Mi a vákuum?

- Gyakorlati szempontból: olyan tér, amelynek nyomása kisebb, mint a környezeté (esetleg: mint az *átlagos légnyomás*)

- Elméleti szempontból: olyan tér, amelyben a közepes szabad úthossz (λ: két ütközés közötti átlagos távolság) nagyobb, mint az edény „karakterisztikus mérete”

Nyomásegységek

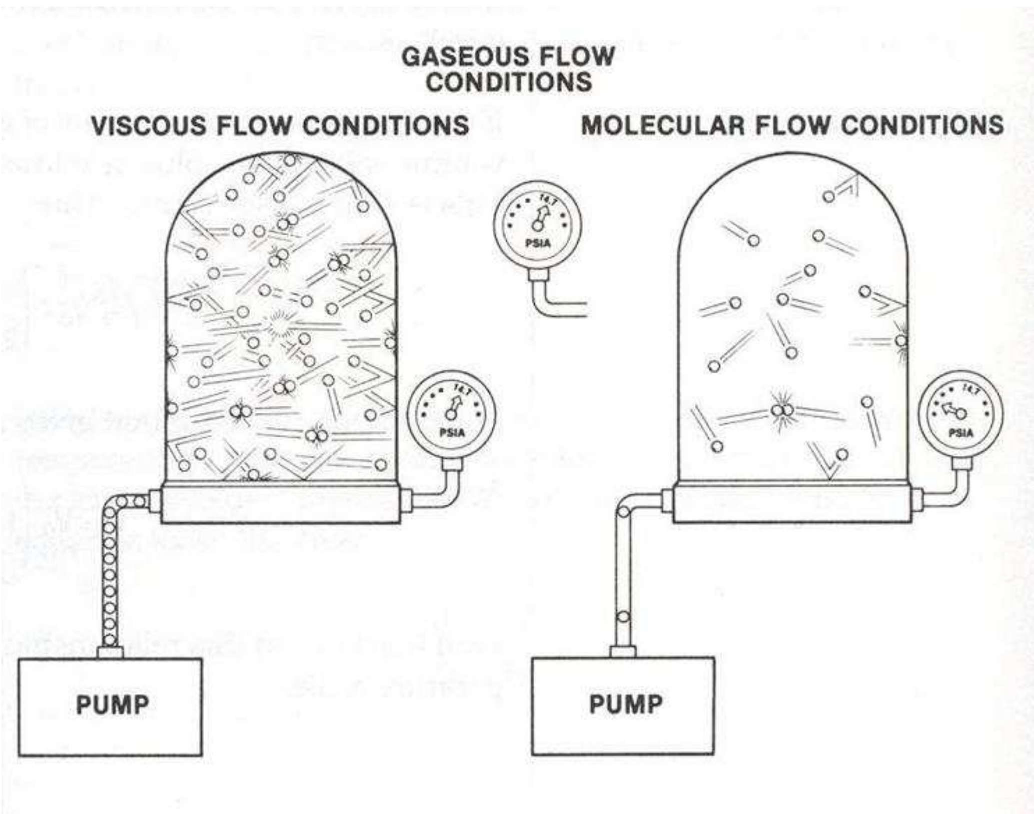
- SI: 1 Pa (≡1 N/m2)
- 1 bar=105 Pa (1 mbar=1 hPa ≈ 1/1000atm)
- 1 atm=1,013 bar
- 1 torr=1 mmHg=1/760 atm
- (1 psi (psia, lbs)= 1/14,7 atm)
- (1 inchHg=1/30 atm)

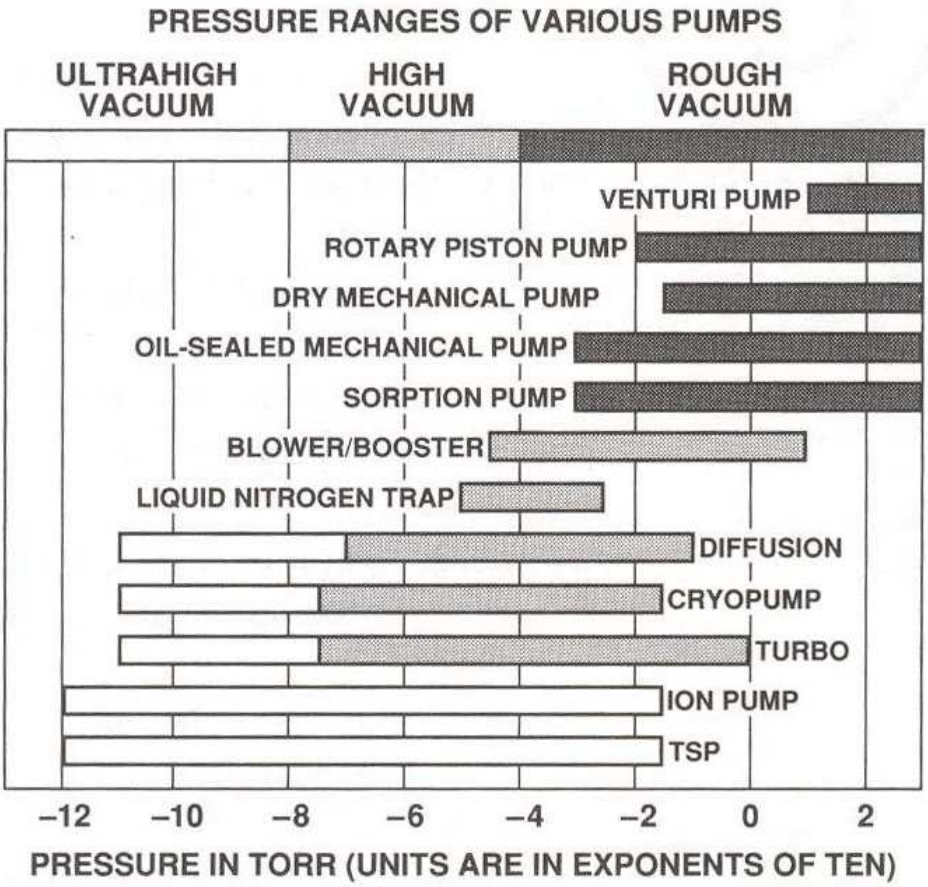
A vákuumrendszerek csoportosítása I.

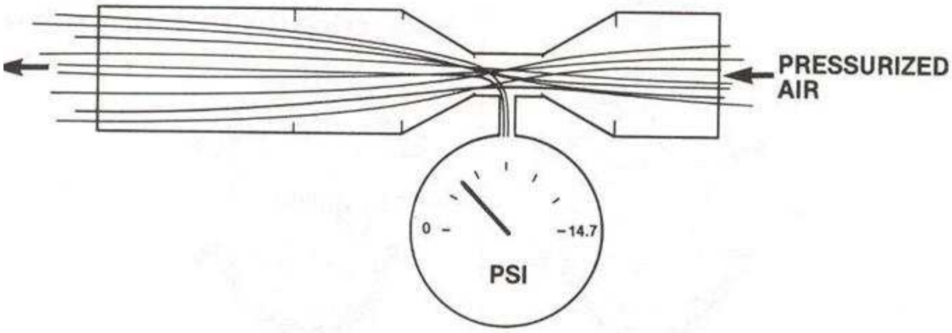
Elő(durva)vákuum	Nagyvákuum	Ultranagy-vákuum
1 atm>p>10^{-3} mbar	10^{-4}>p>10^{-8} mbar	p<10^{-9} mbar
„sok” ütközés	„kevés” ütközés	fallal is ritka
term. egyensúly	hővez. „kicsi”	ua.
kémiai reakciók	csak unimol.	felületi reakciók speciális berendezések

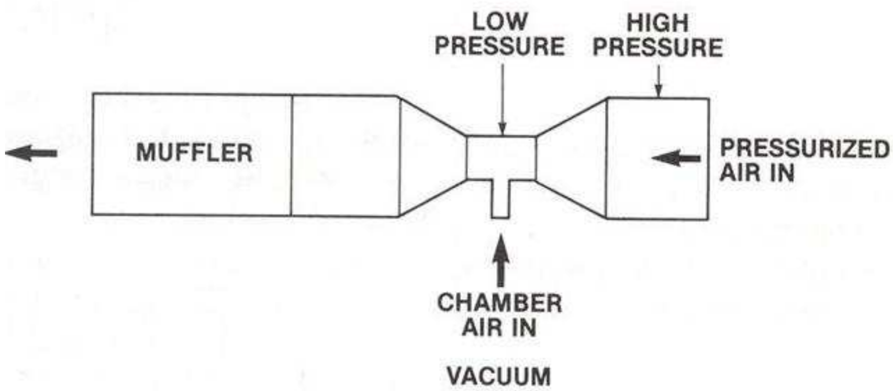
A vákuumrendszerek csoportosítása II.

N_2 , 300K	Atmoszféra	Elővákuum	Nagyvákuum	Ultranagy-vákuum	
Nyomás (mbar)	10^{3}	10^{-3}	10^{-6}	10^{-10}	
db-sűrűség (db/cm^3)	$2\cdot10^{19}$	$2\cdot10^{13}$	$2\cdot10^{10}$	$2\cdot10^{6}$	~p
szabad úthossz (m)	$7\cdot10^{-8}$	$7\cdot10^{-2}$	70	$7\cdot10^{5}$	~1/p
mol. ütk. (/s·cm^3)	$2\cdot10^{29}$	$2\cdot10^{17}$	$2\cdot10^{11}$	$2\cdot10^{5}$	~p^2
ütközési valószínűség (<1m)	1	$1-6\cdot10^{-7}$	$1{,}4\cdot10^{-2}$	$1{,}4\cdot10^{-6}$	
fallal való ütk. (/s·cm^2)	$3\cdot10^{23}$	$3\cdot10^{17}$	$3\cdot10^{14}$	$3\cdot10^{10}$	~p
monoréteg kialakulása (s)	10^{-9}	10^{-3}	1	10^{4}	~1/p

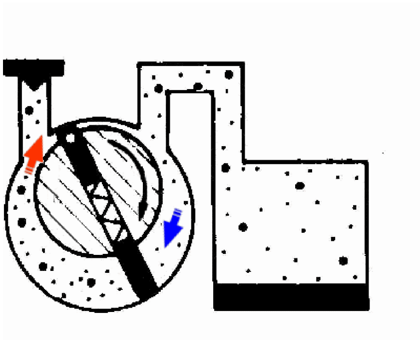








Rotációs szivattyú



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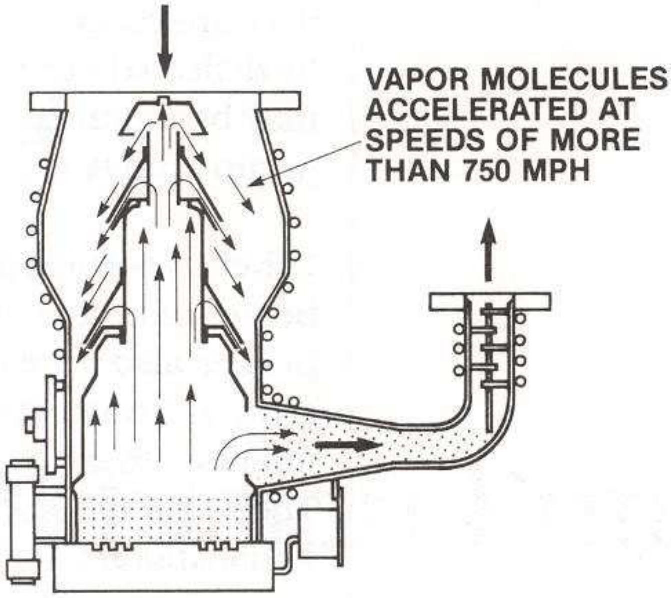
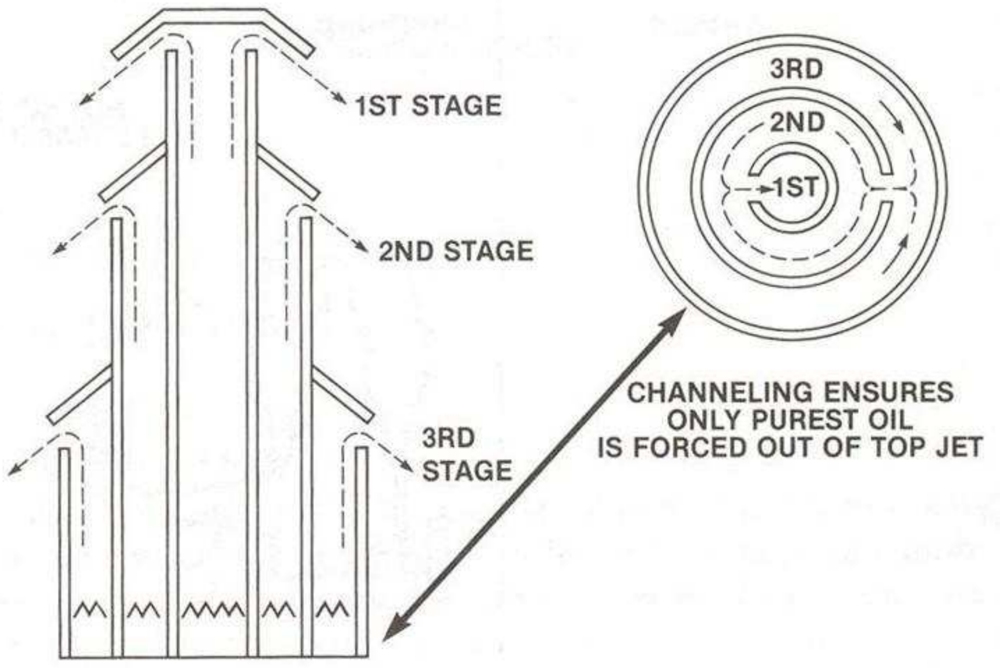
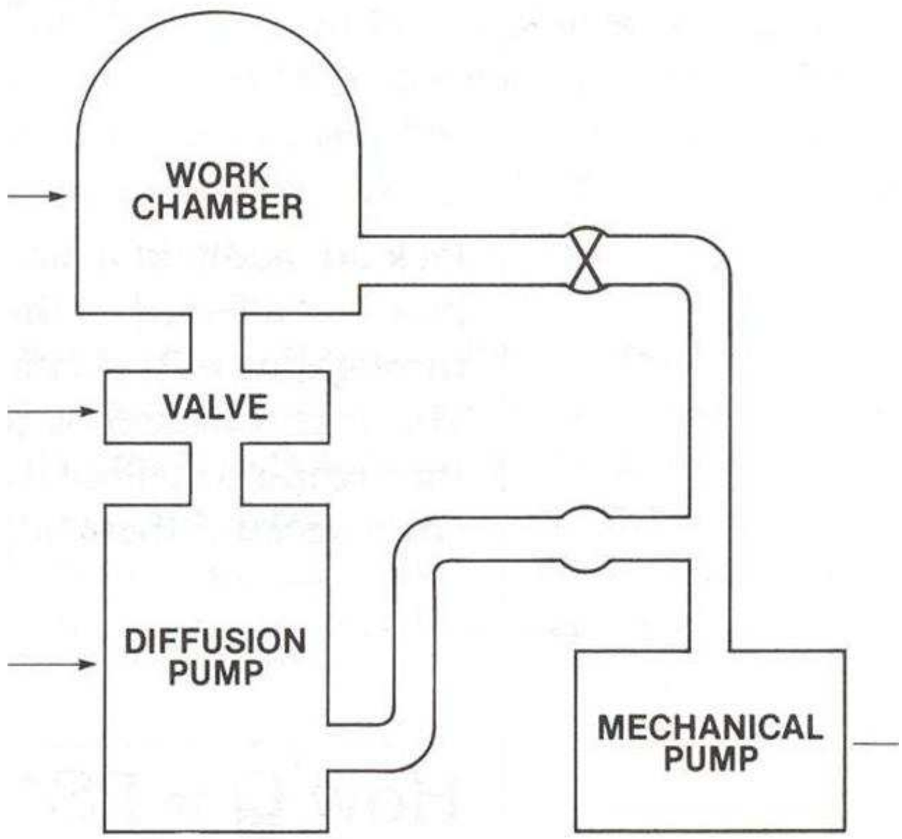


A diffúziós szivattyú II.

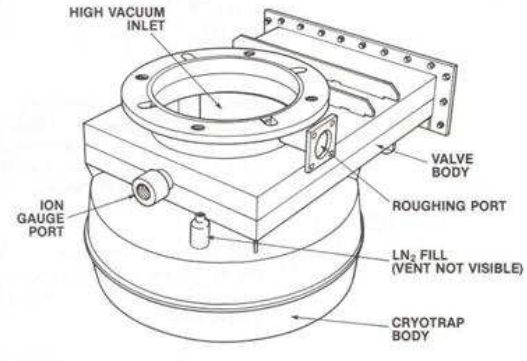


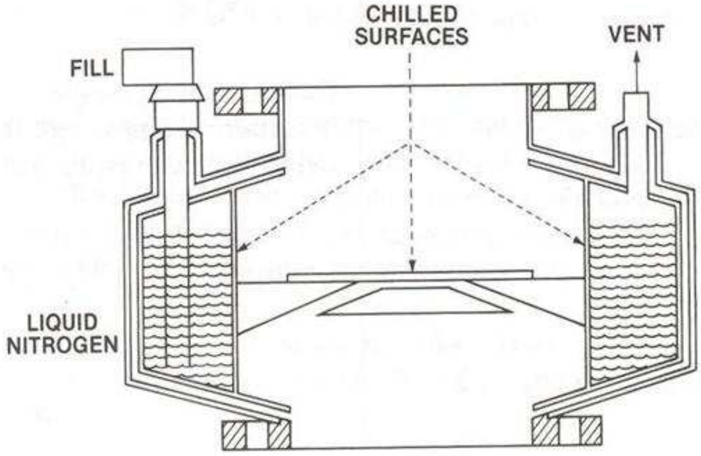


A krioszivattyú

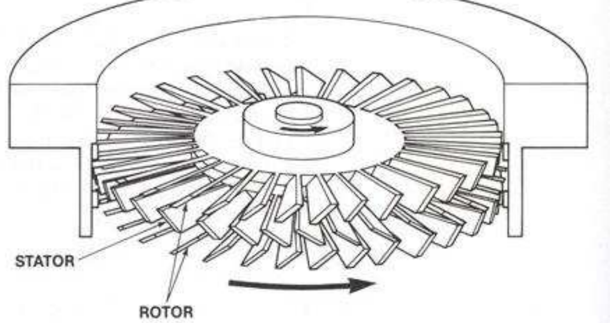
Cryotrap

Cryotraps also aren't designed to be pumps. They do act as a selective pump for certain gases-- namely, water vapor, carbon dioxide and most solvents. Cryotraps also restrict pump fluid backstreaming while giving reasonable conductance figures. A cryotrap is often combined with a high vacuum valve in a single high conductance unit. (See table.)





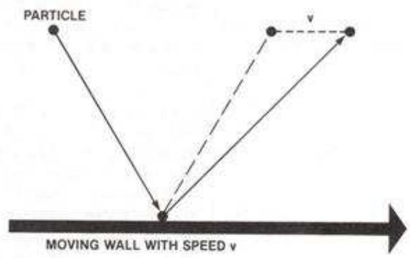
A turbomolekuláris szivattyú



How the Pump Works

Pump Operation

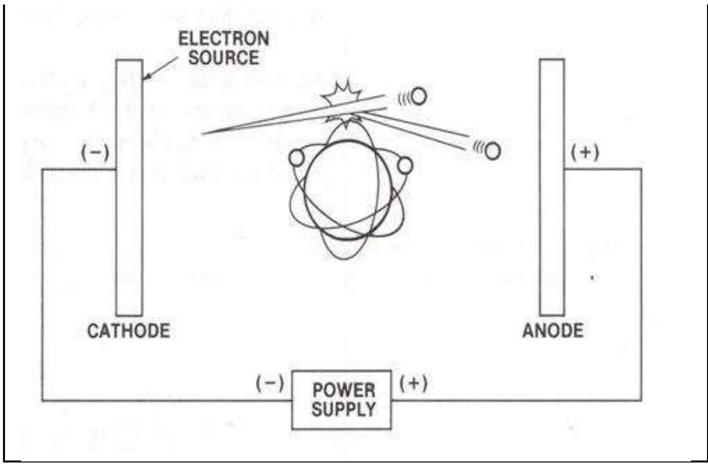
When a gas molecule strikes a moving surface, it keeps its own speed. It also picks up a little more speed and a slightly different direction from the contact with the moving surface. By this process, the movement of molecules can be directed, and pumping takes place.

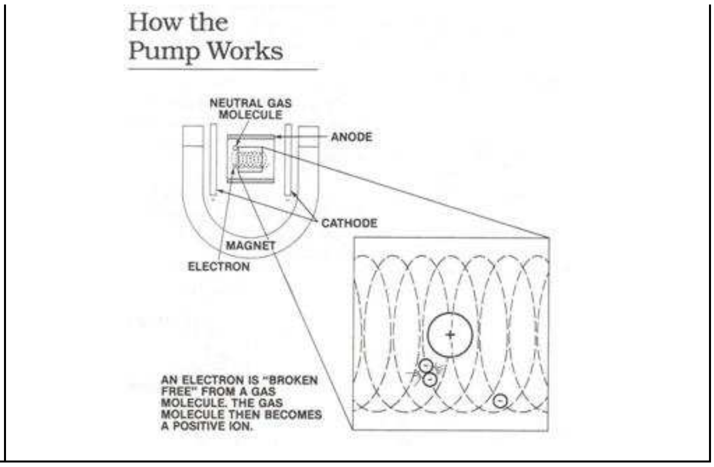


PRINCIPLE OF THE TURBOMOLECULAR PUMP

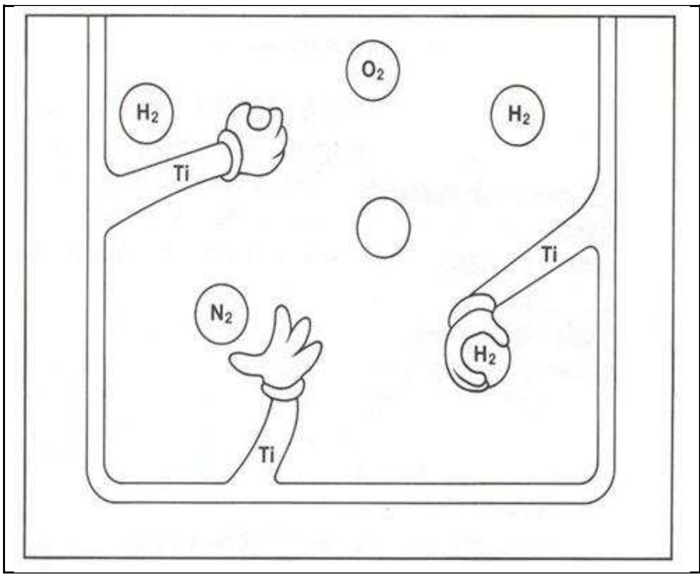
The turbo pump works much like this; however, it adds blades to the moving surface plus a close-coupled stator. The stator also has blades. Each blade, when moving, will give some momentum to the gas molecules it hits. Each rotor blade, then, acts as a molecular pump. The result? Much greater momentum, speed and direction are given to gas molecules entering this pump.

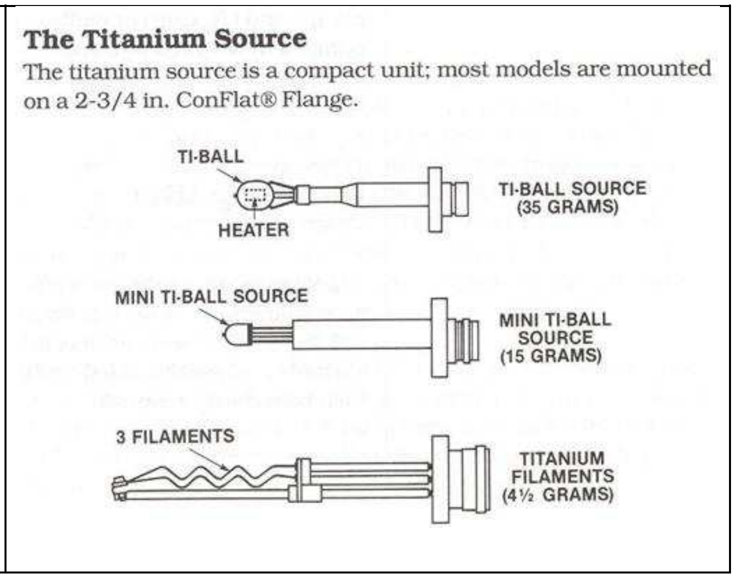
Az ionizációs szivattyú





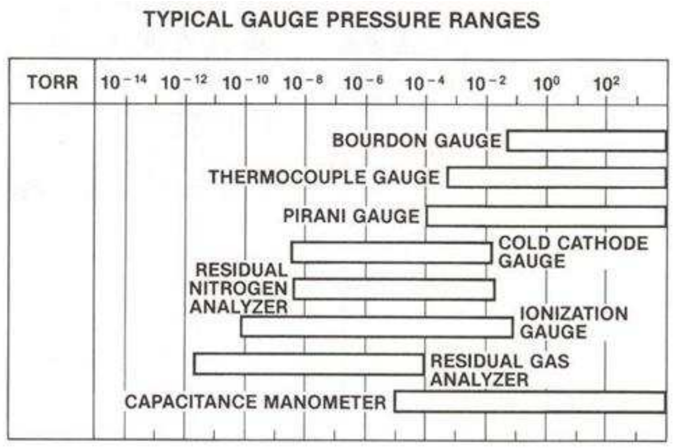
A titánszublimációs szivattyú



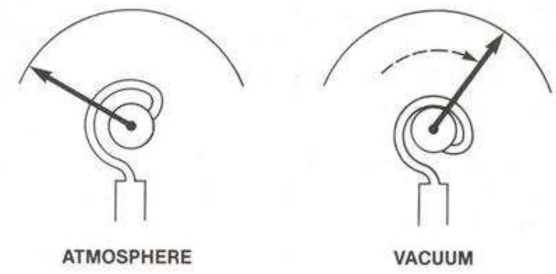


A vákuum mérése

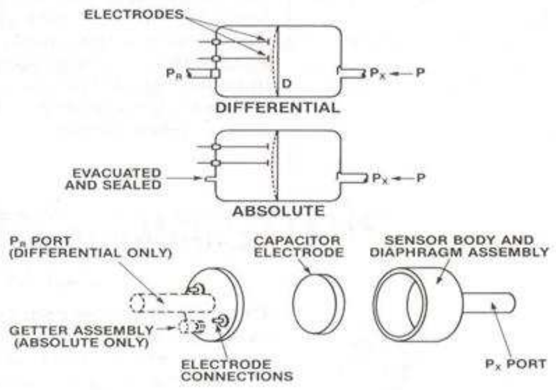
- Higanyos manométer (nyitott illetve zárt)
- Bourdon-csöves manométer
- Kapacitív manométer
- Termopáras vákuummérő
- Pirani vákuummérő
- Ionizációs vákuummérő
- Hidegkatódos vákuummérő
- MS



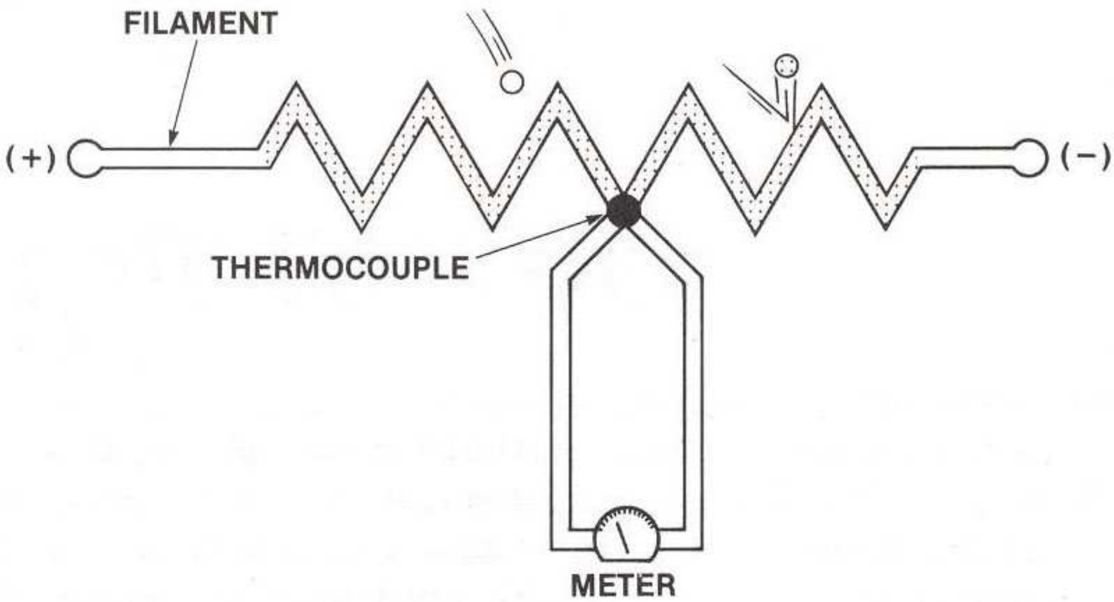
Bourdon-cső



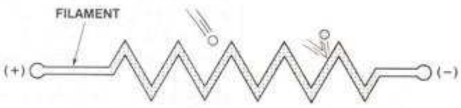
Kapacitív manométer



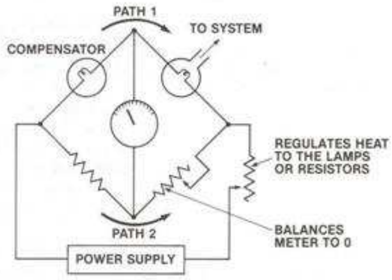
THERMOCOUPLE GAUGE PRINCIPLE



A piarani vákuumérő



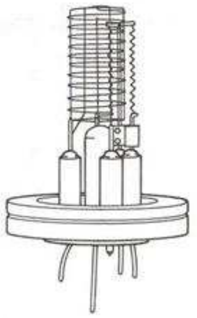
In the Pirani gauge, gas molecules also conduct heat away from a hot filament. In this gauge, we depend on the change in resistance as the temperature changes. The temperature change causes a change in the filament resistance. The filament is part of a bridge circuit that drives the pressure meter. A simplified explanation of this circuit is given below.

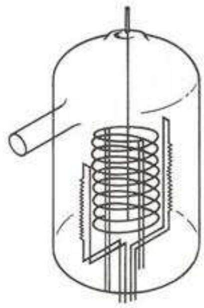


In a balanced bridge circuit, the current flow in Path Number One equals the current flow in Path Number Two. A meter, placed in the center as shown, indicates zero. When heat is conducted away from the filament, its resistance is changed, and this balance is upset. This unbalance develops a voltage difference at the meter connections, and current flows through it. Again, the meter is calibrated in pressure units. The hotter the filament, the more resistance it has. The compensator, which is a very similar filament, remains at a constant temperature and pressure. Therefore, its resistance is relatively constant. Ambient temperature changes do affect the gauge significantly below 10^{-3} torr.

Ionization Gauge

The ionization gauge works on yet another property of molecules. They use the property that if you can energize an atom or molecule, it may lose an electron and become charged. These charged molecules (ions) can be attracted and "counted" as they pick up an electron to become neutral again. This is very similar to the way the ion pump works. Let's look at how this is accomplished as we discuss the gauge.





The ionization gauge is perhaps unique in that it can be used over a pressure range spanning ten orders of magnitude (10^{-2} to 10^{-12} torr). It is commonly used over seven orders of magnitude (10^{-3} to 10^{-10}) and expected to be within 30% to 50% of the correct value over that range. This makes it the most widely used gauge for high vacuum work. Models include both glass and metal envelopes as well as "nude" gauges which mount directly in the chamber.