structure corresponding to grey tin transforms to indium antimonide II having the structure of white tin.

A. JAYARAMAN
R. C. NEWTON
G. C. KENNEDY

Institute of Geophysics,
University of California,
Los Angeles.

[1] Keyes, R. W., *Phys. Rev.*, **99**, 490 (1955).
[2] Gebbie, H. A., Smith, P. L., Austin, I. G., and King, J. H., *Nature*, **188**, 1095 (1960).
[3] Kennedy, G. C., and Newton, R. C., *Solids under Pressure*, edit. by Paul and Warshauer (McGraw-Hill, 1961).
[4] Kennedy, G. C., and La Mori, P. N. (to be published).

A New Photometric Technique using a Variable Shutter Device

THE present standard of accuracy in spectrophotometric measurement is unsatisfactory, partly because of the limitations of conventional techniques. In the measurement of spectral transmission of coloured filters, for example, the precision obtainable from commercially available instruments is limited to $\pm 1/10^3$ of full-scale reading, while the accuracy depends, *inter alia*, on the linearity of a detector-amplifier system or an attentuator-comb. This is found to be inadequate and an alternative approach to the problem is suggested.

In our proposed technique the quantity measured is, effectively, time, while the detector is used as a null indicator. The steady light flux passing through the filter to be measured is compared with the mean flux contained in the same beam when the filter is replaced by a repetitive shutter, the 'open to shut' time-ratio of which can be varied. This ratio is adjusted to make the mean flux reaching the detector the same in the two cases. The transmission factor of the filter, τ, is then obtained by measuring, r, the 'open to shut' time-ratio of the shutter $\left(\tau = \dfrac{r}{1 + r} \right)$.

Three major considerations are: (1) The photocell system adopted must average the pulsed flux correctly, in other words, it must obey Talbot's Law[1]; it need not, however, exhibit d.c. linearity. (2) Since variable shutters of the type required are not available, one must be devised. (3) The timing measurement must be capable of very high accuracy and precision.

As a result of recent work we have been able to show that Talbot's law is obeyed closely by a vacuum photocell, provided the rate of repetition of the pulses is high enough. This is because the 'fatigue' processes producing non-linearity in photocells have a relatively long time constant. This result was foreshadowed by the work of Carruthers and Harrison[2] and Stiles[3], who showed that some cells which were markedly non-linear when used under steady-state conditions did in fact obey Talbot's Law to their limit of accuracy when the light was interrupted at a frequency of a few cycles a second. Preston and Gordon-Smith[4] have suggested that 'fatigue' effects may be caused by the accumulation of a quasi-static electron charge on insulating surfaces inside the photocell: such a process might have a time constant of hundreds of seconds.

As yet the ideal variable shutter does not exist, although some commercial types of high-speed shutter have operating times shorter than 10^{-8} sec. so that the prospect of developing a suitable type for our purpose appears hopeful. Since the shutter ratio could be measured for each transmission reading, it need not retain its calibration for long periods, nor is absolute constancy in operation essential, since the time-ratio measuring technique gives a mean value.

In order to test the possibility of making an accurate time-ratio measurement, we have successfully used a rotating sector disk interrupting a light beam at a very small image to 'imitate' a shutter. Although this 'shutter' was non-ideal, in that the occulting of the image by the sector edge took an appreciable time compared with the repetition period, it was possible to measure it with the same precision as with the most precise d.c. photometry.

Two sectors, having transmissions of 1·5 per cent and 3 per cent respectively, were measured (a) by a high-precision laboratory method of d.c. photometry, using a photometer similar to that described by Jones and Sanders[5], and (b) by using a simple timing technique developed this year. The transmission values obtained by these methods agreed to within the experimental tolerances ($\pm 1/10^5$ of full scale reading), and these values were found to correspond closely with the results of direct measurement of the sector angles.

We conclude, therefore, that the new method is already capable of the same accuracy as the best conventional photometry and that, suitably developed, its potential precision and accuracy are much higher.

O. C. JONES
F. J. J. CLARKE

National Physical Laboratory,
Teddington, Middlesex.

[1] Walsh, J. W. T., *Photometry*, third ed., 98 (Constable, London, 1958).
[2] Carruthers, G. H., and Harrison, T. H., *Phil. Mag.*, **7**, 792 (1929).
[3] Stiles, W. S., *Phil. Mag.*, **7**, 812 (1929).
[4] Preston, J. S., and Gordon-Smith, G. W., *Brit. J. App. Phys.*, **6**, 329 (1955).
[5] Jones, O. C., and Sanders, C. L., *J. Opt. Soc. Amer.*, **51**, 105 (1961).

CHEMISTRY

Determination of Uranium as Pyrophosphate

WITH reference to the communication in *Nature* of June 24, p. 1188, on this subject, the following extract from Soddy's *Chemistry of the Radio-Elements*, published 1911, p. 33, may be of interest.

"This pouring of a solution of uranium containing a complex mixture of other constituents into excess of an alkaline carbonate is always a valuable first step in the separation of the uranium, and when the latter element is the only one being separated or estimated, it affords a ready means of obtaining the whole of the uranium in the filtrate in a state of approximate purity. For analytical estimations it is almost always an advantage to add some ammonium sulphide to complete the precipitation of the iron. Any suitable method can then be employed for the separation and estimation of the uranium in the filtrate. One of the most commonly employed is, after acidification and removal of the carbon dioxide, to add microcosmic salt (sodium ammonium hydrogen phosphate), to neutralize as nearly as possible with ammonia without causing a permanent precipitate to form, and then to add a considerable excess of sodium thiosulphate. Boiling for ten minutes brings down the whole of the