

LETTERS TO THE EDITORS

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A Measurement of the Earth's Magnetic Field by Nuclear Induction

EXPERIMENTS have been carried out recently to measure the total magnetic field in the vicinity of Christchurch, Hants, using the free precession technique briefly reported by Packard and Varian¹.

In these experiments, the protons in a sample of water are initially polarized magnetically at right angles to the earth's field, and then the polarizing field switched off non-adiabatically. The residual magnetic vector is free to precess about the earth's magnetic field F , and in so doing induces a signal voltage in a pick-up coil. The frequency f of the precession is simply related to the field by the equation

$$2\pi f = \gamma_p F,$$

where γ_p is the gyromagnetic ratio for the proton.

The frequency f at this particular site at Christchurch at 12.30 p.m. on June 30, 1955, was 1,997.22 c./s., which corresponds to a value for F of 0.46906 ± 0.00001 gauss.

The frequency was measured in a simple manner by beating the input signal with the second harmonic of a 1,000 c./s. valve-maintained tuning fork checked against Rugby and B.B.C. to about 1 part in 10^6 . The beat pattern was photographed from the cathode-ray oscilloscope display and, by comparison with a crystal-derived 50-c./s. trace, estimated to 1 part in 600. The beat frequency was 2.784 ± 0.005 c./s., hence the error in precession frequency is only 1 part in 4×10^5 . Since the latest available value² of γ_p is $26,753 \pm 0.6$ sec.⁻¹ gauss⁻¹, the computed value for the total magnetic field is therefore limited by this. The value of F obtained is the time average over the period of an observation, about 5 sec.

For relative measurements, where the value of γ_p is not required, differences of the order of 1 microgauss should be just detectable.

The experiment recommends itself for its extreme simplicity. The apparatus consists of a rugged and portable nuclear magnetometer head, requiring no careful orientation in setting up, and standard frequency-measuring equipment. Placing the head on a selected site and taking a reading requires only a few seconds.

The experiment does, incidentally, provide a striking means of demonstrating the nuclear relaxation times T_1 and T_2 .

Full details of the method and results will be reported elsewhere.

G. S. WATERS

Signals Research and Development Establishment
(Ministry of Supply),
Christchurch, Hants.
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¹ Packard, M., and Varian, R., *Phys. Rev.*, **93**, 941 (1954).
² Ramsey, N. F., "Nuclear Moments" (John Wiley, 1953).

Colour of Tellurite Glasses

THE glass-forming properties of tellurium dioxide, and the interesting properties of some tellurite glasses have been described by Stanworth¹. Certain of these glasses have possible applications as optical components owing to their high refractive indices. However, all the tellurite glasses were prepared using commercially available tellurium dioxide and were coloured, usually slightly, yellow-green. This is in contrast to the statement of Berzelius² that clear, colourless glasses could be made by fusing the tetra-tellurites of barium and the alkali metals.

It was considered probable that the colour of the glass originated from impurities present in the tellurium dioxide. Spectrographic examination showed that the amount of impurity in the glasses was very small, that calcium and strontium were the main impurities and that slight traces of aluminium, magnesium, sodium, iron and gold could be detected. Of these it was judged that iron was by far the most probable source of the coloration. Chemical analysis of some tellurite glasses for iron gave values between 0.004 and 0.007 per cent for the total iron expressed as Fe_2O_3 , in the glasses exhibiting least colour.

A number of attempts were then made to prepare a sample of pure TeO_2 , particular reference being paid to the iron content. According to Köthner³, tellurium metal may be separated from all impurities, except antimony, by repeated distillation under reduced pressure. This method was applied by distilling tellurium (50 gm.) in a bent quartz tube connected to a water-jet pump. Half the tube was heated in a small electric furnace, and the middle fraction of the distillate was collected at about 650° under 20 mm. mercury pressure. This procedure was repeated four times. The product was converted to the oxide TeO_2 , via the basic nitrate, by the method described by Marshall⁴, thus effecting a further purification.

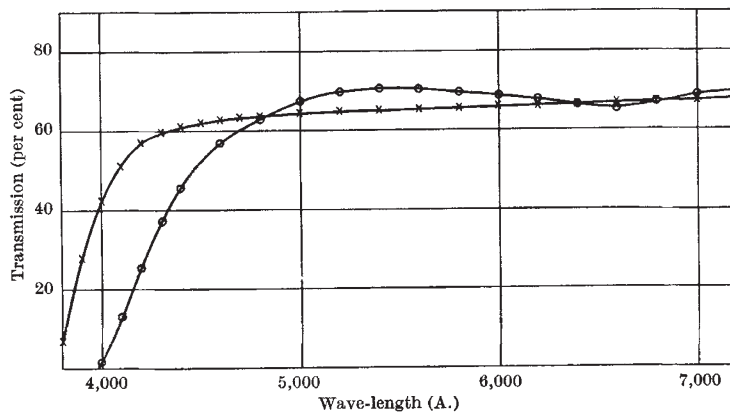


Fig. 1. Spectral transmission of barium tellurite glass of molecular composition $BaO.8TeO_2$. O, Melted in gold, using commercial tellurium oxide; x, melted in gold, using purified tellurium oxide

Glasses of molecular composition $BaO.8TeO_2$ were melted from 'Analar' barium carbonate and various samples of TeO_2 , and it was immediately evident that the TeO_2 purified as above gave glasses with much reduced colour. All the glasses were melted for 10 min., in a gold crucible at 900°, and were afterwards annealed from 310°. The glasses were ground and polished to a thickness of 3.5 mm. and the visual transmission curves obtained. The