Reprinted from *Proceedings of the West Virginia Academy of Science* 45—No. 3:220-227. 1973.

Electret Electrometers

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Abstract

Electrometers and voltmeters having electrets as active elements were built. They are well suited for measuring electric charges down to 10^{-13} coulomb and voltages down to 0.1 volt. The meters are inexpensive and of very simple construction.

The recently discussed electret slot effect[1,2,3] allows one to construct sensitive coulombmeters and voltmeters having electrets as active elements.

We have built and studied two types of meters of this kind: pointer-type meters and mirror-type meters.

A schematic diagram of the pointer-type meter is shown in Fig. 1. Actual photographs of such a meter are shown in Figs. 2 and 3. The two semi-circular electrets are supported by two Plexiglas plates which can be inserted between the electrodes by means of guides mounted on the base of the instrument. This allows one to interchange electrets of different polarization (strength), thus changing the sensitivity of the instrument. The electrodes are "painted" onto two mica disks with conducting paint and are "cross connected" internally (electrode 1 is connected to electrode 3, and electrode 2 is connected with electrode 4). The axle of the electrode assembly is made of a dielectric material (Plexiglas). The electrodes are connected with external (input) contacts of the instrument either with the aid of two spiral springs (not shown) providing the restoring torque, or with the aid of conducting strips on the axle if the restoring torque is provided by gravity.

With a carnauba wax electret of 7 cm diameter and 1 cm thickness the capacitance of the instrument is $\approx 10\ \mu\mu F$, and the sensitivity is ≈ 100 V or 10^{-9} coulombs for a full scale deflection. We have found this instrument especially useful as a coulombmeter. But since it has an input impedance in excess of 10^{17} ohm, it also serves very well as an electrostatic voltmeter (electrometer). The stability curve of the meter is shown in Fig. 4.

A schematic diagram of the mirror-type meter is shown in Fig. 5. Actual photographs of the mirror-type meter are shown in Figs. 6 and 7. Since the electrode assembly is now suspended from a torsion ribbon (standard 0.003 Au suspension from a torsion galvanometer), the sensitivity of this instrument is much greater than that of the one described above. Thus, with a carnauba wax electret 3.5 cm in diameter and 1 cm thick, the deflection observed on a screen 1 m from the reflecting mirror is 20 mm/volt or $\simeq 10^{12}$ mm/coulomb.

We believe that these types of simply constructed meters will soon become standard tools for electrostatic and other electrical measurements.

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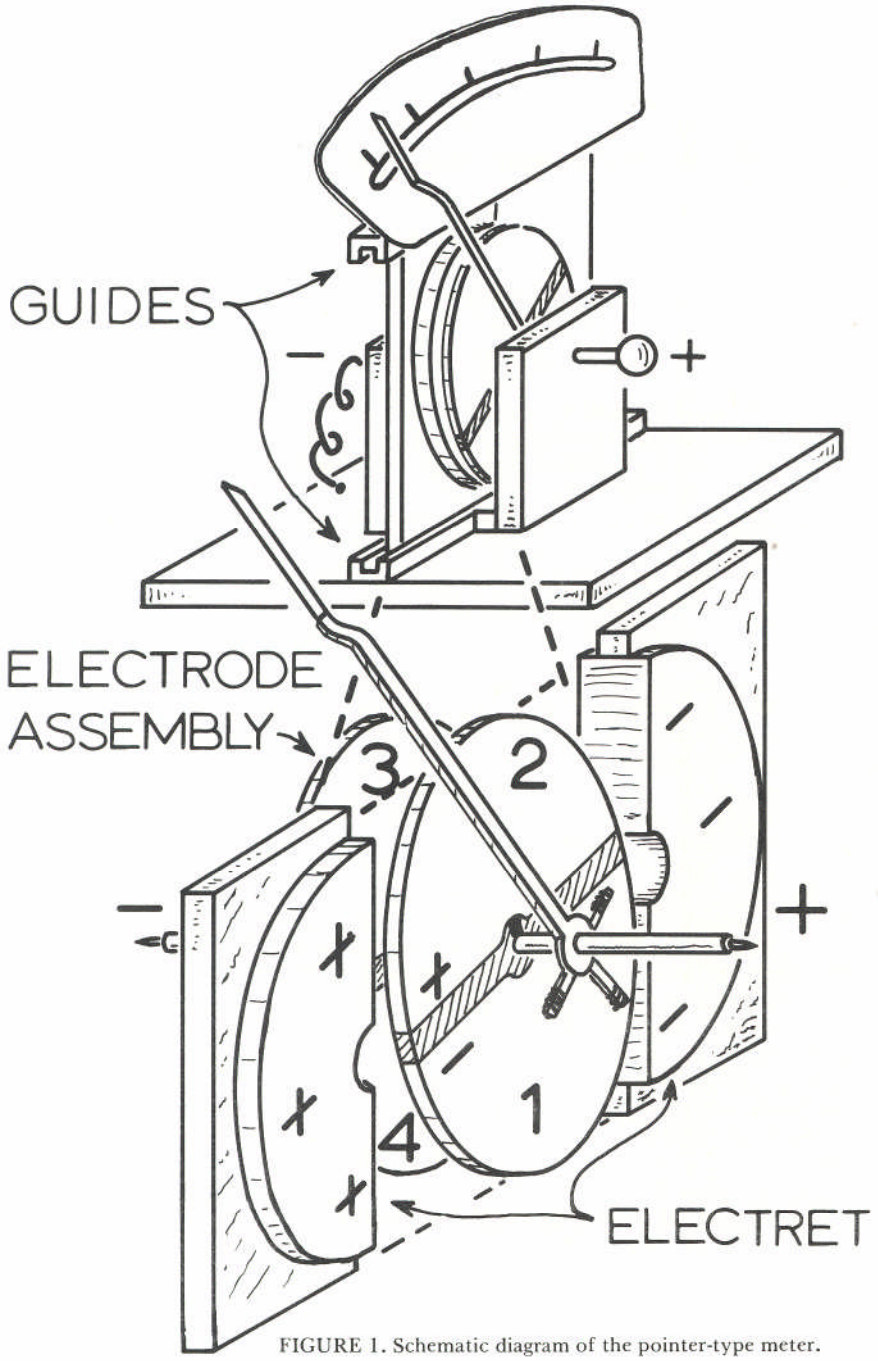


FIGURE 1. Schematic diagram of the pointer-type meter.

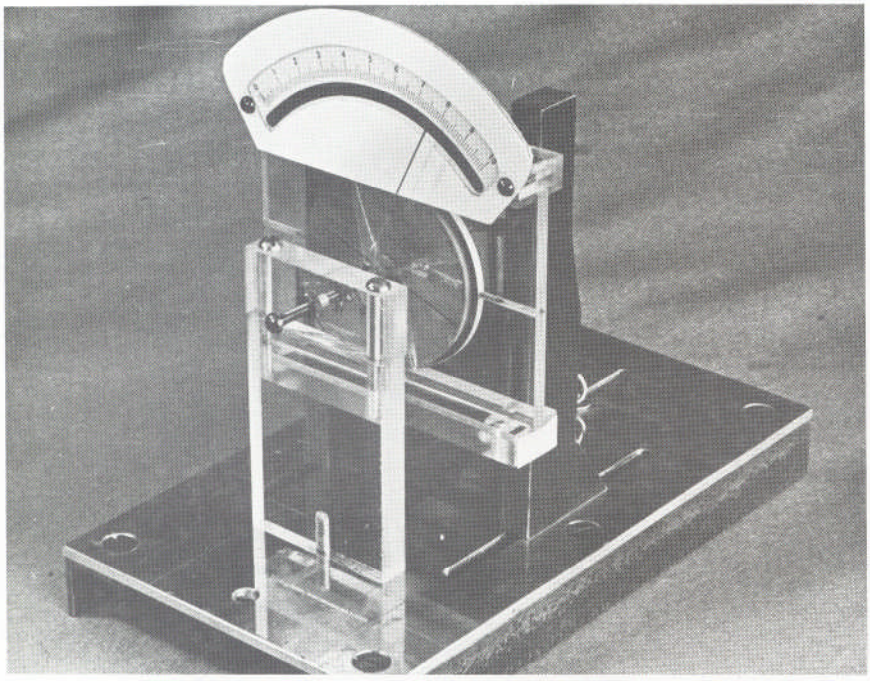


FIGURE 2. Photograph of the pointer-type meter.

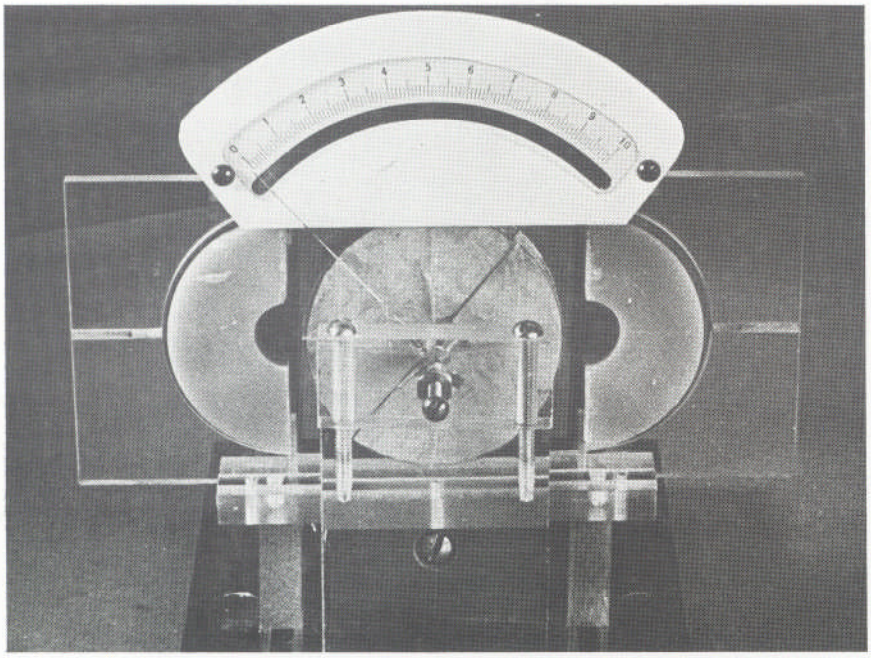
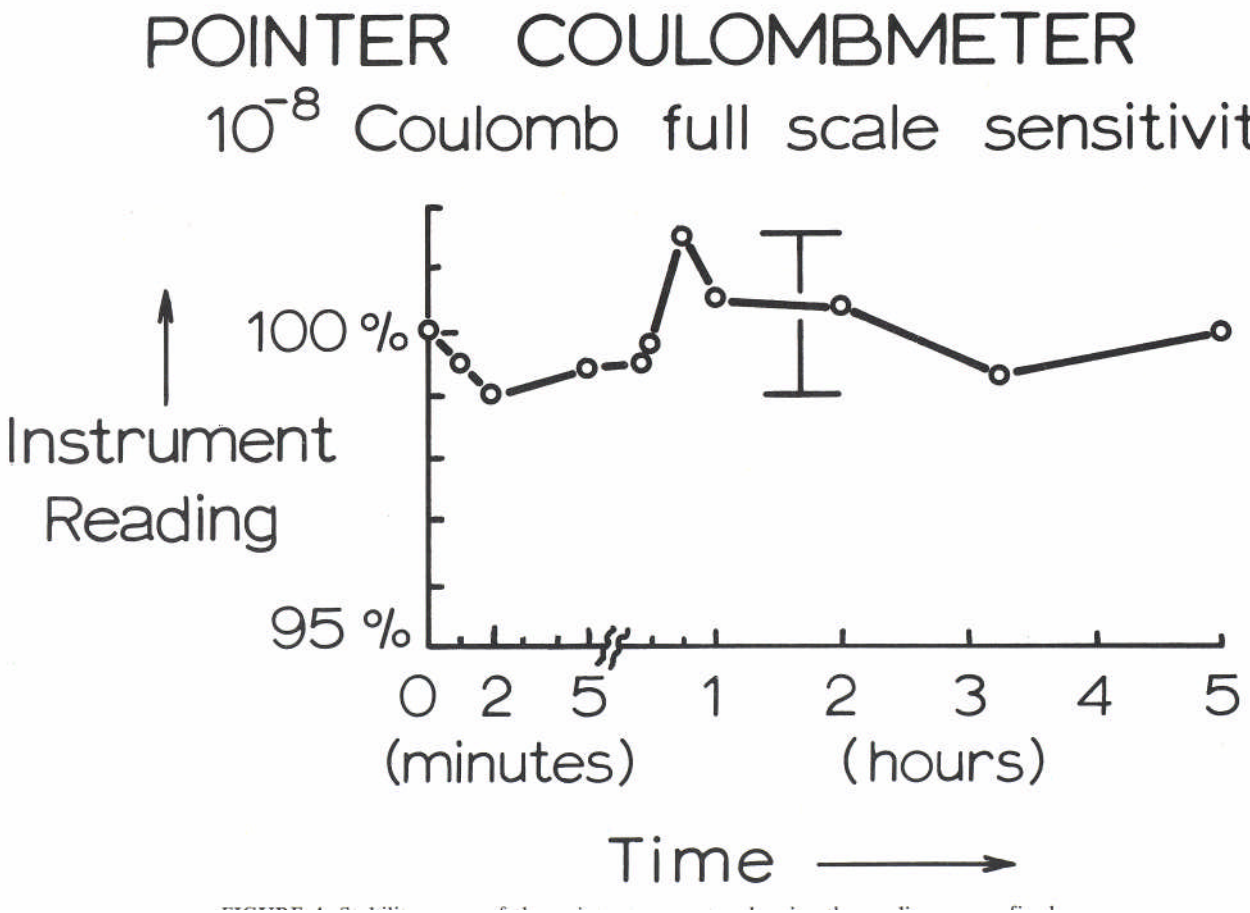


FIGURE 3. Photograph of the pointer-type meter showing the electret sections partially removed.


POINTER COULOMBMETER
10^{-8} Coulomb full scale sensitivity
100 %
95 %
Instrument Reading
0 2 5 1 2 3 4 5
(minutes) (hours)
Time

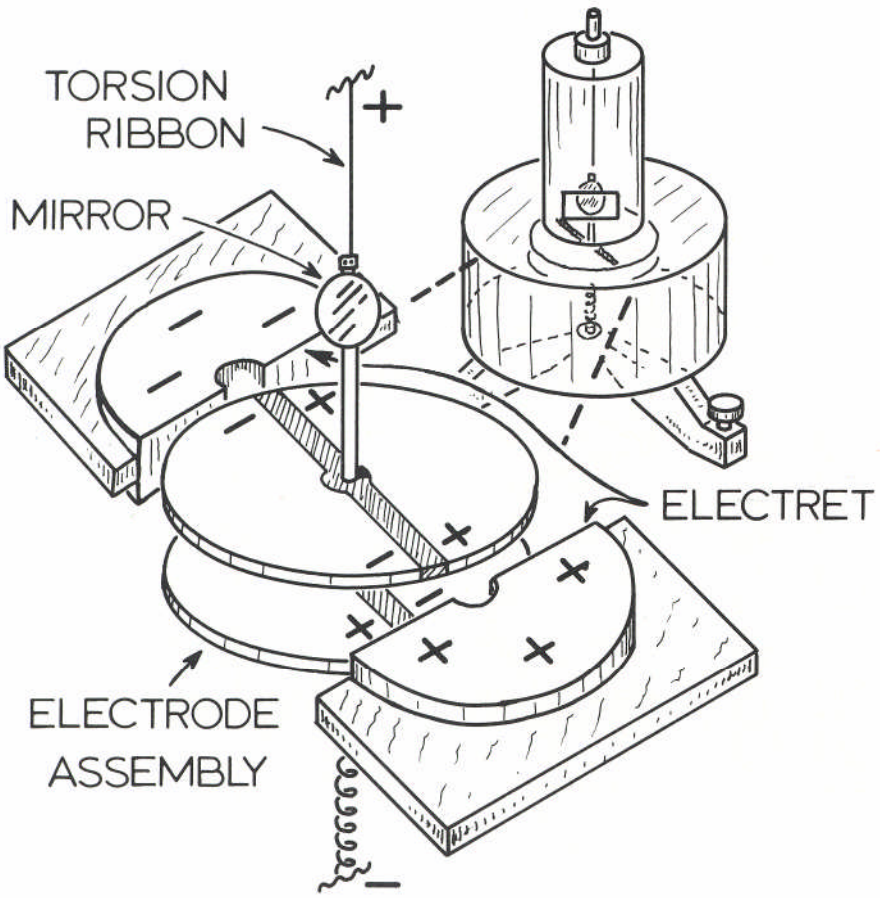


FIGURE 5. Schematic diagram of the mirror-type meter.

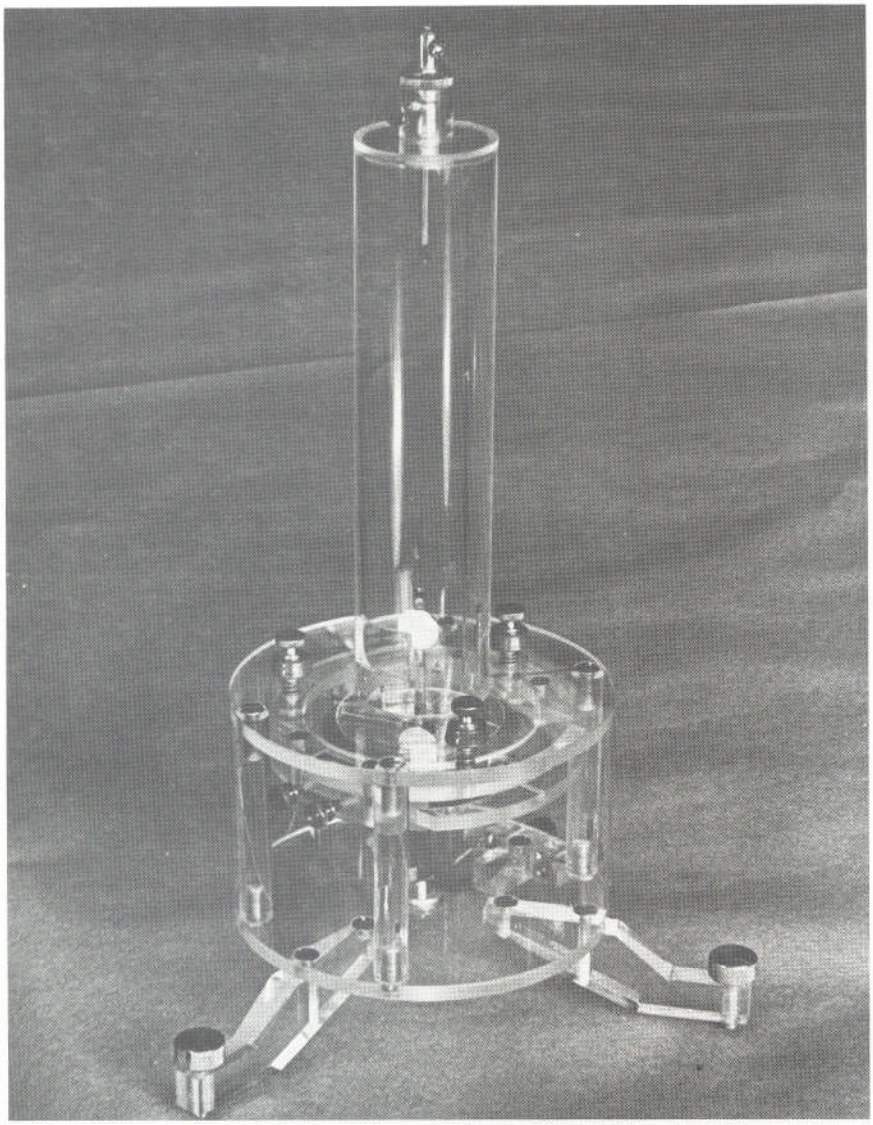


FIGURE 6. Photograph of the mirror-type meter.

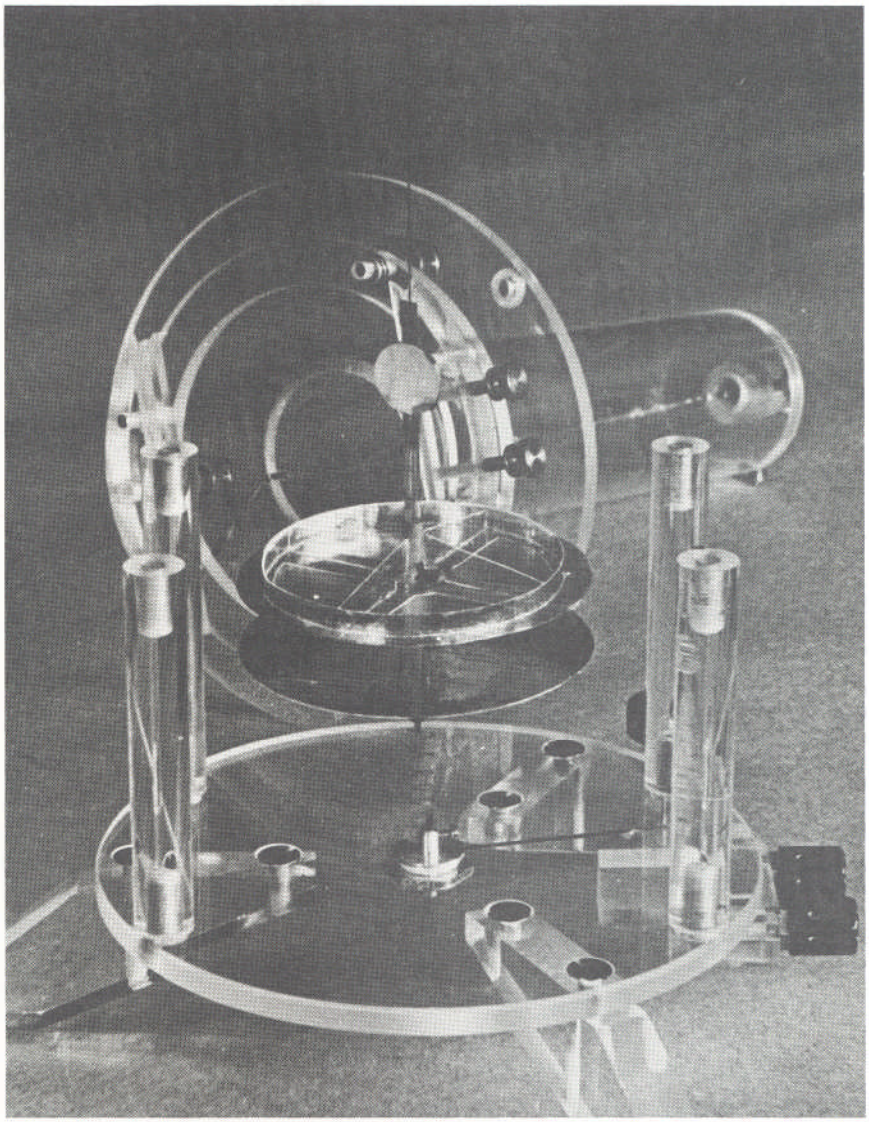


FIGURE 7. Photograph of the mirror-type meter partially disassembled to show the suspension and electrode assembly.

Acknowledgments

The authors would like to thank Mr. Jack Johnson, machinist, for his assistance in constructing the electrometers described in this paper.

Literature Cited

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2. Jefimenko, Oleg, and David K. Walker. 1968. Force measurements on electrets. *Proc. W. Va. Acad. Sci.* 40:338.
3. Walker, David K., and Oleg Jefimenko. 1968. Electrostatic force in electret devices. *Bull. Am. Phys. Soc.* 13:618.