During the last 15 years a great number of high-frequency devices have been described in the literature. There might seem to be little value in adding another to the list. However, in the construction of these devices, the aim has been to achieve high sensitivity, a wide concentration range, and a simple and inexpensive design. When an apparatus is described as stable it usually means that it has sufficient short-time stability to permit accurate titrations.

When a high-frequency titrimeter is to be used as a recording or monitoring instrument, e.g. in chromatography, the requirements are much higher. Even a small long-term drift may be annoying if the chromatography is run for a long time. In the following pages some improvements are described which make a titrimeter suitable for recording in chromatography.

The tuned-plate, tuned-grid oscillator originally used by Jensen and Parrack\(^1\) was not very stable. Improvements were described by several authors\(^2-5\). These authors measured some circuit parameter correlated to the loss in a resonating circuit containing the cell. Beat-frequency methods have been extensively used\(^6-8\) as well as bridge-measurements, especially with the twin-T impedance bridge\(^9,10\).

The stability which may be reached with a beat-frequency oscillator has been investigated\(^8,11\). From data given in these papers it is possible to calculate the stability in chromatographic recording. The aim of this paper is to give the corresponding data for a Q-meter type high-frequency apparatus.

The recording of changes in low-frequency conductance have been highly developed\(^16-18\). The use of high frequency for recording in
chromatography has several advantages if the conductivity is low. Both, conductivity changes\textsuperscript{18,21} and capacitance changes\textsuperscript{19,20} have been recorded using this method.

**Apparatus**

A high-frequency titrimeter using a crystal oscillator was built, in which the grid bias change was measured. This voltage is roughly proportional to the loss in the anode resonant circuit. The circuit diagram is shown in Fig. 1. The grid bias is measured with a vacuum-tube voltmeter. The range can be made smaller by using a compensating voltage. Two separate regulated voltage supplies are thus required. This apparatus has been used successfully for high-frequency titrations. To increase the long-time stability, the heater voltage is supplied from a constant-voltage transformer, and further, the temperature of the room is kept constant. The remaining drift can be attributed to instability in the crystal and to changes in the thermal equilibrium of the oscillator tube caused by the influence of the cell circuit.

In the next apparatus which is shown in Fig. 2, the oscillator is separated from the load. A vacuum-tube works with the crystal in a Pierce-coupling employing the cathode and the two first grids. The oscillator excites the next vacuum-tube whose anode circuit is tuned to the crystal frequency. The total power can be adjusted by a potentiometer controlling the screen grid voltage of the amplifier tube. A link extracts power from the tuned circuit and transfers it to the Q-meter circuit which contains the cell and a precision tuning capacitor. The voltage across the capacitor is rectified and measured by a balanced vacuum-tube voltmeter.

At resonance, if the losses in the capacitor and the cell are neglected, the following relation holds between the introduced e. m. f., $E$, and the measured voltage, $U_1$, 

$$\frac{U_1}{E} = \frac{\omega L}{R}.$$  

If the source resistance of $E$ is small, $\omega L/R$ is equal to the Q-value of the coil. If a resistance $R_p$ is connected in parallel with the tuning capacitor, the measured voltage is decreased to $U_2$: 

$$R_p = \frac{U_1 U_2}{U_1 - U_2} \frac{\omega L}{E}.$$  

The relation between the conductance, $G_p$, and the output voltage, $U$, then takes the form 

$$G_p = \frac{a - U}{b U},$$  

where $a$ and $b$ are constants.