Penning Gauge

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Ionisation Gauges

The most convenient method of measuring pressures below about 0.1 Pa is to ionise the remaining gas molecules, collect the ions and measure the ion current.

Ionisation Gauges

- Cold Cathode
  - Penning Gauge
  - Inverted Magnetron Gauge
- Hot Cathode
  - Bayard Alpert Gauge (B-A Gauge)
  - Extractor gauge

The Cold Cathode Ionisation Gauge

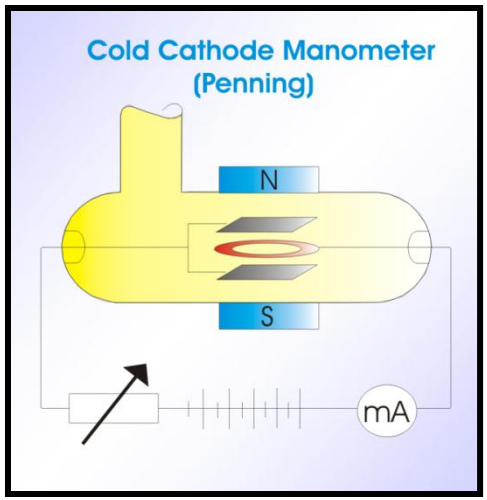
An important class of gauge in the medium to high vacuum ranges is based on a cold gas discharge in crossed electric and magnetic fields. In such discharges, free electrons are accelerated by the electric field and are trapped by the magnetic field so that they have very long path lengths – much longer than the gauge dimensions

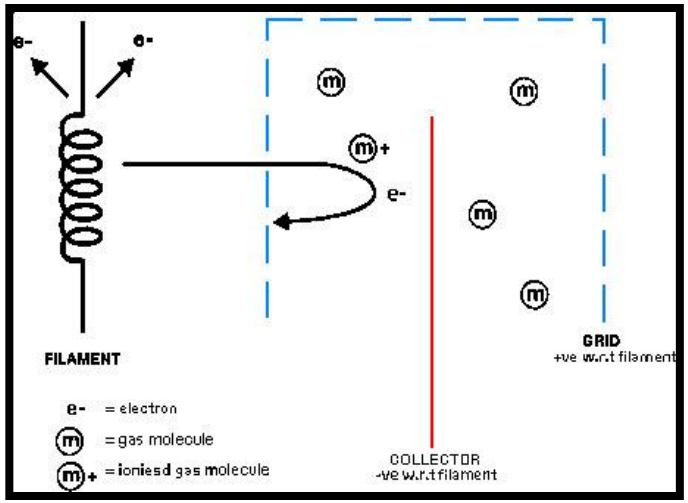
This means that even at low pressures, these electrons have a good chance of ionising a gas molecule

Many configurations are possible for such gauges which are often referred to as **Penning Gauges**, since the most popular configurations are based on the Penning discharge.

Penning Gauge

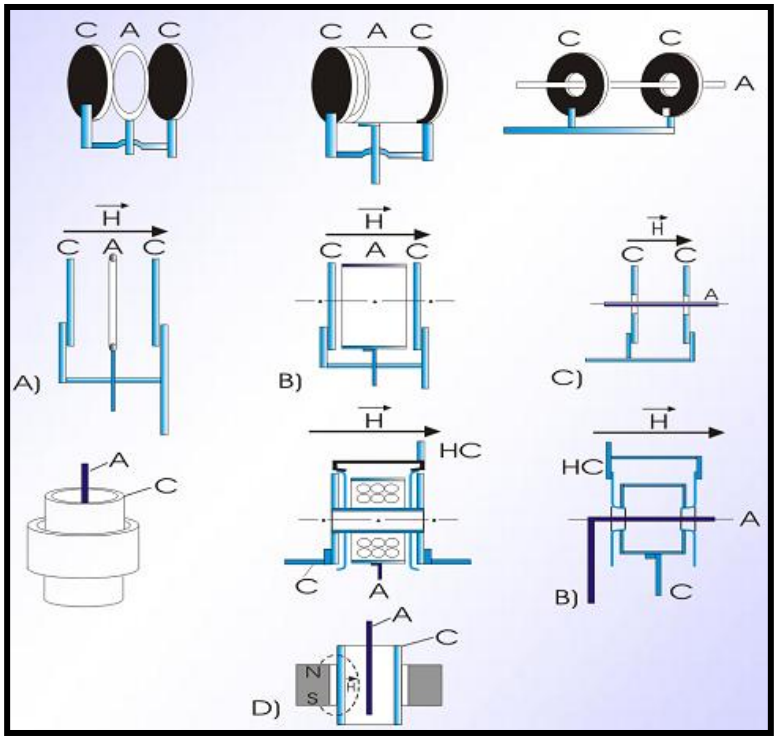
- In 1936 Penning invented the cold-cathode discharge gauge as a method to measure pressures below 10^{-3} torr.
- In a Crookes tube below 10^{-3} torr, little ionization takes place.
- Penning increased the probability of ionization by placing a magnetic field parallel to the paths of ions and electrons, which forces both particles into helical trajectory.



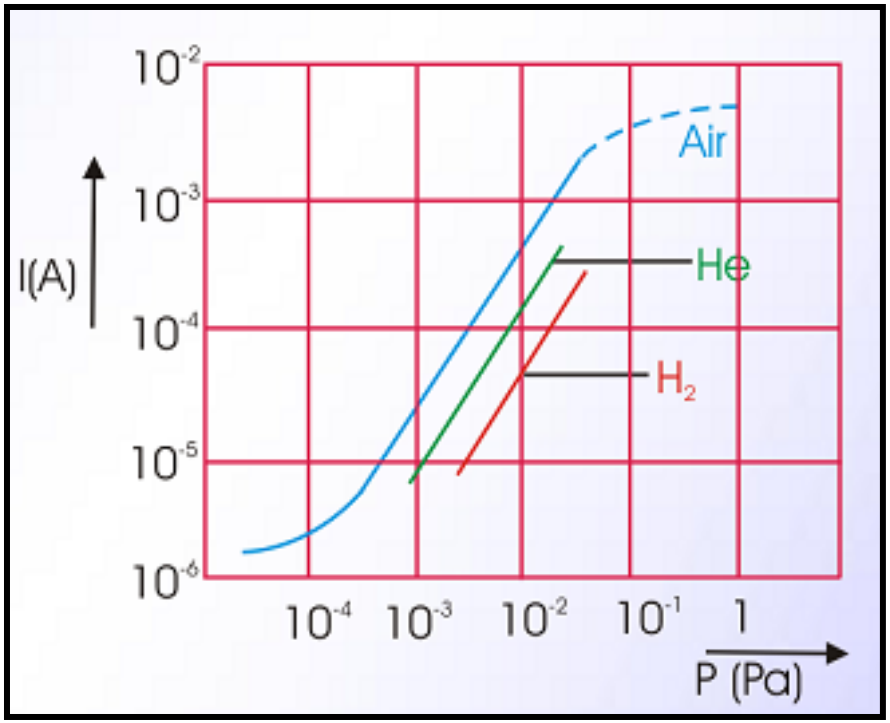


This is the classic Penning discharge configuration. It operates at fixed voltage and fixed magnetic field. Ions are collected on the ring anode

Penning Gauge



Various Penning cell configurations



The gauge characteristic is shown as a function of pressure for a few gases

Penning Gauge

- Measures pressure indirectly. Discharge current is used as a measure of pressure.
- The useful range of standard Penning gauges is between 10^{-3} mbar and 10^{-8} mbar, or in special versions, 10^{-9} mbar.

- Difficult to start and maintain discharge < 10^{-6} Torr
- Indicated value is gas dependent
- Less stable and less accurate than a B-A gauge

Thank you