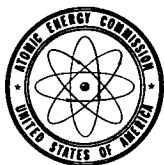# AEC-NASA TECH BRIEF

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Sensitive Bridge Circuit Measures Conductance of Low-Conductivity Electrolyte Solutions
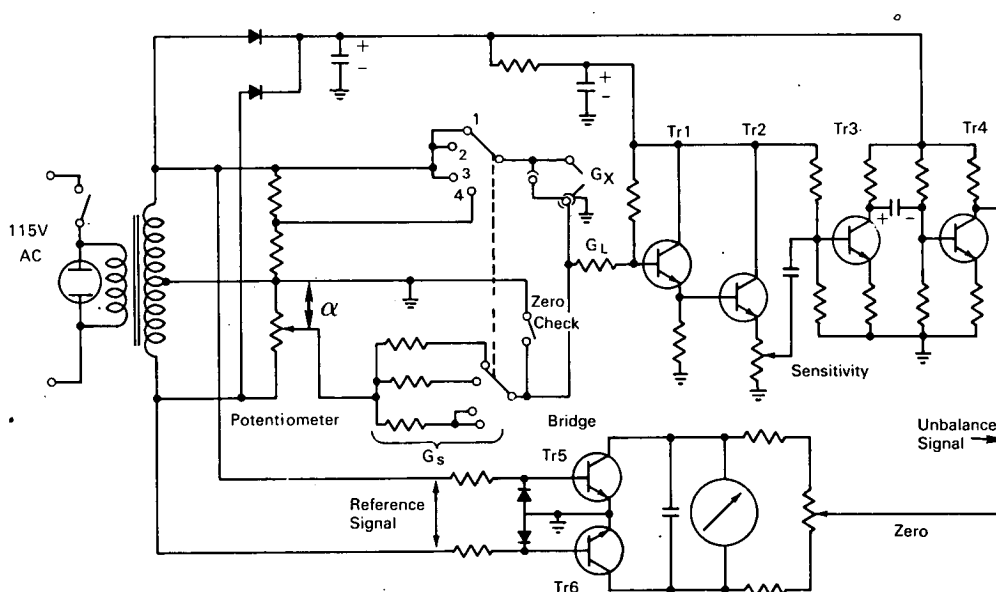
The problem:

To develop a circuit that permits sensitive and accurate conductance measurements of low-conductivity electrolyte solutions. The deflection of the null indicator near the point of balance must depend linearly on the resistance or conductance to be measured in order to facilitate conductometric titrations. The measured conductance must not depend appreciably on the reactive component (lead capacities etc.) of the system to be measured.

The solution:

. A compact bridge circuit that uses a 25-ohm potentiometer to achieve a null-point sensitivity of 10^{-4} or less, and an accuracy of approximately 0.2% when

the tangent of the phase angle between the unbalance and reference voltages is zero. The bridge utilizes a phase sensitive detector to obtain a linear deflection of the null indicator relative to the measured conductance and, within certain limits, a negligible influence of the phase angle ϕ on the point of balance. A phase angle with $\tan \phi = 0.15$ causes an error of only 0.8%. The bridge circuit is operated from a 115 volt, 60 Hz source and provides four conductance measurement ranges: 0 to 1μmho, 0 to 10μmho, 0 to 100 μmho, and 0 to 1 mmho.

How it's done:

The bridge is balanced by a 25-ohm potentiometer that forms part of a variable ratio arm. The approximate balance condition is obtained for the μmho

meter ranges when $G_x = \alpha G_s$ ($G_x = 10\alpha G_s$ for the mmho range), where G_x and G_s are the unknown and known conductances respectively, and α is the fraction of the total potentiometer resistance between the sliding contact and the grounded end of the slidewire.

The unbalance voltage is amplified, substantially free of phase shift, by transistor amplifier network Tr 1–Tr 4, and applied to the phase sensitive detector Tr 5, Tr 6. The phase sensitive detector acts as a reference voltage operated switch, producing a square-wave function reference signal. The unbalance signal is therefore multiplied by the square-wave function, presented as a dc component of the product, and indicated on the microammeter. The meter deflection is proportional to the product of the absolute value of the unbalance voltage, and the cosine of the phase angle between the unbalance and reference voltages.

Notes:

1. The bridge circuit performance was tested by connecting a 1 megohm resistor to the unknown conductance terminals, paralleled by a variable air dielectric capacitor. The bridge was then balanced in the 0- to 1-μmho range for various settings of the capacitor.

2. Additional details are contained in *Review of Scientific Instruments 37*, p. 671–672, May 1966.
3. Inquiries concerning this innovation may be directed to:

Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to: