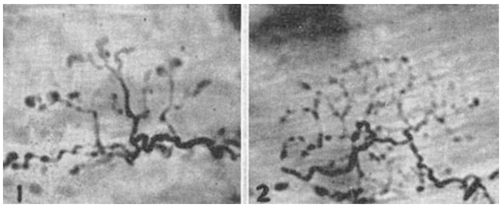

Two types of nerve endings in M. extensor et adductor digitorum of the second and third wing digits of the chicken, stained by the injection of methylene blue into the brachial artery. (× 300)

frog and chicken (Figs. 1 and 2). The endings in the intercostal and diaphragmatic muscles of rats have also been demonstrated by retrograde injection through the carotid artery into the aorta.

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[1] Denz, F. A., *J. Path. Bact.*, **63**, 235 (1951).
[2] McGregor, I. A., *Nature*, **171**, 1070 (1953).

Conductivities of Polyelectrolyte Solutions at High Frequencies

THE electrical conductivity of aqueous solutions of electrolytes increases with increasing frequency of alternating current. For simple electrolytes such as potassium chloride, this increase in conductivity does not become apparent until the frequency is of the order of 10 Mc./s.

The explanation of this phenomenon is given by the Debye–Hückel theory of electrolytes, that when the time of relaxation of the ionic atmosphere is greater than the period of the alternating current used, then an increase in conductivity of the solution will occur. It was found, when experiments were being carried out on aqueous solutions of the polyelectrolyte sodium polymethacrylate, that an increase in conductivity occurred at a much lower frequency than with the corresponding concentration of potassium chloride solution.

If we consider an assembly of uncoiled long-chain polyions in an alternating electric field, the effect of the latter will be to cause displacements of the polyions or segments of polyions within their cylindrical ionic atmospheres. The rate of recovery from displacements in the direction of the axis will be relatively slow, since the ionic atmosphere will retain its cylindrical symmetry, and the restoring force will therefore be small.

As regards displacements resolved at right angles to the axis of the polyion, one would expect the time of relaxation to be similar to that of a small spherical ion. The summation of the various displacements should clearly result in the appearance of a frequency effect at a lower frequency than is observed with small spherical ions.

The apparatus for proving that the effect occurred consisted of a variable-frequency oscillator giving a constant voltage output. The current was passed through the conductivity cell, which was in series with a variable resistance, and a high-frequency milliammeter. At a particular frequency, if the conductivity decreased, then the series resistance could be varied until the same ampere reading on the high-frequency milliammeter was noted. The adjusted reading on the variable resistance gave an indication of whether or not an increase in conductivity had occurred.

The readings from the instrument for the sodium polymethacrylate solutions were compared with standard potassium chloride solution, keeping all the conditions in both experiments identical, so that any stray capacitance effects were the same in both sets of solutions. This showed that the conductivity of sodium polymethacrylate solutions began to increase at a much lower frequency, that is, at about 0·1 Mc./s.

We wish to thank Mr. J. Rawcliffe and the Electrical Engineering Department of the College of Technology, Manchester, for technical advice while carrying out this work.

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Thermal Conductivity Measurements on Inert Media using Internal Calorimetry

INTERNAL calorimetry[1], developed for the measurement of blood flow, is basically a method for thermal conductivity determination. It uses a fine-gauge heated thermocouple embedded in the organ or medium under examination. In simple media a steady heating current applied to the filament raises the temperature recorded by the thermocouple. Temperature equilibration is rapid. Heat exchanges[2] are governed by Carslaw's equation[3] : $I^2R = 4\pi.r.\theta.k$, where k is the thermal conductivity of the medium, I the heating current, R the resistance of the heater, r the radius of a thermodynamically equivalent sphere and θ the temperature increment. Thus the relation between I^2 and θ is linear when k is constant ; $4\pi r/R$ is a constant for any given recorder and constitutes its standardization factor (F), the experimental determination of which has been fully described elsewhere[4].

The accuracy of the method was tested using various media. All determinations were carried out in a temperature-controlled room (20° ± 1° C.), with the medium in a water-bath at 20° C. In each case the relation between I^2 and θ was plotted from 0° to 3° C. at intervals of 0·2 deg. Knowing F, the thermal conductivity, k, was readily determined. The accuracy with solids and semi-solids was good, but was greatly reduced in liquids. The following values represent an average of three separate determinations, and are compared with figures quoted in the "International Critical Tables".

Substance	k (observed)	k (I.C.T.)
'Vaseline' (at 0° C.)	$4·55 \times 10^{-4}$	$4·40 \times 10^{-4}$
Paraffin wax (m.p. 50° C.)	$6·45 \times 10^{-4}$	$6·0 \times 10^{-4}$
Liquid paraffin	$3·66 \times 10^{-4}$	$3·11–4·54 \times 10^{-4}$
Glycerol	$6·72 \times 10^{-4}$	$6·58–7·41 \times 10^{-4}$
Water	$13·6 \times 10^{-4}$	$13·86–14·23 \times 10^{-4}$

To accelerate equilibration it was usual to overheat the filament, then cool to the required temperature increment. In most media, equilibrium, once reached, was thereafter maintained indefinitely.