

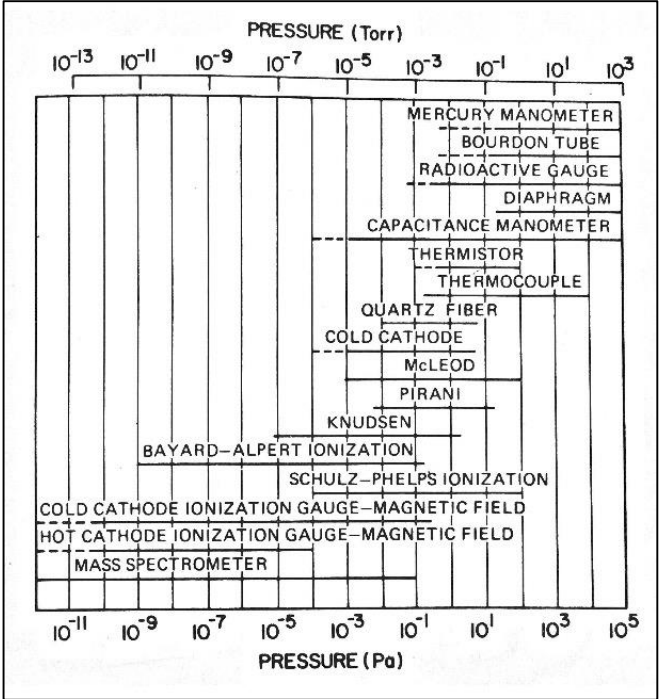
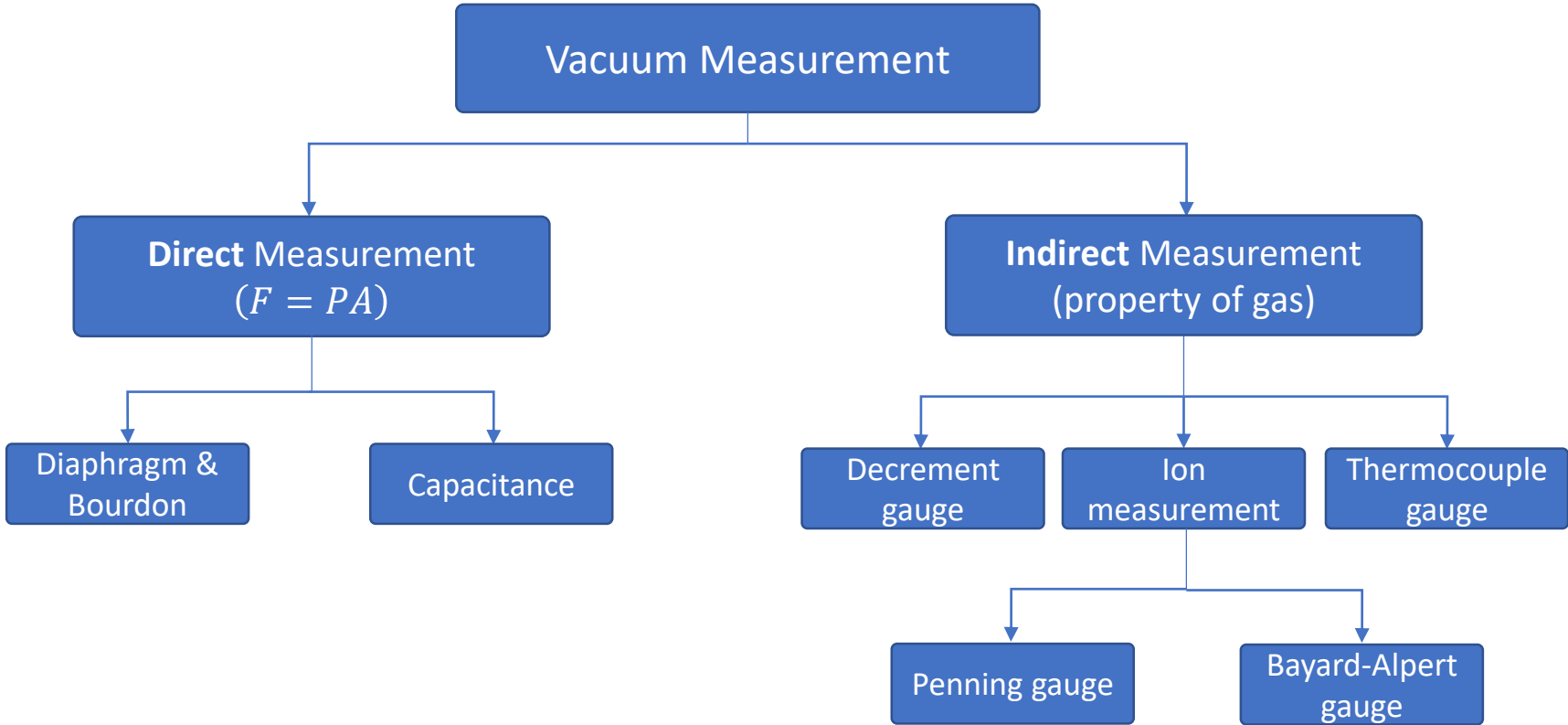
Vacuum Technology III: Pressure Measurement

Corbyn Mellinger

Xu Group Meeting

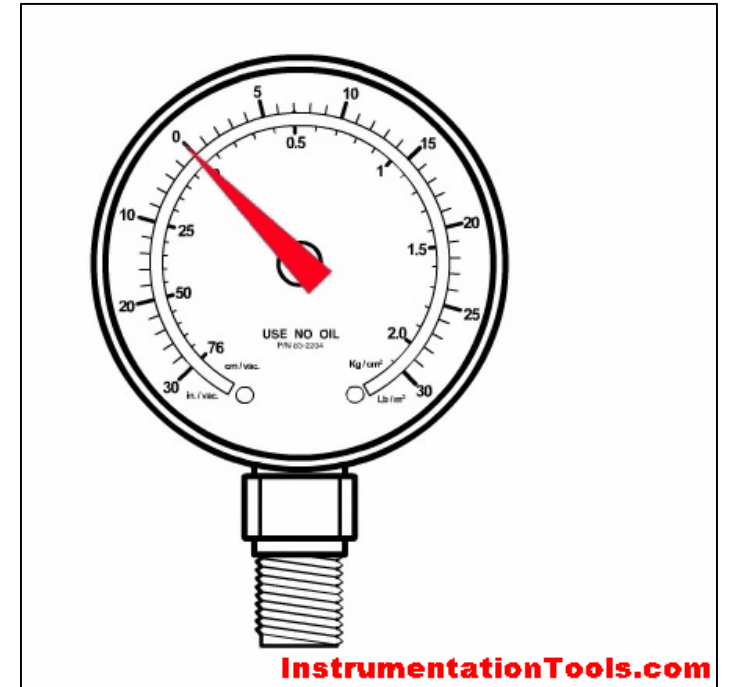
2018-05-25

Measurement Classifications



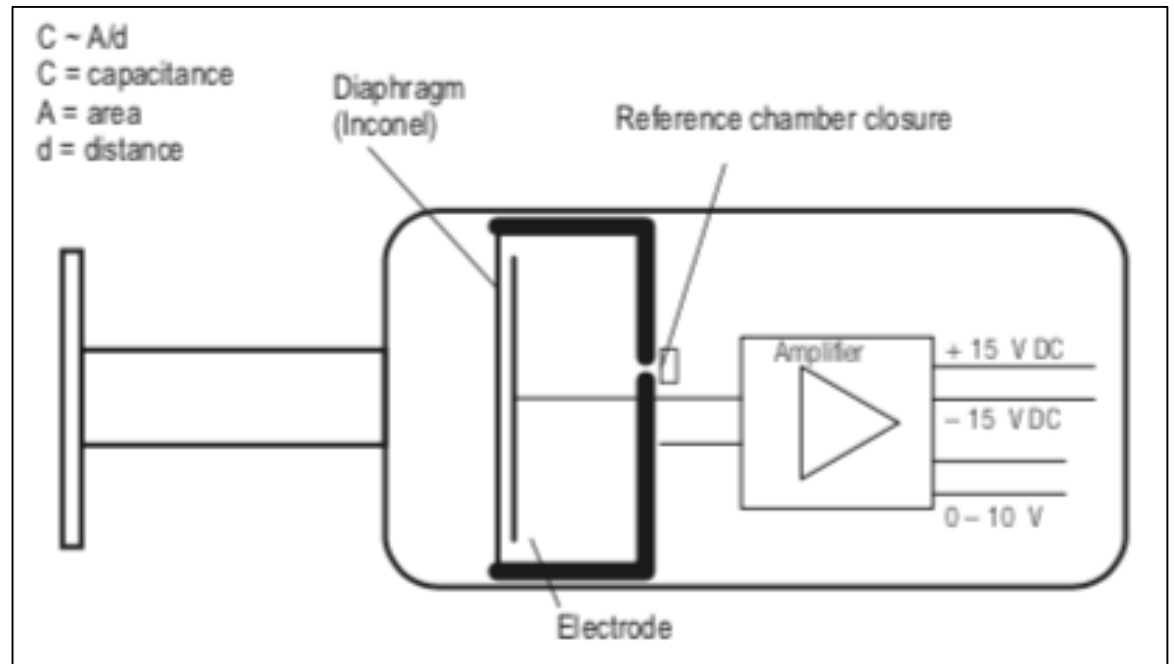
Diaphragm & Bourdon Gauge

- Pressure of a gas exerts a force, causing displacement
 - Measure this displacement to read out pressure
- Diaphragm: flexing of surface moves an indicator in a dial
- Bourdon: curved tube tries to extend when filled with gas, moves indicator on dial



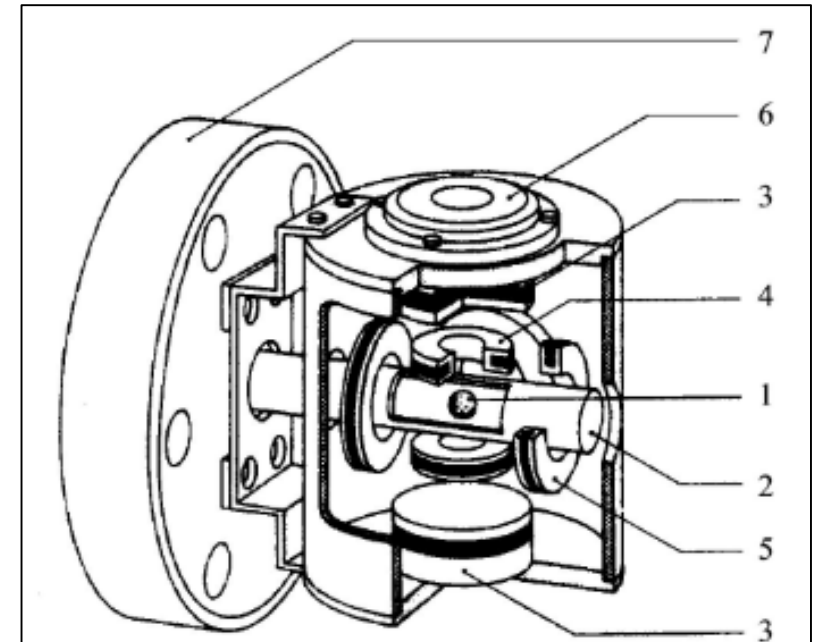
Capacitance Gauge

- Similar to diaphragm gauge, but flexible metal plate moves & changes capacitance
- Have to calibrate reference chamber using another gauge
- Some (but very little) dependence on gas type



Decrement Gauge

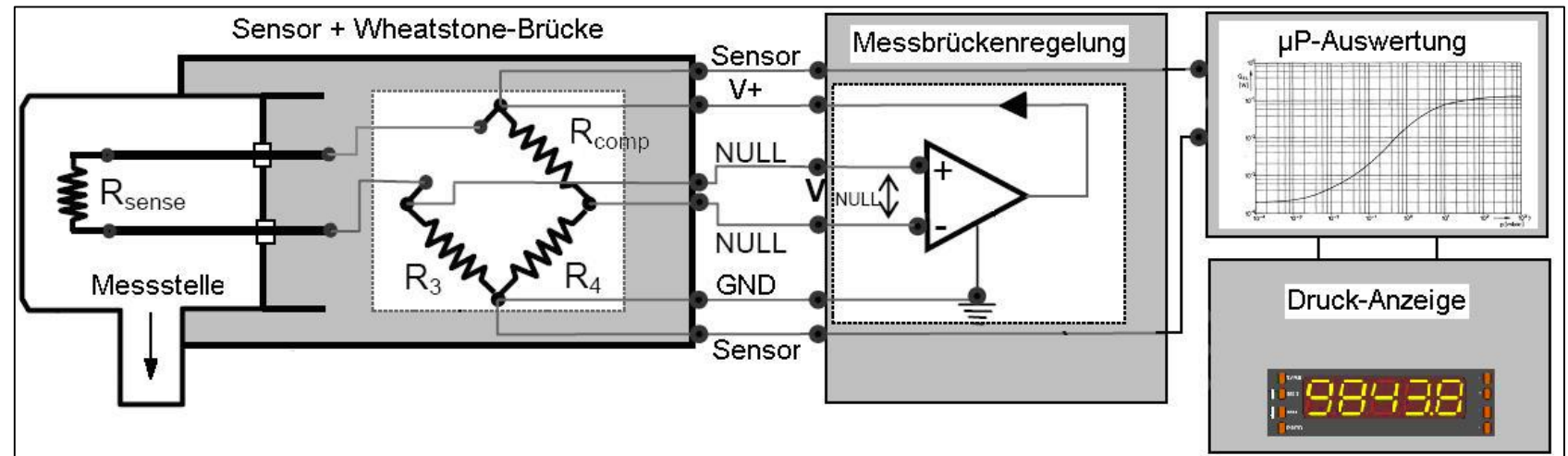
- Measure friction on a levitated steel ball
 - Speed reduction dependent on ball geometry, pressure of gasses
 - $$-f \frac{df}{dt} = \frac{10}{\pi} \frac{p \sigma}{\bar{c} r \rho}$$
 f is decline of speed;
 p is pressure; r , ρ , σ are related to ball geometry; \bar{c} is mean speed of gas (needs calibration)



Cutaway view of a spinning rotor gauge. For clearness sake one drive coil and two sensor coils are omitted. 1 – steel ball, 2 – vacuum tube, 3 – permanent magnets, 4 – horizontal stabilization coils, 5 – drive coils, 6 – level, 7 – connection flange (source: Leybold Vacuum)

Thermocouple Gauge

- Detects change in thermal conductivity of gas
 - “Pirani gauge” most common
- Heat loss of R_{sense} depends on pressure. Feedback to keep temperature constant → measure of chamber pressure

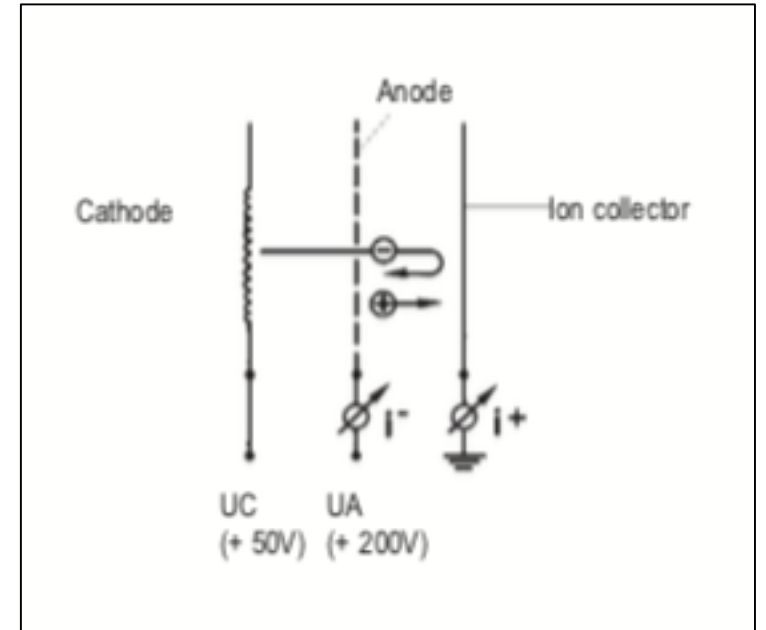


Cold Cathode Ion Gauge (Penning)

- Same configuration as ion pumping device from last week
 - Gasses ionized by free electrons, hit plate to register current
- Widely used due to its low cost and simple operation principles
- Measure below $\sim 10\text{mTorr}$
- Pumping action results in relatively low accuracy

Hot Cathode Ion Gauge (Bayard-Alpert)

- A hot cathode ionizes gas, ions move to anode to register current
- Two limiting effects:
 - X-ray effect: Hot electrons \rightarrow inv. photoelectric effect \rightarrow photoelectrons show as neg. current
 - Ion desorption effect: Electron impacts release adsorbed ions which flow to ion collector



Thanks