

Lawrence Berkeley National Laboratory

Recent Work

Title

VACUUM MEASUREMENT TECHNIQUES I. AN ELECTRONIC DIFFERENTIAL
MICRCMANOMETER

Permalink

<https://escholarship.org/uc/item/6nf39808>

Authors

Rony, Peter R.
Lamers, Kenneth W.

Publication Date

1965-06-11

University of California

Ernest O. Lawrence Radiation Laboratory

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy
which may be borrowed for two weeks.
For a personal retention copy, call
Tech. Info. Division, Ext. 5545*

VACUUM MEASUREMENT TECHNIQUES I. AN ELECTRONIC
DIFFERENTIAL MICROMANOMETER

Berkeley, California

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

UNIVERSITY OF CALIFORNIA

Lawrence Radiation Laboratory
Berkeley, California

AEC Contract No. W-7405-eng-48

VACUUM MEASUREMENT TECHNIQUES I.
AN ELECTRONIC DIFFERENTIAL MICROMANOMETER

Peter R. Rony and Kenneth W. Lamers

June 11, 1965

VACUUM MEASUREMENT TECHNIQUES
I. AN ELECTRONIC DIFFERENTIAL MICROMANOMETER*

Peter R. Rony[†] and Kenneth W. Lamers

Lawrence Radiation Laboratory and
Department of Chemical Engineering
University of California
Berkeley, California

June 11, 1965

A differential micromanometer capable of measuring 100 μ torr to an accuracy of $\pm 2\%$ or better has been designed, constructed, and tested. The micromanometer differs in three important respects from similar units described in the literature:¹⁻⁵ (a) it employs a commercial rather than homemade pressure transducer; (b) it is less expensive to construct; and (c) the details of construction, tuning, and operation are more thoroughly described.^{6,7} At present, there is only one commercial micromanometer that has an equivalent sensitivity and stability, but it is fairly expensive.⁸

The pressure difference is sensed by a diaphragm manometer constructed as a differential capacitor that forms two legs of a resonant-bridge network excited by a radio-frequency source (Fig. 1). The bridge output (2.762 MHz) is amplified and fed to a phase-sensitive detector that determines the direction of unbalance and develops a dc voltage that can be used in (a) a feedback-loop system to restore the diaphragm to its null position, or (b) an open-loop system and recorded directly.

The most favorable system found to date consists of a pressure transducer (Decker Corporation Model 306-2A) operated open loop with the above bridge and electronics (Fig. 2). Differential pressures as low as 50 μ torr can be measured with a short-term zero stability of 1 μ torr and

a long-term zero stability of less than 30 μ torr/hour (Fig. 3). These values represent a 100-fold improvement in the sensitivity and stability of the original commercial system (Fig. 4).

Differential pressures of 0.5 μ torr are detectable, while an attenuator in the amplifier section extends the system to differential pressures as high as 35 mtorr. The micromanometer is calibrated electrostatically. In this pressure region, the system is an excellent secondary standard, being much more convenient and generally more accurate than a McLeod gauge.

FOOTNOTES AND REFERENCES

* This work was performed under the auspices of the U. S. Atomic Energy Commission.

† National Science Foundation Predoctoral Fellow 1961-1964. Present address: Monsanto Company, 800 No. Lindbergh Blvd., St. Louis, Missouri.

1. E. W. Becker and O. Stehl, Z. Angew. Physik 4, 20 (1952).
2. J. J. Opsteltn and N. Warmoltz, Appl. Sci. Res. B4, 329 (1955).
3. J. J. Opsteltn, N. Warmoltz, and J. J. Zaalberg Van Zelst, Appl. Sci. Res. B6, 129 (1956).
4. J. O. Cope, Rev. Sci. Instr. 33, 980 (1962).
5. Robert L. Sharpless, K. C. Clark, and Robert A. Young, Rev. Sci. Instr. 32, 532 (1961).
6. Kenneth W. Lamers, Lawrence Radiation Laboratory Report UCRL-11218, Pt. I, October 1964 (unpublished).
7. Peter R. Rony, Lawrence Radiation Laboratory Report UCRL-11218, Pt. II, April 1965 (unpublished).
8. MKS Instruments, Inc., 45 Middlesex Turnpike, Burlington, Massachusetts.

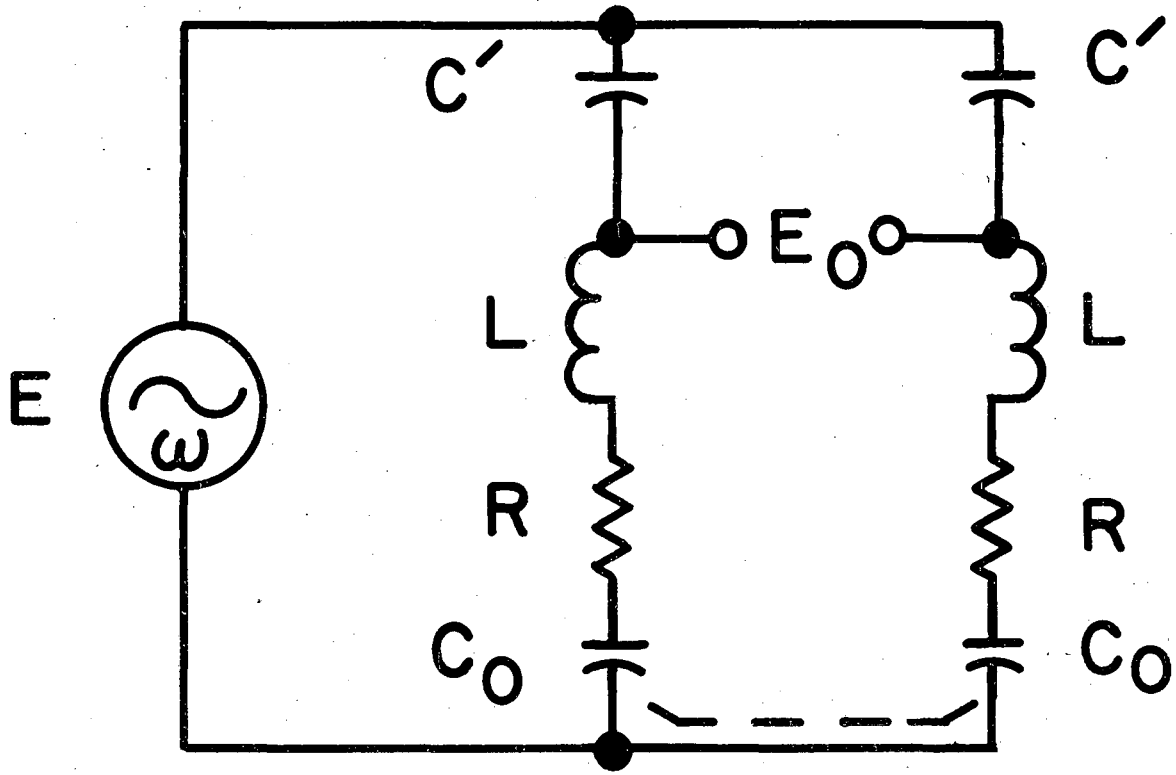
FIGURE CAPTIONS

Fig. 1. Schematic diagram of capacitance bridge with two resonant arms. E and E_o are the input and output voltages, C' and L are bridge components, R is the effective resistance of the inductors at frequency ω , and C_o are the two sides of the pressure sensor, which is a differential capacitor.

Fig. 2. Photograph of the differential micromanometer. The amplifier, phase-sensitive detector, oscillator, power supply, and upper part of the bridge are located in the assembly on the right. The lower part of the bridge is located inside the commercial pressure sensor pictured on the left.

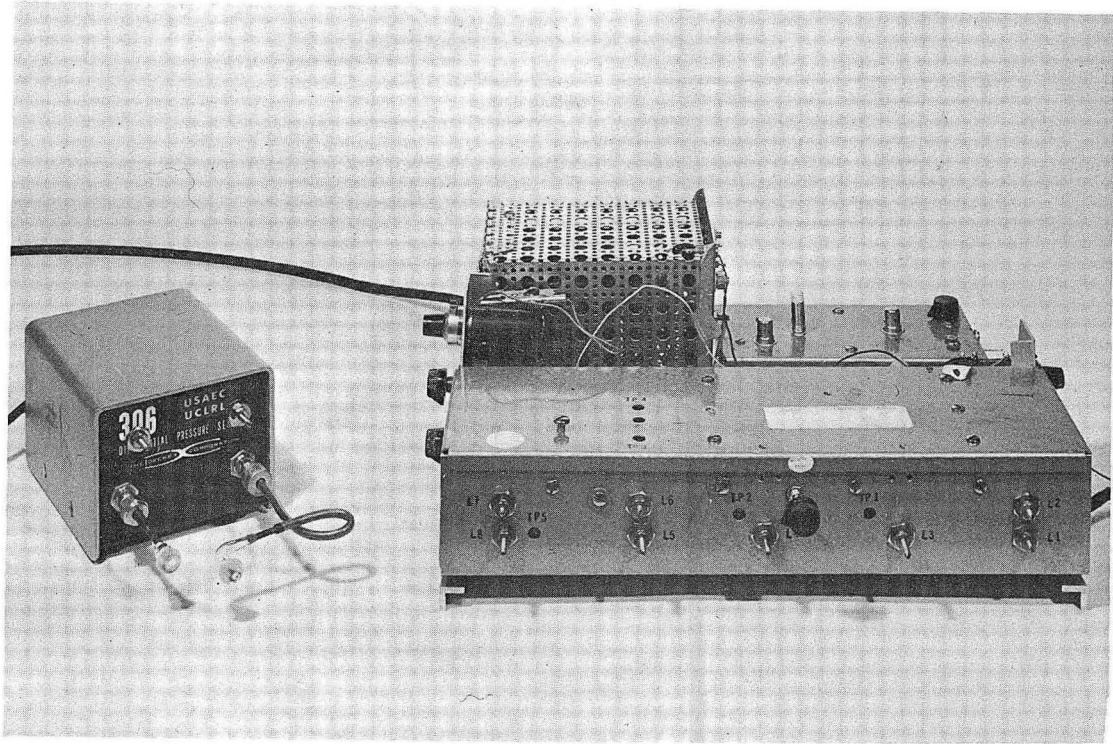
Fig. 3. Short-term and long-term stability curve for the differential micromanometer. The curve represents a time duration of one hour.

Fig. 4. Short-term and long-term stability curve for the original commercial system. The curve represents a time duration of one hour.



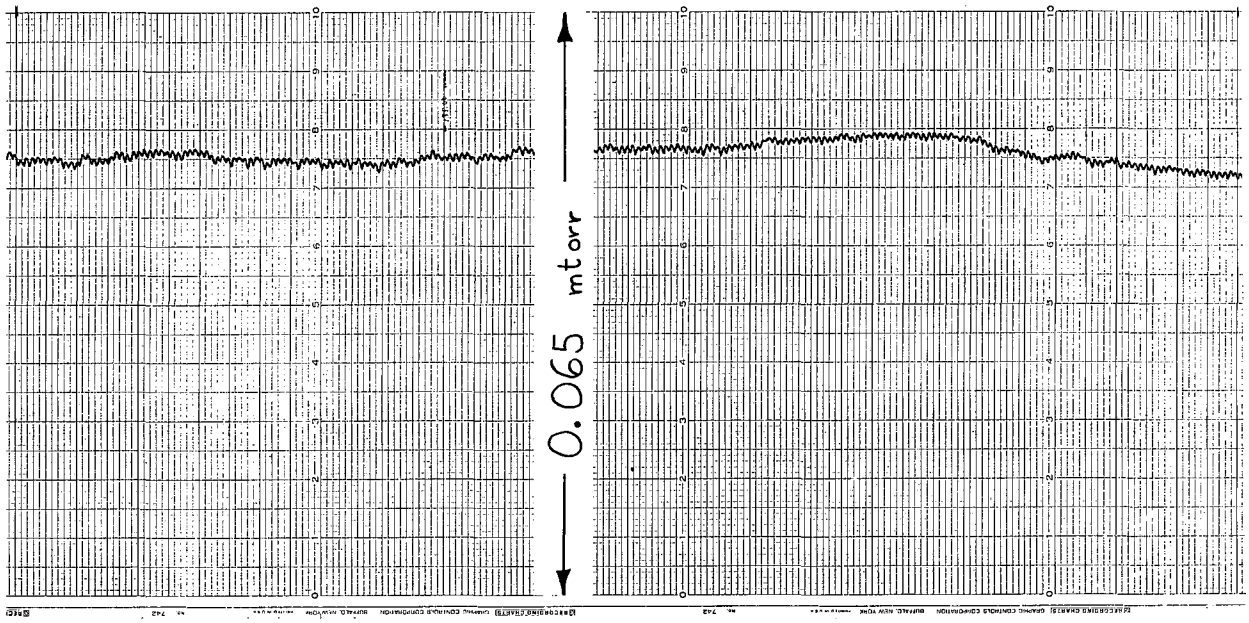
MUB-4409

Fig. 1



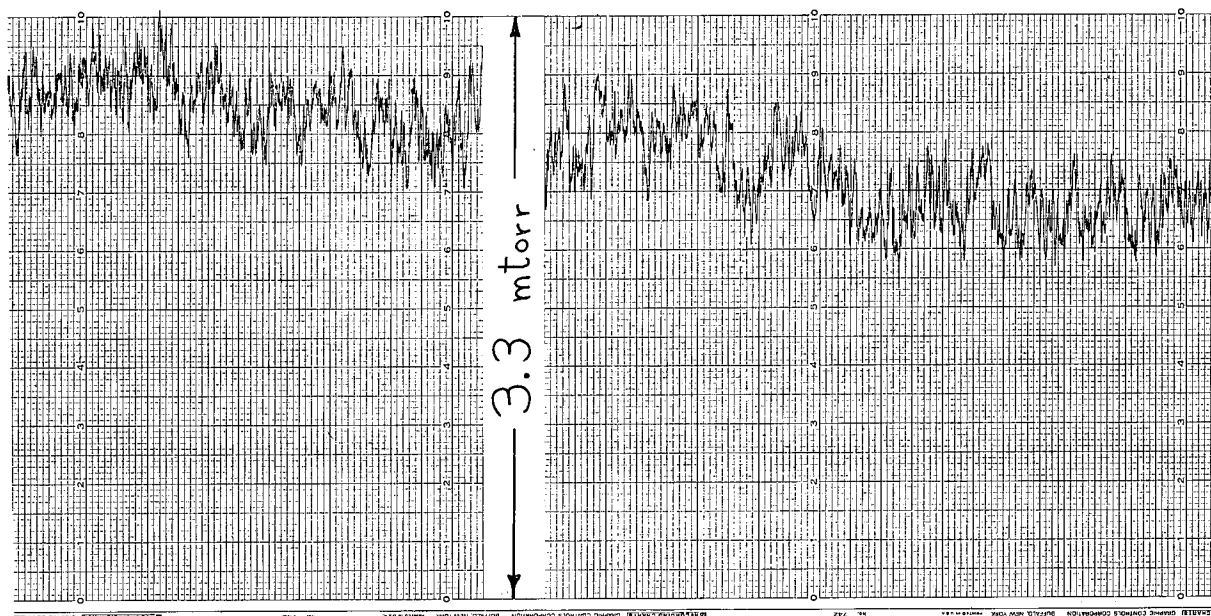
ZN-4932

Fig. 2



MU-35464

Fig. 3



MU-35465

Fig. 4

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

- A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or
- B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

