A camera lucida attachment for the goniometer.

By G. F. Herbert Smith, M.A., D.Sc., F.G.S.
Assistant in the Mineral Department of the British Museum.

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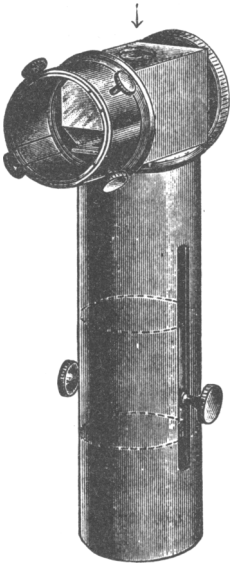
WHEN investigating the morphology of crystals, such as those of schwartzembergite, which are so rounded or striated as to afford no definite reflections of the object-slit of the goniometer, the author found most serviceable a camera lucida which could be attached to the eye-piece of the telescope of the goniometer, and thus used for the direct drawing upon paper of the 'light-figures' given by the crystals, the ordinary signal being replaced by a pin-hole. The cap of the eye-piece in use is unscrewed and the camera lucida is fixed to the tube by means of four clamping screws. The camera lucida is of the ordinary type, consisting of the Amici double-prism, so that the eye looks vertically downwards upon the paper of the drawing, while the image that would ordinarily be visible in the eye-piece is projected in the same direction. The only modification is the additional vertical tube, within which is an inner tube carrying a lens that brings the drawing sharply into focus and removes the parallax that otherwise exists between the image and the drawing. The inner tube can be held in any desired position by means of two clamping screws which pass through the vertical slots of the outer tube and grip it. The lens is carried in a cell, and may be removed by unscrewing the ring fixing it, and replaced, if necessary, by another of more suitable focal length for the purpose in view.



Camera lucida attachment for the goniometer.[1] (The arrow indicates the direction of vision.)

The camera lucida is of service for two purposes:—

1. *The representation of 'light-figures'.*—Imperfectly formed crystals with rounded or striated faces are not suitable for measurement in the

[1] The block for this figure has been kindly lent by Dr. A. E. H. Tutton, F.R.S., with the permission of Messrs. Macmillan & Co., Ltd., the publishers of his forthcoming book on crystallography.

ordinary way, and the determination of the position-angles of even a few conspicuous parts of the 'light-figures' would be a tedious operation. By means of the camera lucida the figures may be drawn directly upon a projection if a two- or three-circle form of goniometer be employed. The most convenient course is to map out the projection by parallels referred to the centre of the projection, the distances remaining constant for each revolution. The crystal should be revolved a convenient number of degrees—10°, 15° or 20°—at a time, and the drawing revolved simultaneously through the same angle. The scale of magnification is determined by the known angular width of the field of the telescope of the goniometer; it must, however, be remembered that the angular distance between two images in the field of the telescope is double that actually subsisting between the corresponding small faces, and therefore for the purposes of the projection the angular width of the field must be taken as half its actual value. A lens of suitable focal length must be selected to fit the scale; slight modifications can be secured by raising or lowering the paper slightly, or by revolving the eye-piece through a small angle so that the tube of the camera lucida is slightly out of the vertical. In the case of the stereographic projection the linear equivalent of angular distance is at the equatorial plane just double that near the pole. The longer the focal length of the lens used with the camera lucida, the larger the scale of the projection.

2. *The delineation of small crystals.*—With any form of goniometer which admits of the simultaneous determination of the distance and azimuth of the poles of a crystal with respect to a fixed pole as origin, no difficulty is experienced in determining the relative positions of the faces developed on a crystal, however tiny and complex it be, once it has been mounted on the crystal-holder; but the faithful drawing of such a crystal and the correct identification of the faces is not easy in the ordinary way. If the crystal be drawn by means of a camera lucida under a microscope it may be impossible to recognize with certainty, from the freehand sketches previously made, the faces depicted. No such difficulty exists if the crystal be drawn while still on the goniometer, since in any case of doubt the co-ordinates of the particular face may be at once re-determined. A small portable electric lamp to illuminate the crystal from different points will be found useful. The author has also found it convenient to have an attachment for converting the telescope into a microscope by placing before the eye-piece a lens which has a sliding arrangement for focusing purposes. The longer the focal length of the lens used with the camera lucida, the larger the resulting drawing.