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Autor: Muller, F.A.
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An electrometer with mechanical conversion

by **F. A. Muller**

Laboratory of Physics, Amsterdam University.

A short description is given of a type of converting vacuum-tube electrometer developed in Amsterdam during recent years. The principal part of such an electrometer is a vibrating condensor which converts DC charges into AC voltages. The vibrating element in this condensor is a square steel plate of 0.5 mm thickness and 30 mm sides. This plate vibrates with the corners alternately in phase thus leaving the center stationary and flat to a high degree of approximation. Here the plate is tightly fixed on a quartz insulator.

Opposite the corners of the plate there are eight soft iron pole pieces, rods with coils around them, of which four drive the plate at two corners in its natural vibration frequence, while the remaining four provide the feedback voltage for the oscillator. In order to make electromagnetic driving possible the whole instrument is magnetized by a direct current. If the driving current magnetizes two poles opposite one corner, with the same polarity, this corner is magnetized too and drawn to one side by the constant magnetic field. The feedback voltage originates from the same mechanism in the opposite direction. The eight poles are also acting as the grounded (or feedback) electrode of the vibrating condensor.

Thus the capacitance varies in the second harmonic of the vibration. Around the plate an electrostatic shielding is provided, while the coil-forms are made from brass and grounded.

This condensor is of a comparatively simple construction and has the following properties:

It is extremely rugged, it has a high conversion frequency (4600 Cps) and as the conversion frequency is the second harmonic of the driving frequency the latter is not apt to give much trouble.

The conversion is not very high, the effective capacitance variation is about 1 pF (2.5 pF top to top), the total capacitance being 16 pF. Due to the high conversion frequency it allows to measure quite easily with a RMS error of 10^{-16} C in 1 second corresponding with a RMS error of $3 \cdot 10^{-16}$ A measuring a current during 1 second and of $1 \cdot 10^{-16}$ A measuring during 2 seconds. The utmost performance seems to give an accuracy which is twice as good.