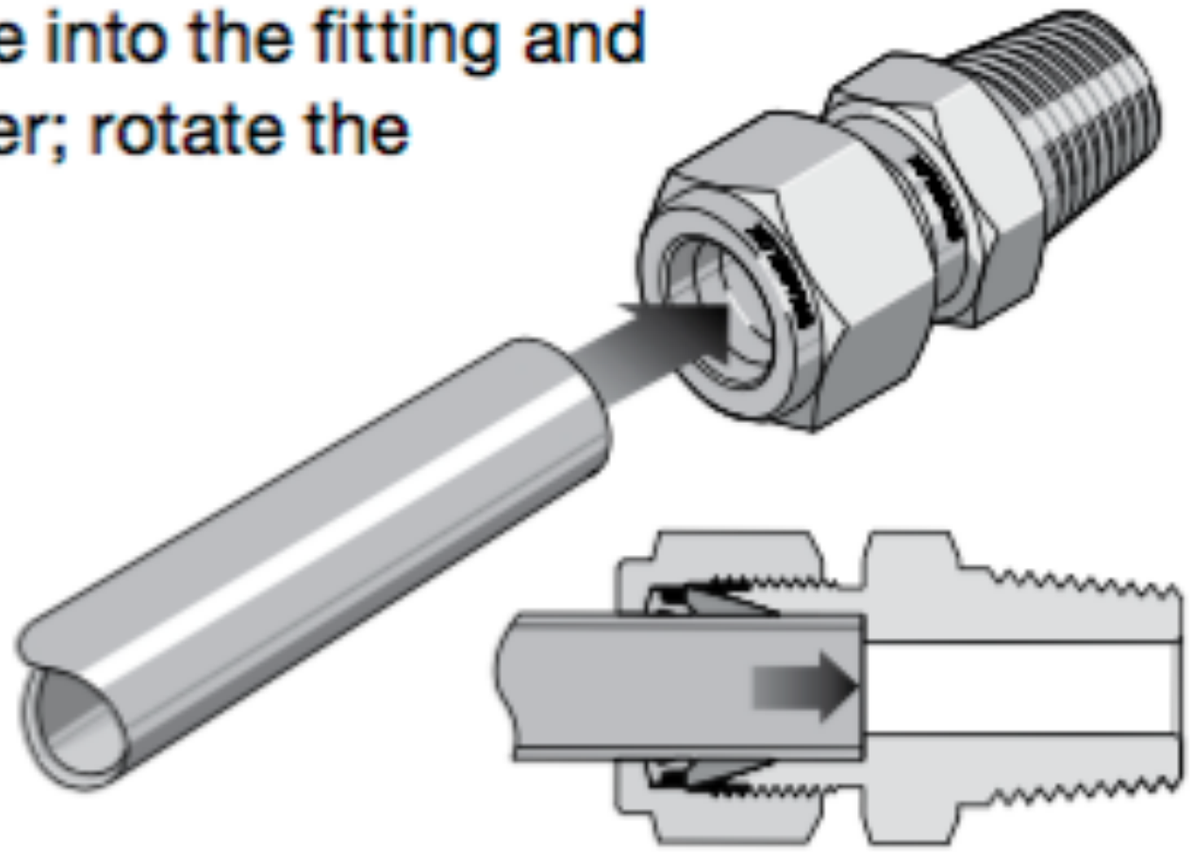


Image: swagelok.com

Mark the nut at the 6 o'clock position.

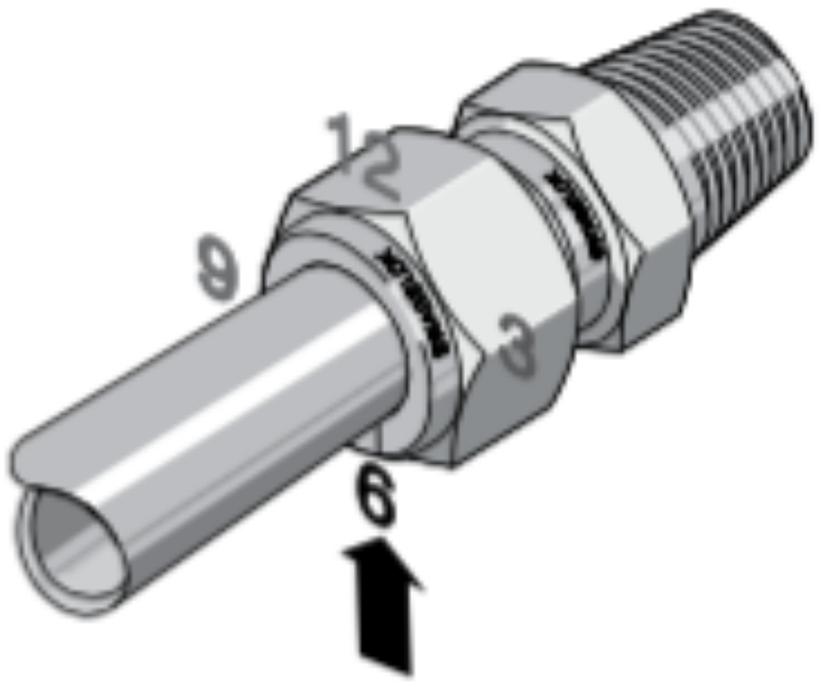


Image: swagelok.com

While holding the fitting body steady, tighten the nut one and one-quarter turns to the 9 o'clock position.

For 1/16, 1/8, and 3/16 in.; 2, 3, and 4 mm tube fittings, tighten the nut three-quarters turn to the 3 o'clock position.

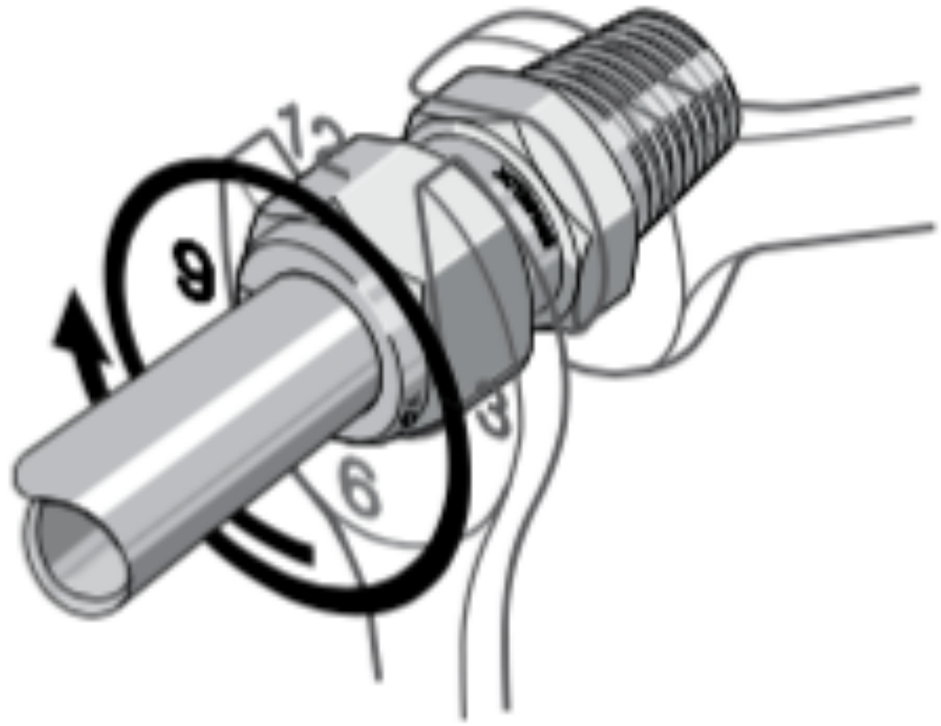
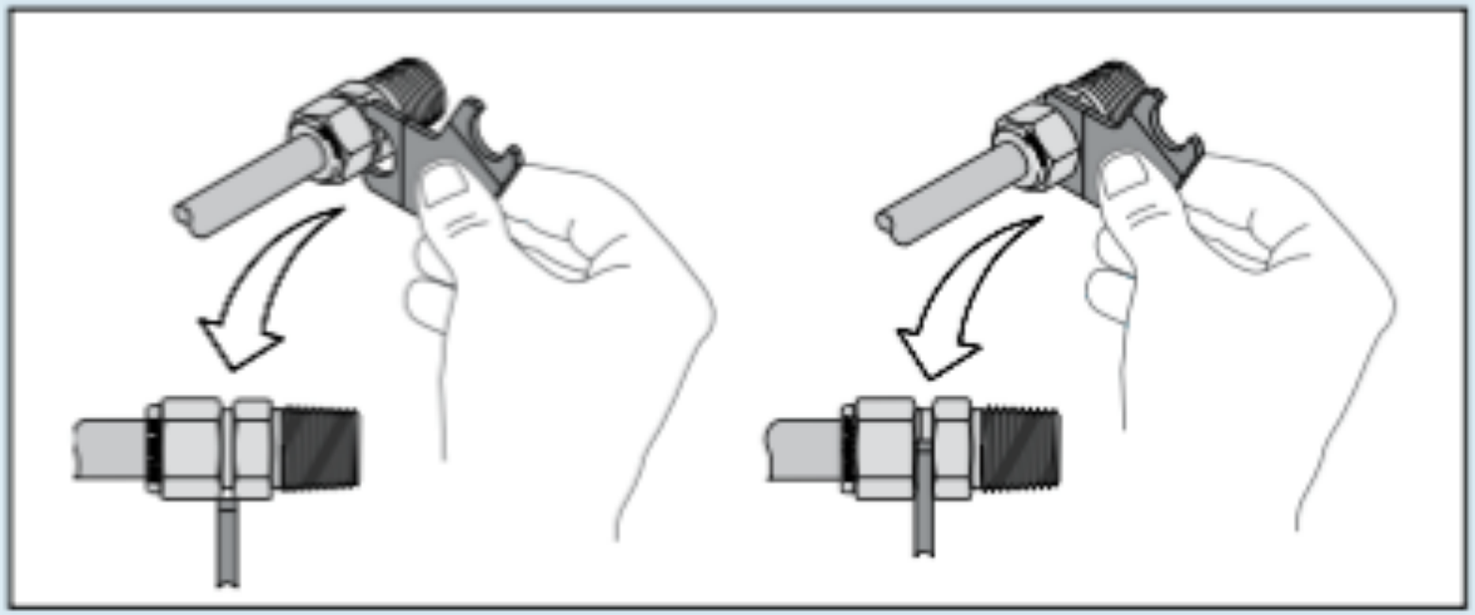


Image: swagelok.com

Gaugeability

On initial installation, the Swagelok gap inspection gauge assures the installer or inspector that a fitting has been sufficiently tightened.

Position the Swagelok gap inspection gauge next to the gap between the nut and body.



If the gauge **will not** enter the gap, **the fitting is sufficiently tightened.**

If the gauge **will** enter the gap, **additional tightening is required.**

⚠ **Always depressurize a system before adjusting the tightness of a tube fitting connection.**

Image: swagelok.com

There are many glues/epoxies out there, and using the correct one is essential

Image: Ben Krasnow

JB Weld is a handy multi-material bonding agent

Image: homedepot.com

Hot glue is surprisingly useful as a vibration adsorbing hold down

Image: wikipedia.com

Assignment: Project Parts Lists

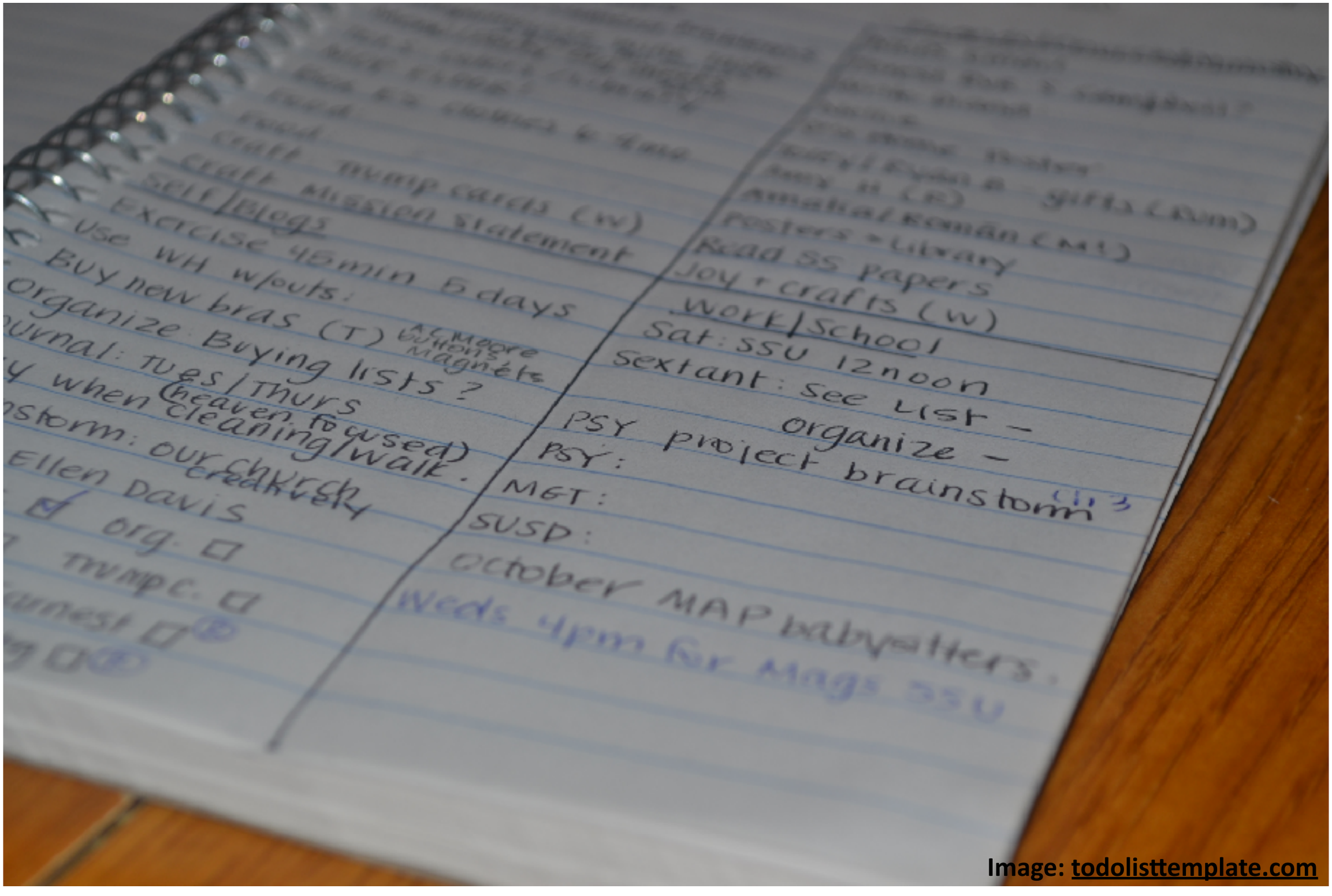


Image: todolisttemplate.com

DUE: 10/6/16

Activity: Swagelok Demo

An Installer's
Pocket Guide
for Swagelok®

Tube Fittings