

### Conditions Determining the Intensity of X-Ray Reflections from Microcrystalline Layers

THE letter of Messrs. Stephen and Barnes on a "New Technique for Obtaining X-Ray Powder Patterns" in *NATURE* of November 16, p. 793, raises some points of interest with regard to the geometrical-optical conditions governing the device they describe.

As is done in the flat layer method we have developed<sup>1</sup>, they observe X-ray reflections from a flat microcrystalline layer by making use of wide beams. The X-ray source is at some distance from the camera and the layer is set so as to make only small glancing angles with the reflected rays. Such conditions correspond to our focusing relation  $\sin \alpha / \sin \beta = a/b$  for the case  $a > b$ . In Fig. 1, this relation is illustrated by reference to the 'toroidal' surface, discussed in previous papers<sup>2</sup>, which determines the locus of the points so situated as to reflect from a source  $A$  to  $C$  through an angle  $2\pi - (\alpha + \beta)$ . Since the magnification between  $A$  and  $C$  depends on the zone of the toroid, by making  $a > b$  a reduced image of the source with a corresponding increase of intensity can

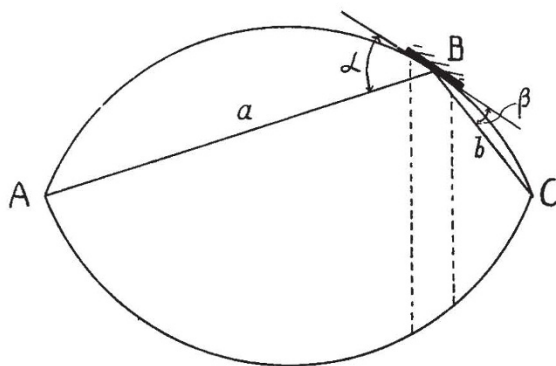


FIG. 1.

be obtained. Apart from this factor of magnification, the intensity is determined by the angular width of the incident beam. To obtain the maximum intensity we have met these combined requirements by placing the source  $A$ , which generally is a slit, back in the anticathode itself. The multiple diaphragm used by Messrs. Stephen and Barnes approximates to these conditions, as for a parallel beam  $a = \infty$ , when the focusing relations always requires the angle  $\beta$  to be small. It would thus appear that their method is in its principles the same as our method of the flat layer. Although they do not use the term focusing, the sharpening of lines and the increased intensity with shortening of exposure are two aspects of focusing and scarcely involve a new principle, claimed in the letter.

This view seems to be supported by Dr. W. H. George's elegant method<sup>3</sup> referred to in Messrs. Stephen and Barnes' letter, of obtaining a strong monochromatic reflection from a copper crystal cut so that its surface is oblique to the reflecting lattice planes. This corresponds to the reflection from an element of the toroid with  $a \neq b$ , and is entirely accounted for by the focusing relations; we described this in our earlier discussion by saying "that the lattice planes from which reflection takes place are inclined to the surface of the toroid like the tiles of a roof". They are indicated in Fig. 1 by the shaded lines at  $B$ .

We look forward to finding in the more extended publication foreshadowed by Messrs. Stephen and Barnes a fuller exposition of the distinctive features of their method and of the underlying principles. In some measurements with a source  $A$  at finite distance and a flat microcrystalline layer, we found that with decrease of  $\beta$  below the angle of focusing the intensities did not increase but decreased in accordance with an absorption effect<sup>4</sup> which could not be discussed within the limits of this letter.

J. BRENTANO.

Physical Laboratories,  
University,  
Manchester.

<sup>1</sup> J. Brentano, *NATURE*, **112**, 652; 1923. *Proc. Phys. Soc.*, **37**, 184; 1925.

<sup>2</sup> J. Brentano, *Arch. Sci. Phys. et Nat.*, (4), **44**, 66; 1917; (5), **1**, 550; 1919. Also loc. cit.

<sup>3</sup> W. H. George, *NATURE*, **136**, 180, Aug. 3, 1935.

<sup>4</sup> J. Brentano, *Z. Phys.*, **70**, 74; 1931. *Proc. Phys. Soc.*, **47**, 932; 1935.

### Variation in the Lattice Constant of Zinc Oxide

IN the course of electron diffraction investigations, it is often necessary to have a more accurate method of measuring voltage than the spark gap affords. Reference films have been used by several workers, the electron voltage being calculated from the lattice constant as known from X-ray work. Gold films were originally used, but more recently metallic oxide films have been preferred, as they yield very good diffraction patterns. The use of such films obviously demands that the crystal structure shall be stable and the lattice dimensions constant.

During the past three years, I have been using both gold and zinc oxide films in this way. Whilst the former have behaved uniformly well, the latter have showed small but consistent variation in lattice constant, as tested against a high-resistance voltmeter. It is conceivable, but scarcely possible, that both the voltmeter and gold film varied, and that the zinc oxide films were actually stable.

The oxide films were prepared by withdrawing a brass washer of 5 mm. diameter from a skimmed melt of granulated zinc contained in a crucible. The lattice constants of such a newly prepared film were found to be:  $a = 3.234 \pm 0.005$  A.;  $c = 1.615 \pm 0.005$  A. After an interval of one year, during which the film was protected from dust but was exposed to the air, the constants were found to be:  $a = 3.262 \pm 0.005$  A.;  $c = 1.628 \pm 0.005$  A. Six months later the values were found to be slightly higher still:  $a = 3.279$  A. and  $c = 1.637$  A., with the same probable error as before. No changes in these latter values were observed after the lapse of a further two months. To check this drift in the lattice constants, a fresh zinc oxide film was then prepared. This gave values very near to those first obtained with the previous film:  $a = 3.242$  A.,  $c = 1.620$  A. These values compare with those given by Bragg<sup>1</sup>:  $a = 3.220$  A.,  $c = 1.608$  A.; the difference is not significant, as there is a constant error of  $\pm 0.5$  per cent in the present work, owing to uncertainty as to the camera length. This error will affect all the values equally, and therefore can have no part in causing the observed drift.

The fact that the lattice constants of zinc oxide films vary in this regular way with time, whilst those of gold films remain constant, must be the result of stresses set up in the films during the rapid cooling