VACUUM GAUGE CALIBRATION WITH SPINNING ROTOR DRAG GAUGE PRESSURE RANGE $10^{-2} \sim 10^{-12}$ Torr, FOR NUCLEAR EXPERIMENTAL MACHINES

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Abstract

Measurements of pressure in various nuclear experimental machines on the working are important. Therefore,those precise vacuum gauges (:hot or cold cathode ionization gauge,) must be calibrated with various methods. In these cases, the Spinning Rotor Gauge (ab.SRG) are expressed as the standard of the low pressure.

Introduction

Over these more than ten years,semiconductor manufacturing has been prominent in japan. Under the circumstances, we are more and more getting to pressure standards in vacua to "SRG", which is on the market. The number of units of SRG distributed so far in this field is more than 200 in our country.

Discussion

Fig.1 shows the structure of SRG. #1 is the ball (dia.4.5mm) which is made of SUS (fero-magnetic) and is suspended by levitation in a magnetic field. #2 is the thimble(I.D.7.5mm),one of which end is closed and the other is connected to the vacuum chamber. The rotating velocity of the ball, is allowed to coast in the thimble (#2), defined as $\nu(0)$Hz at the time "0"second. And then after a period of "t"second is expressed as $\nu(t)$Hz. The rotation between the deceleration rate of ν $(= -\dot{\nu}/\nu)$ and the pressure inside #2 :P is shone as the following formula:

$$P = -(\pi r \bar{c} \rho_B / 10 \sigma t) \ln [\nu(t) / \nu(0)]$$

Here, $\bar{c}$ is arithmetic mean value of thermal equilibrium molecular velocity of the gas $[= (8RT/\pi M)^{1/2}]$, r =the ball radius (e.g.4.5mm÷2), ρ_B =it's density, σ is important factor among them, which the accommodation coefficient relating to the momentum and energy exchange during the collision between gas molecules and the ball surface. In the general view point, σ is nearly equal to the unity $(= 1 \pm 3\%)$, but more accurately, the numerical value calibrated by PTB (ab. Physikalisch-Technische Bundesanstalt, Institut Berlin, Germany), and now has been known as one of the international bureau of low pressure standards.

1. Ball
2. Thimble
3. Permanent magnet (2)
4. Coils (2) for vertical stabilization
5. Driving coils (4)
6. Level
7. Connecting flange

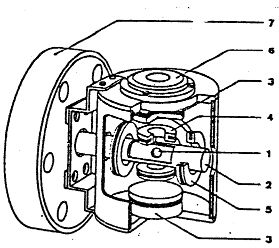

Fig.1. Structure of SRG (VISCOVAK 240 sensing head)

Relation to the nuclear experimental machines

In those machines are, of course, important to maintain and control the pressure of working vacuum constantly by exhaust of ion source, accelerators and relating particle accumulation rings. Otherwise, when we design these machines, we need to know the working pressure and the outgassing rate in those and exhaust pumping speed in system of then, and working pressure have to be determind dependence on which vacuum gauges (mainly

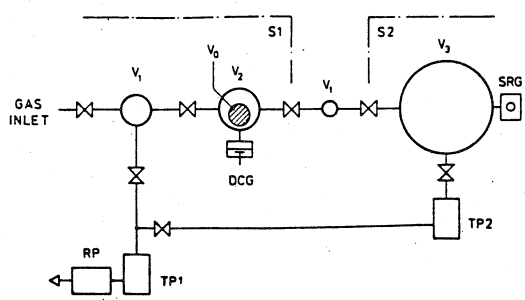

Fig.2.. Schematic diagram of the static pressure divider.

above mentioned them,) up to the pressure of order 10^{-8}Torr. These may be carried out by help of static expansion method [2] with SRG within the accuracy better than ±10%.(Fig.2)

When order of pressure is below 10^{-9}Torr, we can only relay the dynamic expansion method [3] (Fig.3), however, many countries in the world, which accept PTB (since 1980), have pressure standard methods [4] in vacua and there is a tendency, that the pressure around 10^{-12} Torr are calibrated by them and therefore these ionization gauges are calibrated at PTB.

SPS of CERN is one of the example for it with SRG up to 10^{-10} Torr.[5]

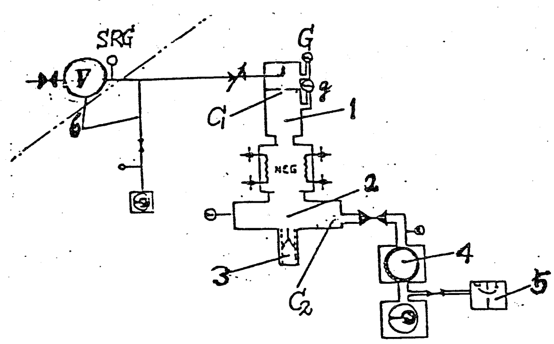

Fig.3. Vakuumsystem für NEG-Pumpen-Testmessungen
1. Fischer-Dom
2. Kreuzstück
3. Ionenpumpe (60 l/sec)
4. Turbomolekularpumpe (500 l/sec)
5. Lecktester
6. Injektionssystem
C 1 und C 2 kalibrierte Leitwerte

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