VIVEKANAND COLLEGE, KOLHAPUR (EMPOWERED AUTONOMOUS)

VACUUM PUMPS

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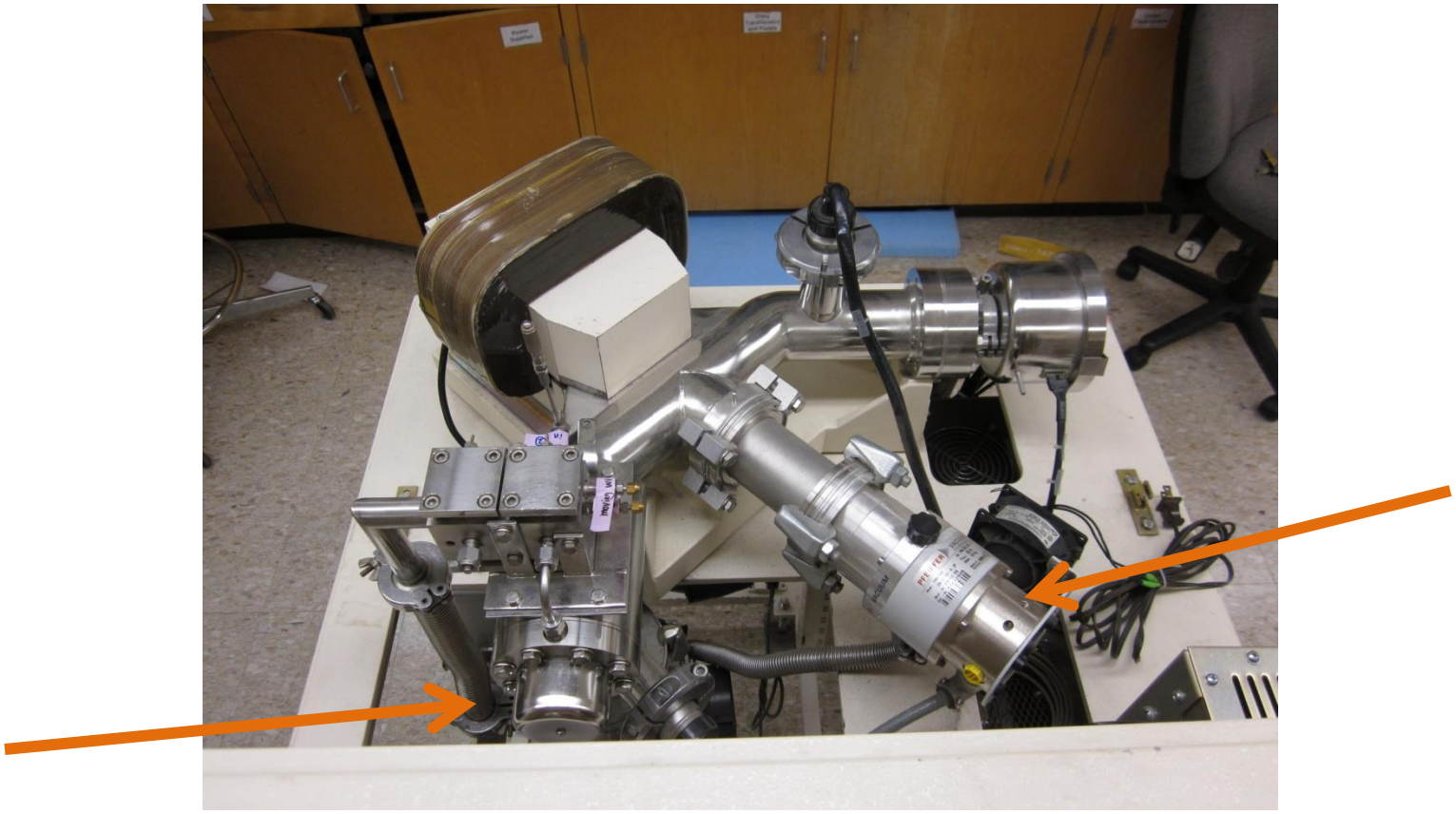
Vacuum Pumps



Basics

- **vacuum**
  - noun 1. a space entirely devoid of matter.
  - 2. an enclosed space from which matter, especially air, has been partially removed so that the matter or gas remaining in the space exerts less pressure than the atmosphere (opposed to plenum).
- Exhaust pressure= atm generally
- Base pressure = pressure pump gets down to
- Compression ratio = exhaust/base= big number
- Boyles Law $P_1V_1=P_2V_2$

History of vacuum pumps

- Suction pumps go way back (Romans, Byzantine empire, etc)
- Major improvements on the idea of vacuum made by Galileo, Evangeilist Torricelli, and Blaise Pascal
- Otto von Guericke made first pump and famous for Magdeburg hemispheres experiment

Types of Vacuum pumps

- Positive displacement pumps
  - Expand a cavity, seal, exhaust, repeat
- Momentum transfer pumps (molecular pumps)
  - High speed liquids or blades to knock gasses around
- Entrapment
  - Create solids or adsorbed gases (cryopumps)

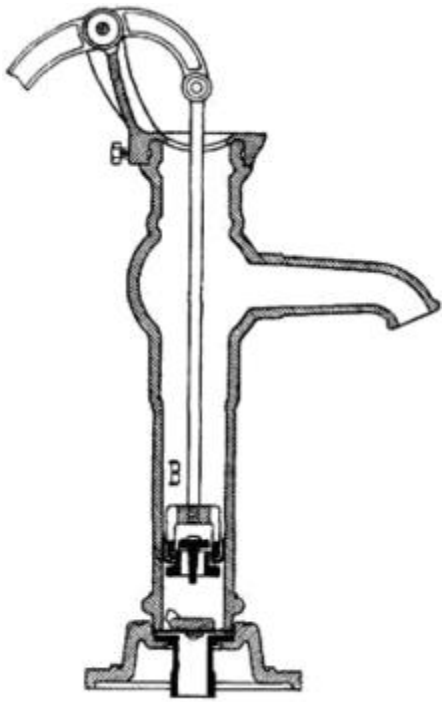
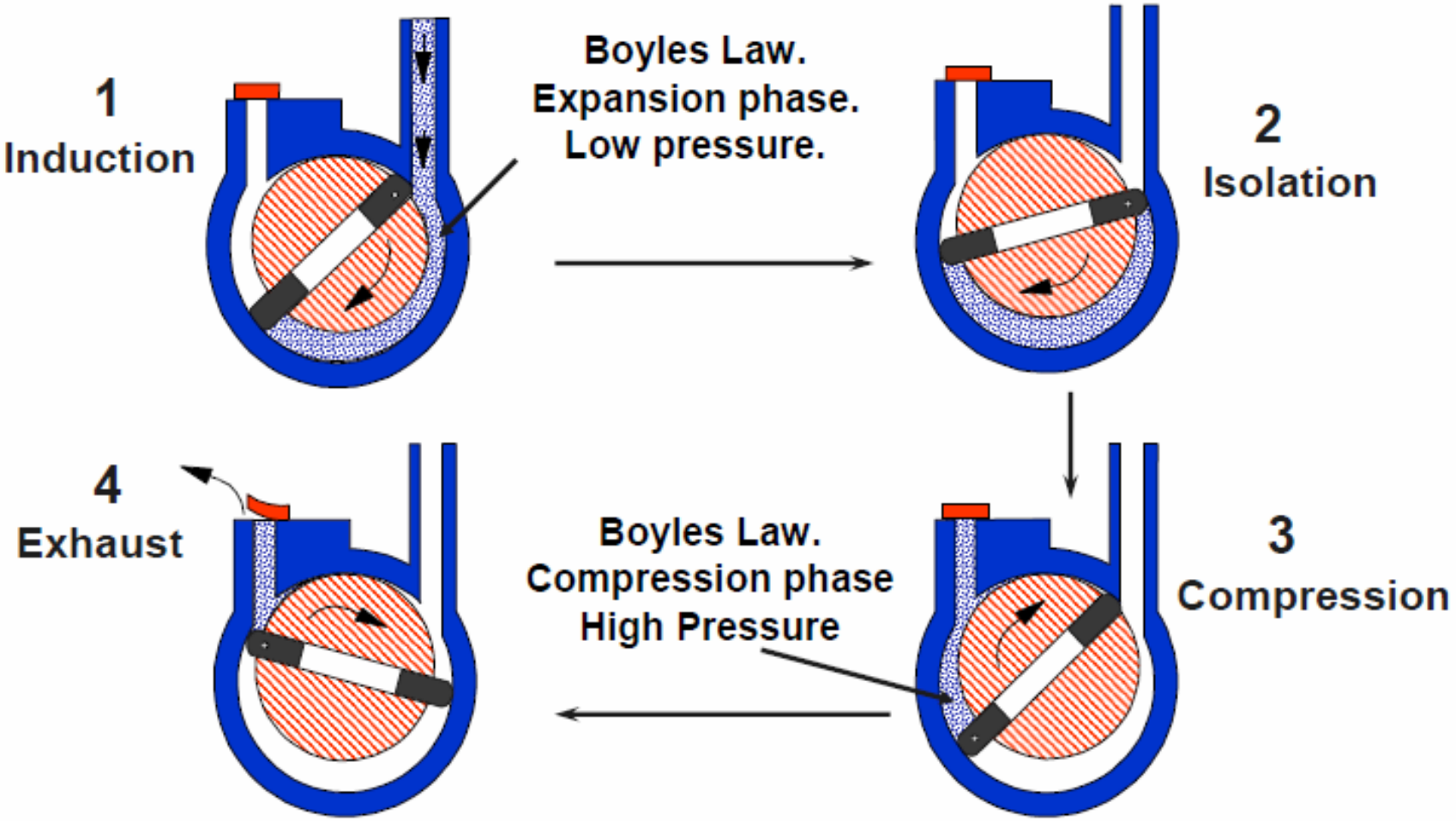


Fig. 9.

Roughing pumps

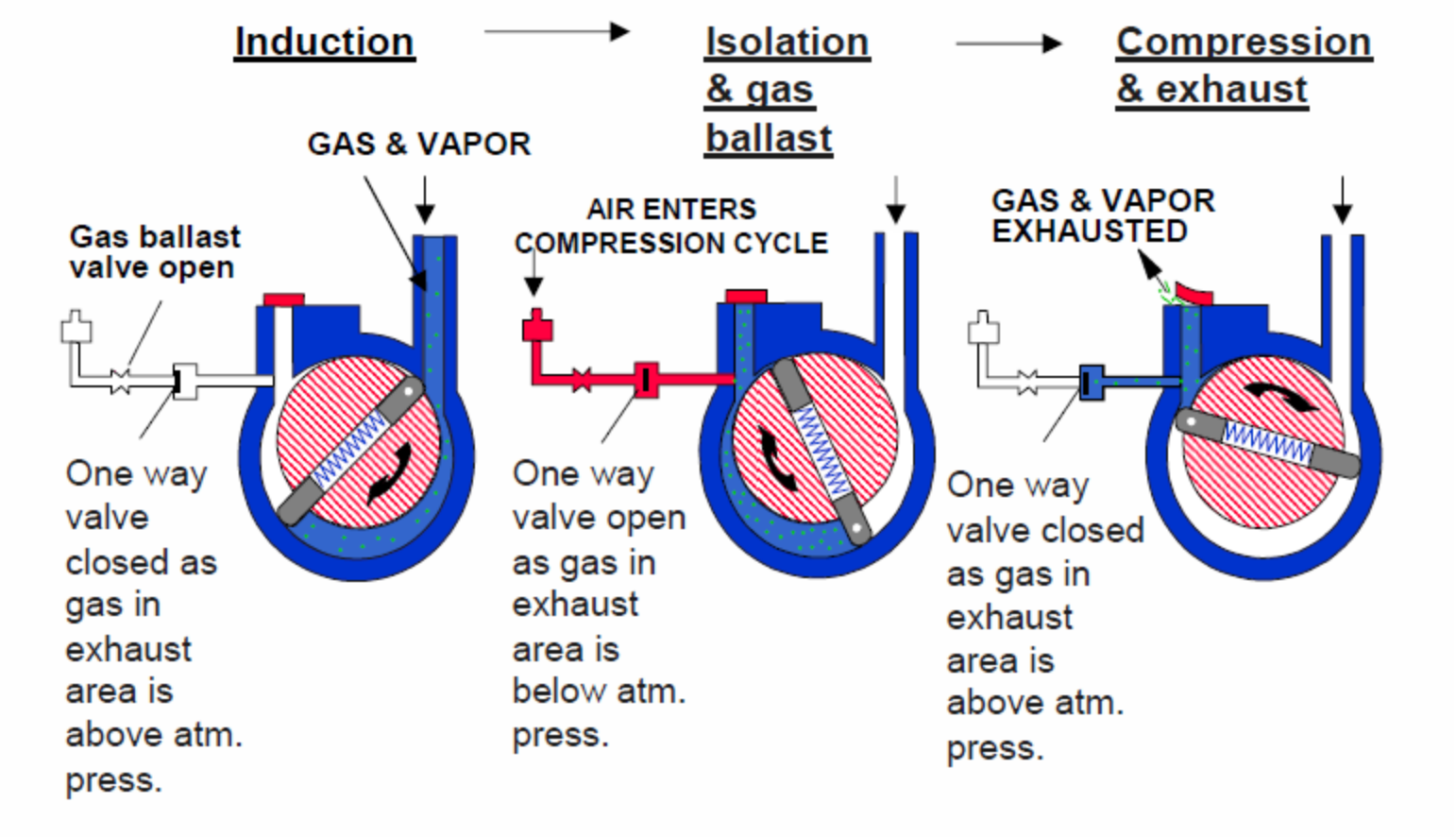
- Pumps from atm pressure down to rough vacuum (0.1 Pa, $1X10^{-3}$ torr)
- Necessary because turbo pumps have trouble starting from atmospheric pressure
- Usually Rotary Vane pumps
- Can have oil or not

Rotary vane pumps



Rotary vane pumps

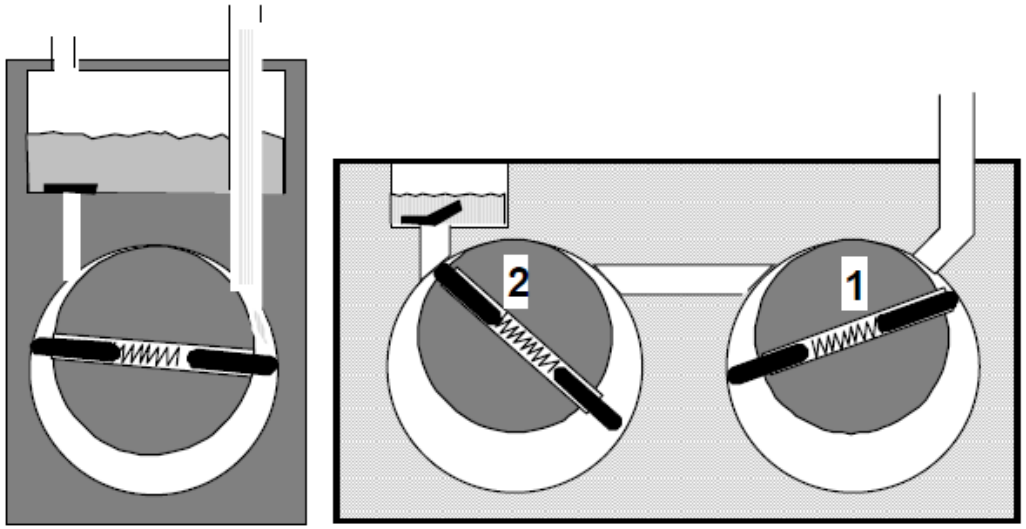
Condensation of vapor in the gas mixture is a problem with these pumps. Solution **Ballasting**



Works by increasing the gas/vapor ratio (air is mostly gas)
As you might imagine this interferes with the final vacuum

Types

- One stage or two stage



- Belt Drive or direct drive

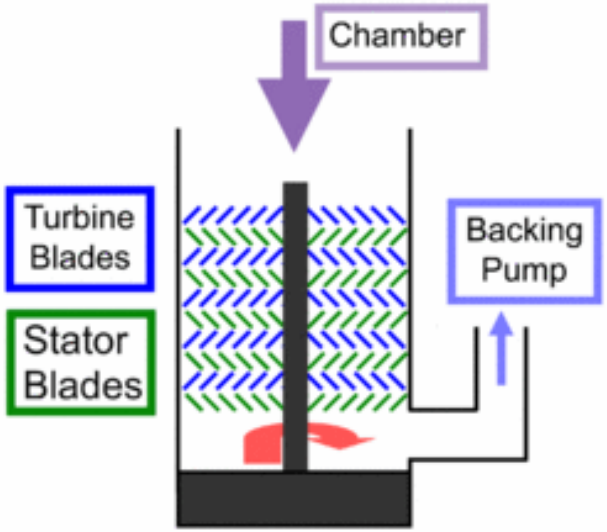
Slower 400-600 RPM
Bigger, Cheaper

Faster 1500 to 1725 RPM

Smaller, lighter

Turbo (molecular) pumps

- Gas molecules interact with spinning blades and are preferentially forced downward



- High vacuum (10^{-6} Pa) requires rotation of 20,000 to 90,000 revolutions per minute
- Generally work between 10-3 and 10-7 Torr
- Ineffective before gas is in “molecular flow”

Turbo (molecular) pumps

- Options:
  - Bearings: Ceramic (oil lubricated) Magnetic (supported w/out physical contact), also hybrid
  - Rotor options (Blade configuration)
  - Cooling (air or water)

Units of pressure for your notes

	Pascal (Pa)	Bar (bar)	Technical atmosphere (at)	Atmosphere (atm)	Torr (Torr)	Pound-force per square inch (psi)
1 Pa	≡ 1 N/m^2	10^{-5}	1.0197×10^{-5}	9.8692×10^{-6}	7.5006×10^{-3}	145.04×10^{-6}
1 bar	10^5	≡ 10^6 dyn/cm^2	1.0197	0.98692	750.06	14.5037744
1 at	0.980665×10^5	0.980665	≡ 1 kgf/cm^2	0.96784	735.56	14.223
1 atm	1.01325×10^5	1.01325	1.0332	≡ 1 atm	760	14.696
1 Torr	133.322	1.3332×10^{-3}	1.3595×10^{-3}	1.3158×10^{-3}	≡ 1 Torr; ≈ 1 mmHg	19.337×10^{-3}
1 psi	6.895×10^3	68.948×10^{-3}	70.307×10^{-3}	68.046×10^{-3}	51.715	≡ 1 lbf/in^2