ciprocals of the interplanar spacings of the internal standard against distance along the film. This should be nearly linear, and the values of $1/d$ for the substance being investigated can be readily interpolated.

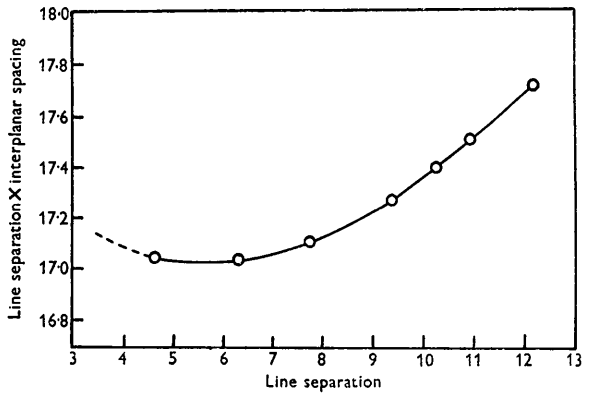

Fig. 2.

All of these methods have been applied to the identification of constituents of mixtures with an added standard substance or with a cubic or other substance already present in the mixture. The first two methods have been occasionally applied to the determination of unit-cell dimensions, whilst the last two in particular are only suitable for the approximate determination of cell dimensions, the accuracy being relatively low.

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Suggested device for the production of a monochromatic divergent beam.

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The appearance of absorption conics on divergent-beam photographs (e.g. Lonsdale, 1947) is in accordance with the expected *increase* of absorption of X-rays in the Bragg position. It has been shown, however (Borrmann, 1950), that for highly perfect crystals of quartz and calcite, *dark* conics are observed instead of light absorption

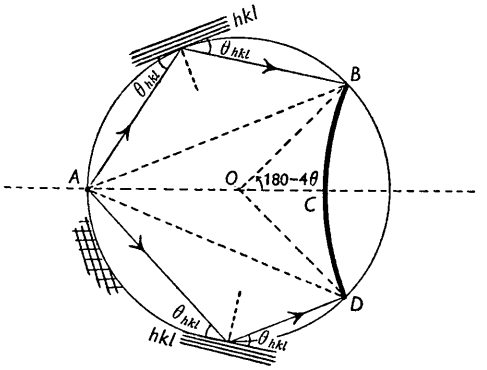

Fig. 1. General case. The monochromatic component of the X-rays diverging from a point on the circumference of a hollow sphere of polycrystalline material in which a form of planes $\{hkl\}$ has Bragg angle θ_{hkl}, are focused on the circle BCD defined by $\angle\ BOC = 180° - 4\theta$.

conics, indicating a *decrease* of absorption in the Bragg position. This discovery accentuates the importance of quantitative measurements of absorption and extinction, and these could usefully be made by divergent-beam methods if a monochromatic divergent beam could be produced.

No method of producing such a beam appears to have been published hitherto, but it does not seem to be impossible, and the principle on which it could be done is given below.

This principle (Fig. 1) makes use of an integrating sphere. A polychromatic divergent beam containing a strong monochromatic component—such as can be generated from a wide-angle tube—diverging from a point on the surface of a polycrystalline sphere would produce

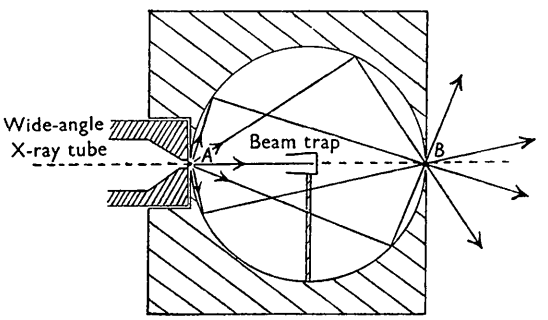

Fig. 2. Special case. When $\theta = 45°$, then $\angle\ BOC = 0$, and a monochromatic component of the original polychromatic beam diverging from A is focused at B, which thus becomes the origin of a monochromatic divergent beam.

a ring of monochromatic radiation on the surface of the sphere for each form of planes $\{hkl\}$ present in the polycrystalline sphere. When the Bragg angle is 45° for such a form of planes, this ring degenerates into a point and a divergent monochromatic beam will be generated with its apparent origin at this point, B (Fig. 2). Since $\theta = 45°$, each component of the new beam will be completely plane polarized, but, as the components come from all

directions, the resulting beam will be unpolarized. It will, however, like all such monochromatic beams, contain harmonics of wave-lengths $\frac{1}{2}\lambda$, etc., if the plane (*hkl*) reflects in higher orders.

An advantage of the method is that the size of the sphere is immaterial, and it can be made to fulfil any requirements which may simplify the actual construction. To avoid unnecessary loss of intensity, a small sphere would probably be best.

The production of such a sphere for monochromatizing Cu $K\alpha$ divergent radiation would be relatively easy, because copper itself has a Bragg angle of 45° 5′ for the {311} planes for Cu $K\alpha$ radiation. This is quite a strong reflexion, and the integrating effect should in any case result in a comparatively powerful beam.

It is intended to construct such a device for several purposes, including measurements of absorption and extinction in diamond. Diamond gives excellent divergent-beam photographs of the Lonsdale type, and some specimens give no divergent beam pattern at all with the ordinary polychromatic divergent beam. A pattern of the Borrmann type, however, has never been observed for diamond, either by Lonsdale or by the author (Grenville-Wells, 1951) (or by Borrmann himself, though many specimens have been tried—private communication).

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Some X-ray measurements on single crystals of hamster carbonmonoxyhemoglobin.*

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The interpretation of X-ray photographs obtained from stationary crystals having large unit cells was first described by Crowfoot & Schmidt (1945) in their study of a derivative of tobacco mosaic virus. More recently the method was used by Carlisle & Dornberger (1948) in the examination of crystals of bushy stunt virus. In the present investigation this method was applied to the analysis of small-angle rotation photographs of hamster carbonmonoxyhemoglobin.

Crystals of carbonmonoxyhemoglobin were prepared from citrated hamster blood. The red cells were separated, washed, and hemolysed as described by Drabkin (1946),

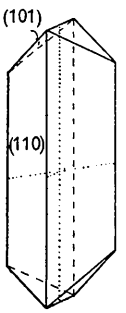

Fig. 1. The crystalline habit of hamster carbonmonoxyhemoglobin.

and the resulting hemoglobin solution was saturated with carbon monoxide. Crystallization was carried out at 4° C. by dialysis against a solution of half-saturated $(NH_4)_2SO_4$ solution adjusted to pH = 6·5. Within a few days prismatic crystals about 0·5 mm. across were obtained; their appearance suggested orthorhombic symmetry (Fig. 1). Selected wet crystals were sealed in thin capillary tubes and photographed at 4° C. with Cu K radiation, in a cylindrical camera of 5 cm. radius. The crystal was oscillated through an angle of 1·0–1·5°. The photographs were measured and interpreted by a modification of the method of Crowfoot & Schmidt adapted to cylindrical films. The calculations are analogous to those described by Carlisle & Dornberger.

The analysis of about twenty X-ray photographs gave the following crystallographic information:

Laue symmetry: D_{2h}–*mmm*.
Unit cell dimensions: $a = 123$, $b = 88$, $c = 60$ A.
Lattice type: Primitive.

Space group: the following planes were in position to reflect

(h00) Observed: 600, 800, 10.0.0, 12.0.0, 14.0.0, 16.0.0;
Absent: 700, 900, 11.0.0, 13.0.0, 15.0.0.
(0k0) Observed: 060, 080;
Absent: 070, 090.
(00l) Observed: 004;
Absent: 005, 006.

Probable space group derived from the systematic absences and from the stereochemical nature of proteins: $P2_12_12_1$.

It is interesting to observe that Boyes-Watson, Davidson & Perutz (1947) have described a form of horse methemoglobin which shows absences characteristic of the space group $P2_12_12_1$ and which has cell dimensions $a = 122$, $b = 82{\cdot}4$, $c = 63{\cdot}7$ A. From this similarity of space group and dimensions it might be inferred that there is some similarity between the arrangement of the molecules in crystals of this form of horse methemoglobin and in crystals of hamster carbonmonoxyhemoglobin.

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* Contribution No. 1568 from the Gates and Crellin Laboratories.