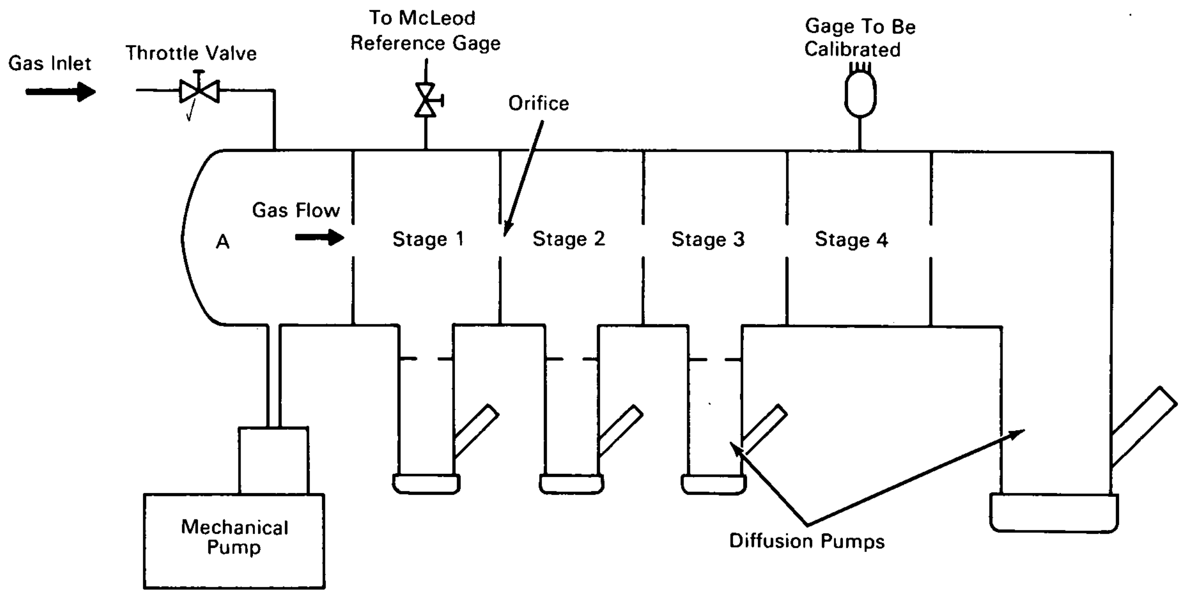
NASA TECH BRIEF

Absolute Low-Pressure Calibration System



A system has been developed for absolute calibration of vacuum gages in the very low pressure range (i.e., less than 10^{-5} torr). The system involves steady-state flow of a gas through a cascade of differentially pumped chambers or stages connected by precisely defined orifices. A McLeod gage (which provides accurate measurements from 10 torr down to 10^{-5} torr) is used as the primary reference standard in the calibration system. The most important characteristic of a stage is its pressure reduction ratio, the factor by which the pressure in the stage is reduced below that in the preceding stage. Thus if the pressure in the first stage is accurately measured with the primary McLeod gage, the lower pressure in the second and subsequent stages can be accurately calculated from the pressure reduction ratios, which are determined from the physical parameters of the orifices and the pumping speed.

Operation of the system can be understood from the schematic diagram. Chamber A is connected to a pump which serves only to reduce the inlet pressure to a convenient level. The stage 1 chamber comprises the "high pressure" or reference region; the reference McLeod gage is attached to this chamber. Stage 1 and the two succeeding stages (2 and 3) are each pumped by a diffusion pump. The fourth stage is the low pressure or calibration region to which the gages to be calibrated are attached. If, for example, the pressure ratio between each stage is 100:1, the system will have an overall ratio of 10^6:1. This ratio will provide a calibration pressure of 10^{-10} torr (in stage 4) when the McLeod gage attached to stage 1 reads 10^{-4} torr.

(continued overleaf)

The pressure at the gage being calibrated can be varied by varying the reference pressure (by means of the throttle valve) and by selecting the appropriate orifice combinations.

Inherent advantages of this calibration method, essential to the accurate calibration of vacuum gages, are as follows:

1. The reference standard is the McLeod gage, recognized standard of pressure measurement.
2. The pressure ratios across the orifice stages may be calculated from accurately measureable dimensions on the system, and need not be experimentally determined.
3. The method is independent of gas composition.
4. The trapped diffusion pumping systems will handle a variety of gases, active and inert, without loss of pumping speed at low pressures and therefore no correction for speed decline need be made.
5. The method does not rely on extrapolation.
6. The orifice areas are small in relation to test surface area. As a result, the pressure distribution in the test volume is isotropic.
7. There are no cryogenically cooled surfaces within the test volume. As a result the gas composition in the gage and test volume is the same and the conditions of calibration correspond generally to the conditions of use.

Note:

Complete details may be obtained from:

Technology Utilization Officer
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No patent action is contemplated by NASA.

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