

*A Student's Goniometer.*

By H. A. MIZERS, M.A.

*(With Plates III., IV., and V.)*

[Read October 25th, 1887.]

**T**HIS instrument, which was designed for use in the Crystallographic Laboratory of the City and Guilds of London Institute (Central Institution), is in its simplest form (Plate III.) a strong and inexpensive Wollaston Goniometer. It is, however, constructed in such a way that it may be converted into an instrument of greater precision (Plates IV. V.) by the simple addition of accessory parts to the apparatus of Plate III. without any previous alteration.

L is the graduated disc, and B the milled head by which it is turned ; the vernier *v* is not the slender tongue of metal which is usual in such instruments, but is engraved upon a portion of the fixed disc V ; and L is kept in continual contact with V by means of a circular steel spring inserted between B and the bearing of the axle. L has an inner lip by means of which it may be clamped by the screw C to the fixed disc V ; the fine adjustment may then be effected by the slow motion screw D, which works against a spring and is fixed to V at a convenient angle on the side furthest from the observer.

The bearing of the axle is cast in a single piece with the metal cross-piece which supports the disc, and is made longer and more massive than is usual in similar instruments.

The only essentially new feature is to be found in the mounting and adjustment of the mirror ; this part of the apparatus is carried by a strong brass tube A firmly screwed to the solid crosspiece. Upon A is a sliding tube E which can be clamped in any position by a split ring and screw shown at *e* ; upon E and at right angles to it is fixed the tube F, in which slides a cylinder also clamped by a split ring and screw shown at *f*, but this cylinder has a pin fitting to a slot in F, so that it can only slide without rotation ; the mirror is attached to it by the capstan-head screw H.

It will be seen, therefore, that the mirror is capable of adjustment by two sliding movements along straight lines perpendicular to each other, namely, along the cylinders A and F, and by two movements of rotation about these lines.

To adjust the mirror the screw H is loosened, and the mirror is set parallel to the axis of the instrument in the usual way by means of a distant signal and a small plate with parallel faces mounted upon the goniometer; H is then clamped once for all, after which the other movements may be employed without disturbing this adjustment; the mirror may for instance be set at any desired inclination by rotating the tube E about A.

Plate IV. shows a modification of the same instrument in which the simple crystal holder and adjustments of Wollaston are replaced by the more complicated centring and adjusting apparatus devised by von Lang.

To receive this addition the axle of Plate III. is made hollow, so that nothing more is required than to remove the crystal adjustment-piece of Plate III. and to pass into the hollow axle a second axle attached to the adjustment-piece of Plate IV. The latter consists as usual of two traversing screws, M N, working at right angles to each other, for centring, and two tangent screws working parallel to them for adjustment of an edge.

In this instrument the centring movements are not, as is usual, effected by a slide which travels between straight guides, but the screws M N set in motion two plane discs which swing about pivots at *m* and *n*, and move in contact with one another.

The motion imparted to the discs by the screws M N is therefore not rectilinear, but a circular motion about *m* and *n* as centres. There is little or no practical inconvenience in this arrangement, and it is simpler in construction and stronger than the usual sliding motions between guides. The moving pieces are kept in true plane contact by spring nuts which pass through slots having the form of circular arcs described about *m* and *n* respectively as centres. Q is the milled head which turns the piece M N.

Finally, a third modification of the same instrument is shown in Plate V.

Here the levelling screw at the end of A having been unscrewed, the mirror is removed and replaced by a strong tube P, provided with two clamps *x x*, which slides on to A in place of E. This tube carries a telescope T and collimator W, attached to supports which slide upon opposite sides of a solid vertical circular arc; upon this they may be set at any desired inclinations by means of screw clamps on their inner sides;

*s s s* are adjustment screws, by which the telescope and collimator are brought into the same vertical plane and directed towards the axis of the instrument.

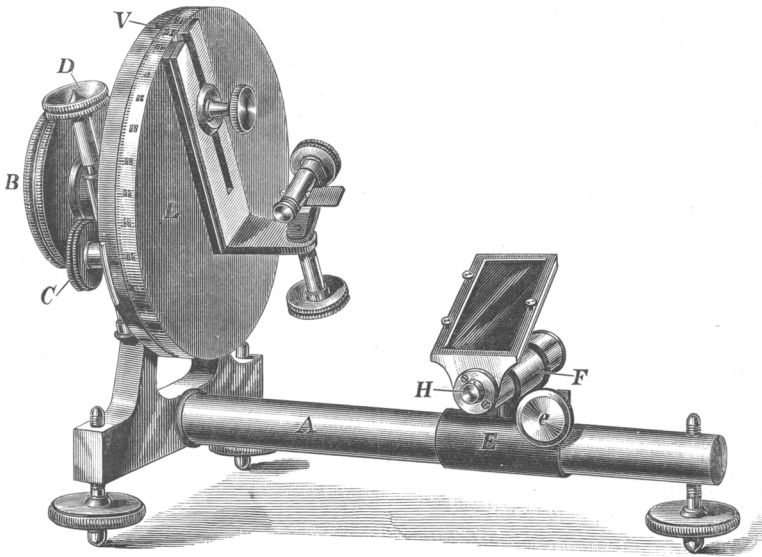
This Goniometer has been constructed by Messrs. Troughton and Simms, of New Charlton, whose circles are, as is well known, divided with great accuracy.

The instrument of Plates III., IV. may be used with a horizontal slit placed in front of a window at a distance greater than 10 feet from the goniometer, as a distant bright signal. Prof. Miller originally recommended the employment of a separate faint signal which is to be seen reflected in the mirror, while the bright signal is observed by reflection in the crystal. I have found it advisable to use only one bright signal to supply both the image in the mirror and that in the crystal face.

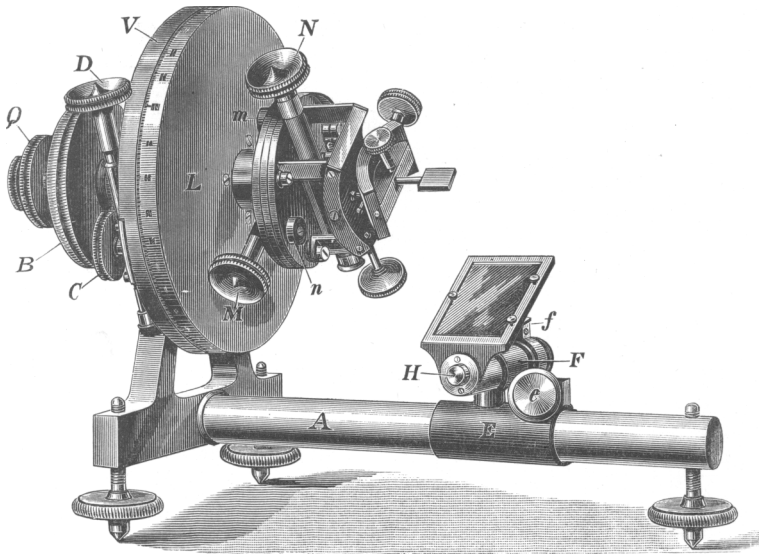
To bring the two images into coincidence it is only necessary to introduce before the mirror a small card screen of such a height that it can intercept all the light which falls from the slit upon the mirror, but not the light which falls upon the crystal; if the screen is then moved laterally until it cuts off half or more of the image in the mirror, the adjustable image seen in the crystal face may easily be set with accuracy so as to form an exact prolongation of the remaining portion of the fixed image seen in the mirror; any desired amount of the latter can be cut off by moving the card screen.

A still more convenient signal is that recommended by Prof. Mallard; a small slit placed at its focus behind a large lens of about 5 inches focal length which stands close to the goniometer and is illuminated by a lamp.

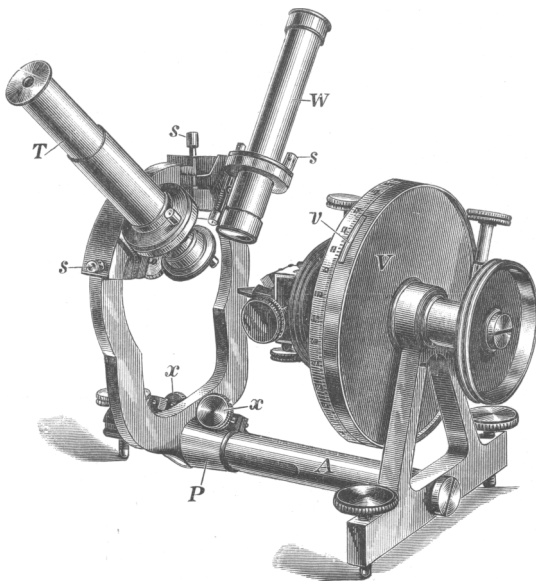
To fix crystals to the holder nothing is more convenient than a mixture of beeswax and pitch, which may be fused together in different proportions to form a cement of any desired consistency; for this purpose a mixture in the proportion of two parts by weight of wax to one of pitch is generally suitable.



*Fig. 1.*



*Fig. 2.*



*Fig. 3.*