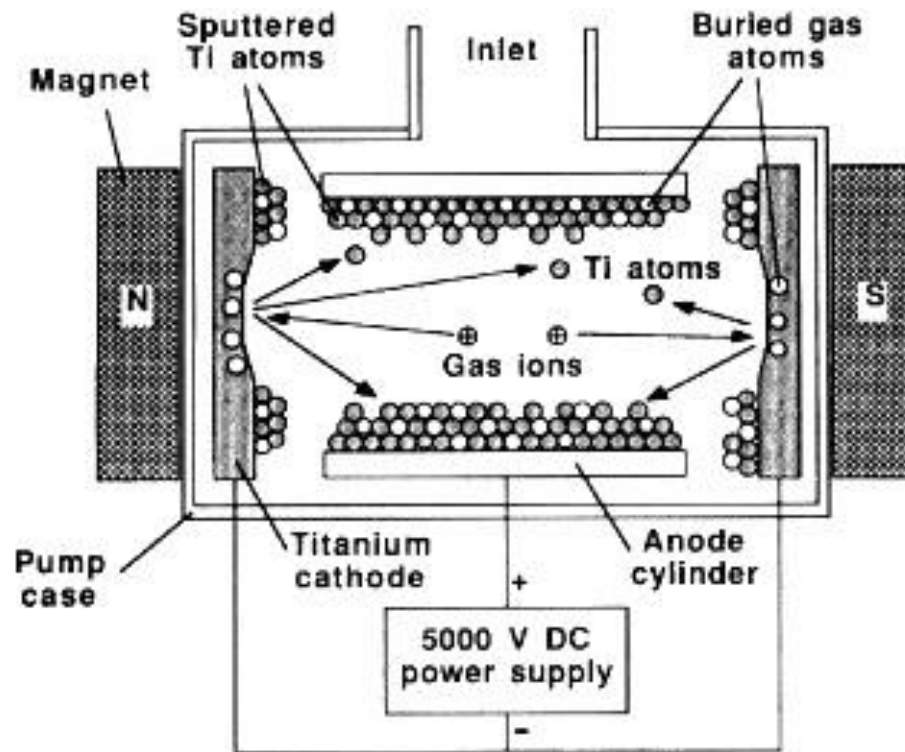


Sputter Ion Pump (Ion Pump)



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- ❖ An **ion pump** is a type of vacuum pump capable of reaching pressures as low as 10^{-11} mbar under ideal conditions. An ion pump ionizes gas within the vessel it is attached to and employs a strong electrical potential, typically 3–7 kV, which allows the ions to accelerate into and be captured by a solid electrode and its residue.

Early History of Ion Pump:

- ❖ The first ion pump was invented by Varian Associates. **Varian Associates** was one of the first high-tech companies in Silicon Valley. It was founded in 1948 by Russell H. and Sigurd F. Varian, William Webster Hansen and Edward Grinzton.
- ❖ Then Robert Jepsen led the investigation about electronic vacuum pumping in 1957 to the realization of the first sputter ion pump (SIP).
- ❖ Lewis Hall and John Helmer were members of the research team, involved in the choice of the most suitable cathode material and in the optimization of the ion pump design.
- ❖ Renn Zaphiropoulos worked on high voltage feedthroughs, magnets, control units, systems, flanges, valves, sorption pumps and Titanium Sublimation Pumps (TSP) in 1957.
- ❖ In 1960 the “slotted” titanium cathode, named “Super Vaclon Pump”, was introduced on the basis of observations about noble gas pumping mechanism and unstable Argon pumping phenomena.

Types of Ion Pump:

- ❖ There are three main types of ion pumps: the conventional or standard diode pump, the noble diode pump and the triode pump.

1. Standard diode pump:

- ❖ A standard diode pump is a type of ion pump employed in high vacuum processes which contains only chemically active cathodes.

2. Noble diode pump:

- ❖ A noble diode pump is a type of ion pump used in high-vacuum applications that employs both a chemically reactive cathode, such as titanium, and an additional cathode composed of tantalum.
- ❖ The tantalum cathode serves as a high-inertia crystal lattice structure for the reflection and burial of neutrals, increasing pumping effectiveness of inert gas ions.

3. Triode pump:

- ❖ The triode sputter ion pumps are employed to create hydrocarbon-free ultra high vacuum.
- ❖ They utilize the high intensity cold cathode discharge produced in a magnetic field to sputter a highly reactive metal.
- ❖ The reactive metal layer called getter film combined with the active gas molecules such as hydrogen, nitrogen, oxygen, water vapour etc to form low vapour pressure stable compounds, thus reducing the number of gas molecules and hence gas pressure in the system volume.

Working Principle:

Step 1: Create a high magnetic field:

- ❖ The ion pumps have magnets located outside the vacuum. Those magnets generate a 1200 gauss magnetic field, which contains and guides electrons within circular anode rings.

Step 2: Generate a plasma:

- ❖ After an initial rough pumping to remove much of the gas, high voltage is applied to the element assembly. Electrons are pulled into the anode tube assembly where they spin in a cloud; this cloud is commonly referred to as plasma. The plasma is trapped by the high magnetic field.

Step 3: Ionize gas molecules:

- ❖ As gases move into the anode assembly, electrons strike the gas molecules. This collision removes electrons from the gas molecule's valence shell, and changes the gas molecule into a positive ion (it has a positive charge). The positive ion is forced out of the anode tube by the high voltage field at a high velocity toward the cathode plate.

Step 4: Capture gas ions:

- ❖ When the positive ion strikes the cathode plate, that impact is called sputtering. Cathode materials are ejected toward the anode tube and the ion chemically and physically reacts with the cathode material.

Applications:

- ❖ Ion pumps are commonly used in ultra-high vacuum (UHV) systems, as they can attain ultimate pressures less than 10^{-11} mbar.
- ❖ In contrast to other common UHV pumps, such as turbomolecular pumps and diffusion pumps, ion pumps have no moving parts and use no oil.
- ❖ They are therefore clean, need little maintenance, and produce no vibrations. These advantages make ion pumps well-suited for use in Transmission electron microscopy, scanning probe microscopy and other high-precision apparatuses.

Disadvantage:

- ❖ Recent work has suggested that free radicals escaping from ion pumps can influence the results of some experiments.

THANK YOU