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VACUUM MEASUREMENT TECHNIQUES I. AN ELECTRONIC DIFFERENTIAL MICROMANOMETER

Berkeley, California

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Peter R. Rony and Kenneth W. Lamers

June 11, 1965

VACUUM MEASUREMENT TECHNIQUES
I. AN ELECTRONIC DIFFERENTIAL MICROMANOMETER*

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A differential micromanometer capable of measuring 100 μtorr to an accuracy of ± 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 μtorr can be measured with a short-term zero stability of 1 μtorr and

a long-term zero stability of less than 30 μtorr/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 μtorr 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.

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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.

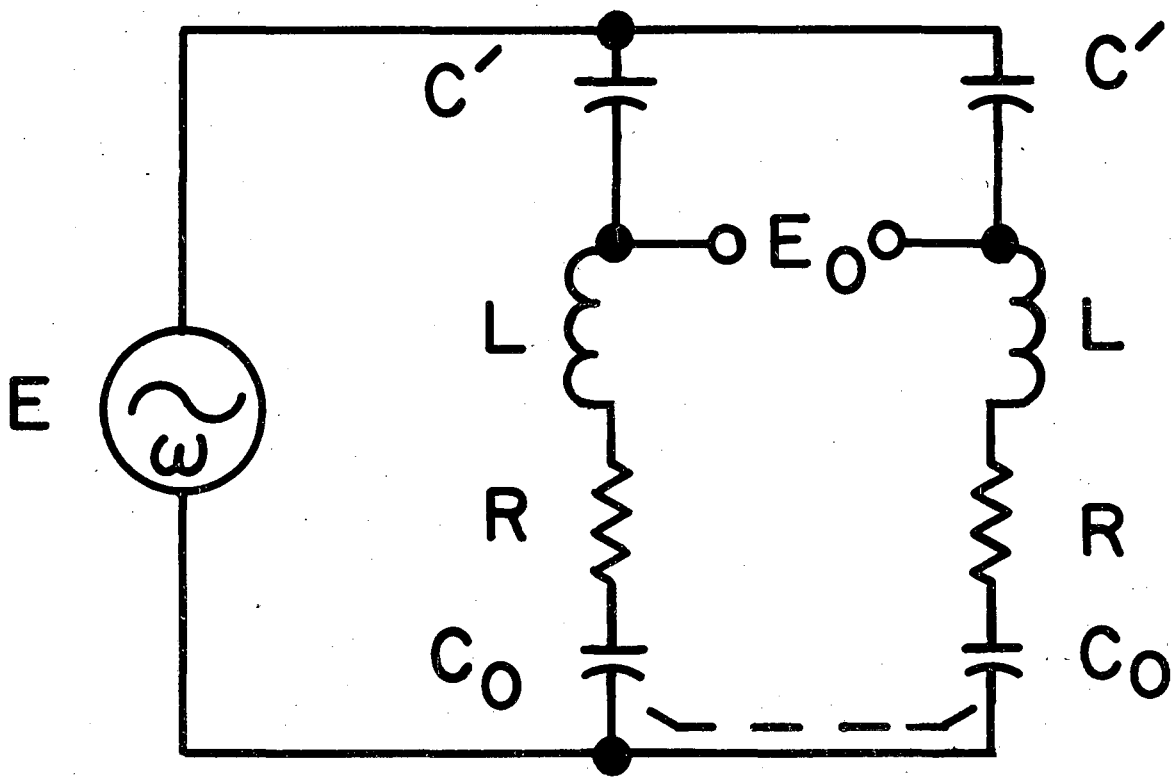

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Fig. 1

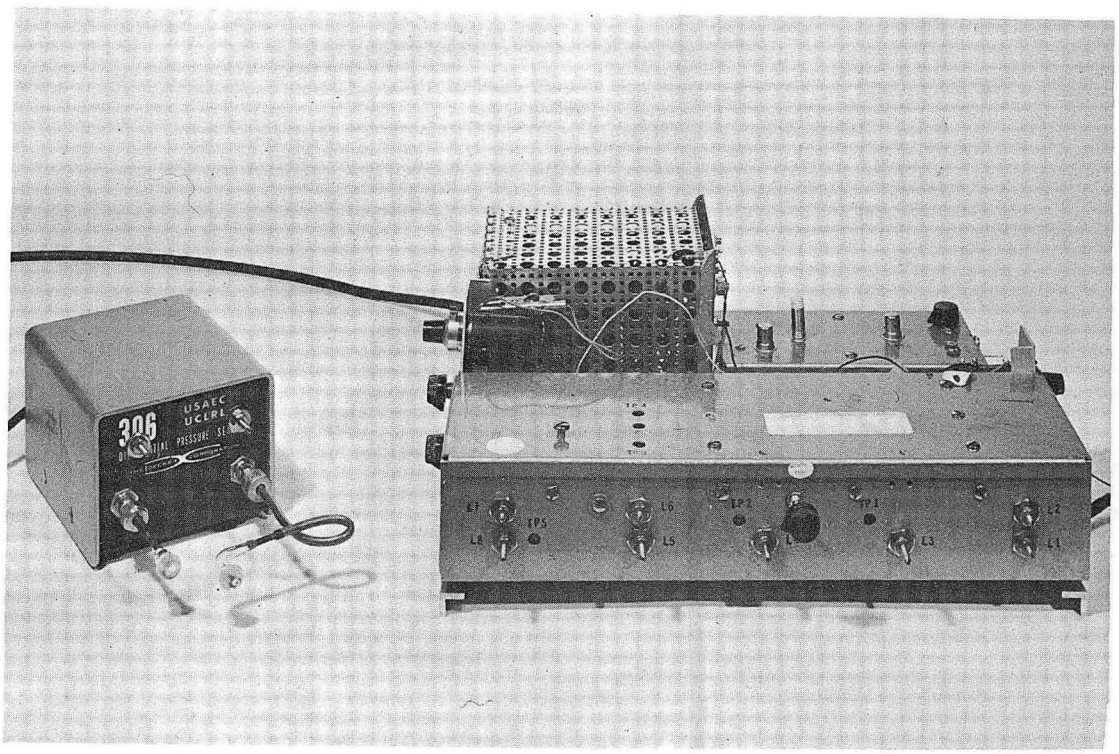

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Fig. 2

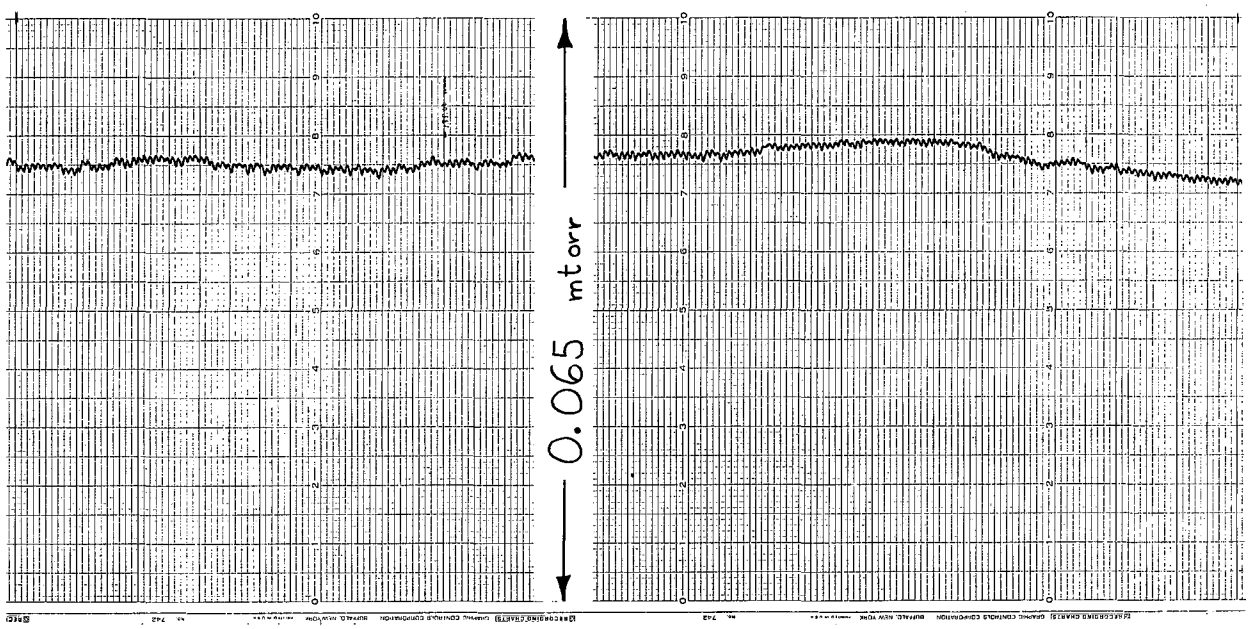

Fig. 3

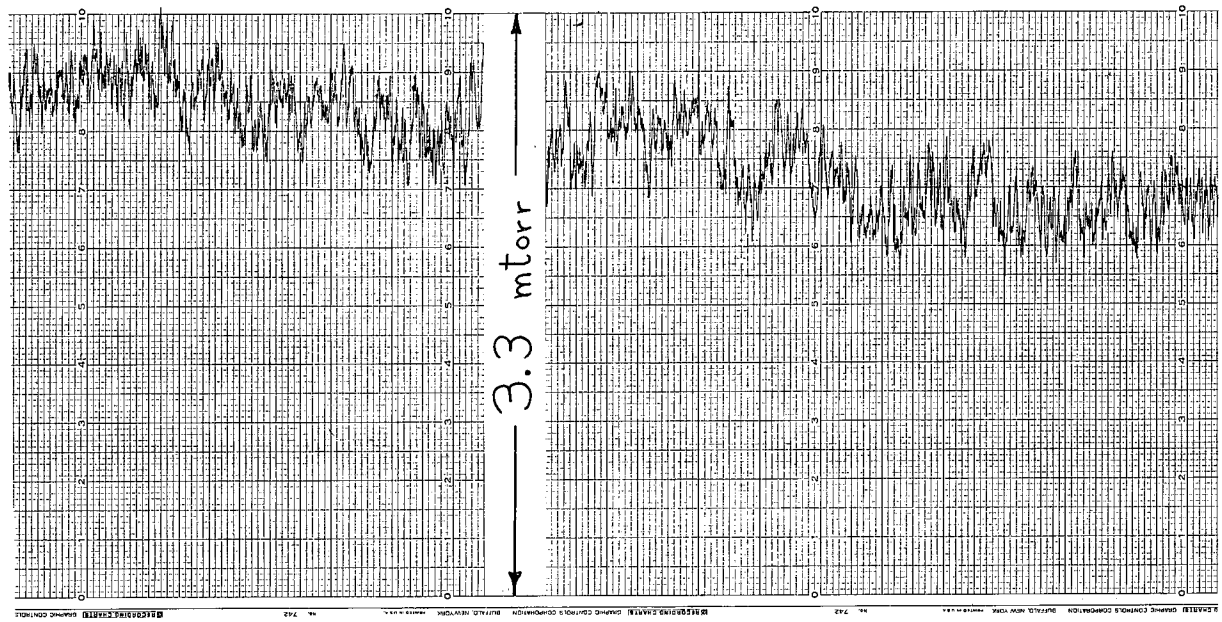

Fig. 4