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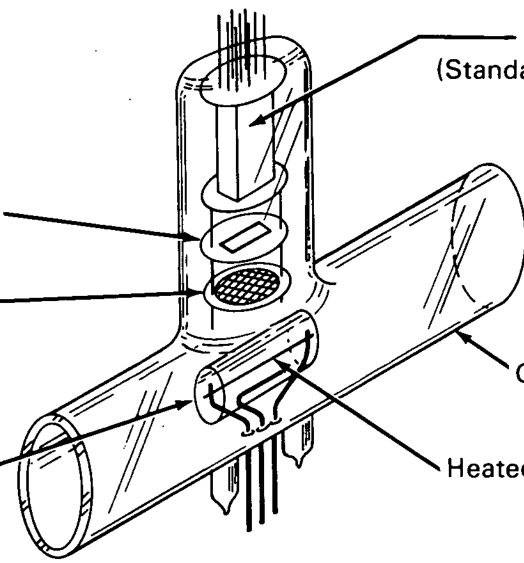
Brief 63-10597

NASA TECH BRIEF

Precision Gage Measures Ultrahigh Vacuum Levels



The problem: Accurate measurement of pressures of less than 10^{-14} torr.

Ionization gages are the instruments most often used to measure gas pressures in ultrahigh systems. Such gages have a hot filament, usually tungsten, that maintains a constant electron current between it and a positively biased grid structure (the electron collector grid). Gas from the system under investigation is drawn through the grid structure where it is ionized by the electron current. The number of positive ions formed is directly proportional to the density of gas molecules and of the electron current. These positive ions are then collected on a negatively biased anode. The resulting current is directly proportional to the gas pressure.

The lowest pressure that the ionization gage can measure is determined by the quantity of soft X-rays formed during the process described above. When electrons from the filament strike the positively biased grid structure, soft X-rays are produced, the quantity being directly proportional to the strength of the electron current. Some of these X-rays strike the anode and cause secondary electron emission from the anode. Since the resulting secondary emission current cannot be distinguished from the positive ion current and is not pressure dependent, it sets a lower limit for the gage.

The solution: An improved ionization gage in which internally generated X-rays are minimized, permitting gas pressures of 10^{-18} torr to be measured.

(continued overleaf)

How it's done: Two methods are combined to decrease the production of X-rays and, hence, the X-ray current. The first is to reduce the area of the anode and thus decrease its X-ray cross section. The second method is to reduce the electron current needed to give positive ion production by increasing the electron path between filament and grid, thus increasing the efficiency of a given electron as an ion former. To compensate for the lower positive ion current, an electron multiplier is used as the anode to increase the output current.

Two accelerator grids are positioned between the collector grid and the dynode of the multiplier to facilitate the movement of positive ions from the collector grid to the dynode of the multiplier. With this design, the lower limit of gage is set by the "dark current" in the multiplier. Present multipliers have dark currents as low as 10^{-20} ampere, which is equivalent to a gas pressure of 10^{-18} torr in this gage.

Notes:

1. Where the range of gages currently used is approaching a lower limit, as in research laboratories, this gage would have definite utility. Industrial usefulness will require further development, since the life of the dynode coatings under vacuum bake-out conditions is not well established.
2. For further information about this innovation inquiries may be directed to:
   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland 20771
   Reference: B63-10597

Patent status: NASA encourages the immediate commercial use of this invention. It is owned by NASA, and inquiries about obtaining royalty-free rights for its commercial use may be made to NASA Headquarters, Washington, D.C. 20546.

Source: General Dynamics Corporation
under contract to
Goddard Space Flight Center (GSFC-114)