A simple single-axis rotation apparatus

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Summary. The apparatus enables a small crystal to be rotated through 360° about an axis parallel to the stage of a polarizing microscope, while immersed in a liquid of known refractive index. Angles of rotation are measured on a graduated drum to the nearest degree. The working distances separating the crystal from the objective and the condenser are sufficiently small for wide-angle interference figures to be obtained. The crystal is easily mounted and centred.

MANY forms of apparatus have been devised for rotating a small crystal, immersed in a few drops of a liquid of known refractive index, about an axis parallel to the stage of a polarizing microscope, such as, for example, those described by Wood and Ayliffe (1935), Bernal and Carlisle (1947), Rosenfeld (1950), Tatarskii (1951), Hartshorne and Swift (1955), and Wilcox (1959). The advantages of this simple technique in determining the optical properties of crystals have been demonstrated by several authors, notably by Vedeneeva and Kolotushkin (1934), Joel (1950), Swift (1954), Joel and Garaycochea (1957), and Hartshorne and Stuart (1960), as well as by those just mentioned. More recently, Fisher (1962) has described a modification of a Vigfusson-type warm stage to take a needle and graduated drum, so that the refractive indices of small single crystals can be determined by the double variation method.

Among these various devices the 'spindle stage' of Wilcox (1959) has impressed the writer by its elegant simplicity, and by the fact that the working distances separating the crystal from the objective and the condenser are so small that wide-angle interference figures can be obtained with ease. It has, however, the disadvantages for some operations that the rotation of the crystal is restricted to 180°, and that the plastic half-circle against which angles of rotation are measured is only graduated at intervals of 5°.

The apparatus here described (fig. 1) combines working distances

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comparable with those of Wilcox's stage with complete freedom of rotation of the crystal around 360°, and enables angles of rotation to be read to the nearest degree. It incorporates some of the features of the larger apparatus described by Hartshorne and Swift (1955), notably the graduated drum with quick clamping device. The needle A (fig. 1*a*), made of $\frac{1}{32}$ in. steel rod, is tapered at the end carrying the crystal *B*, and rests in a V-groove cut in the upper surface of the brass plate *C*, which is $\frac{1}{16}$ in. thick or slightly less (say $\frac{3}{64}$ in.). A is held in the groove by the three turn-clips *D*. This method of support effectively corrects any slight curvature that *A* may have when unsupported, and which is difficult to avoid entirely in such thin rod. The depth of the groove is such that the axis of *A* is level with the upper surface of *C*. At *E*, *C* is recessed to a depth of 0·045 in. over a diameter of $\frac{3}{4}$ in., and a central hole $\frac{3}{8}$ in. wide is drilled through the plate (see also fig. 1*b*). This recess accommodates a $\frac{3}{4}$ in. no. 2 coverslip and two glass blocks (*c*. $\frac{1}{16}$ in. or 1·5 mm thick) as shown, to form the bottom and sides of the immersion cell. The coverslip and blocks are cemented in place with 'Durofix', or some other adhesive that is not attacked by the usual immersion liquids. In use the cell is completed by a strip of coverslip laid on the glass blocks, the immersion liquid being held by capillarity. Rotation angles are measured by the light alloy drum *F*, 1 in. in diameter and graduated at intervals of 2°, which can be clamped to the needle *A* by means of the milled head *G* acting on the split and tapered shank of *F* (see detail in fig. 1*c*). Angles are read against the fixed mark on the quadrant *H*. Two legs *J*, about $\frac{5}{8}$ in. long, project downwards from the plate *C*, and on the Cooke microscope for which the apparatus actually figured was made, these act as stops to prevent the drum *F* from fouling the stage clamp. They also prevent the drum from coming into contact with the bench when the apparatus is removed from the microscope and laid down. The apparatus is clamped to the microscope stage by two finger screws (not shown) passing through the holes *K*, which are drilled oversize to allow for centring, as on the usual type of universal stage.

To set up the apparatus, it is first laid on the microscope stage, centred, and clamped in position. The needle and drum are then removed and separated from one another. The crystal is mounted on the needle (see Wilcox, 1959, pp. 1276, 1277, for useful hints and methods), and when the adhesive has set the drum is returned to the needle, but not clamped, and the whole assembly is replaced on the plate and secured by the clips *D*. After bringing the crystal to the centre of the field by sliding the needle along the groove, the drum is securely clamped to the

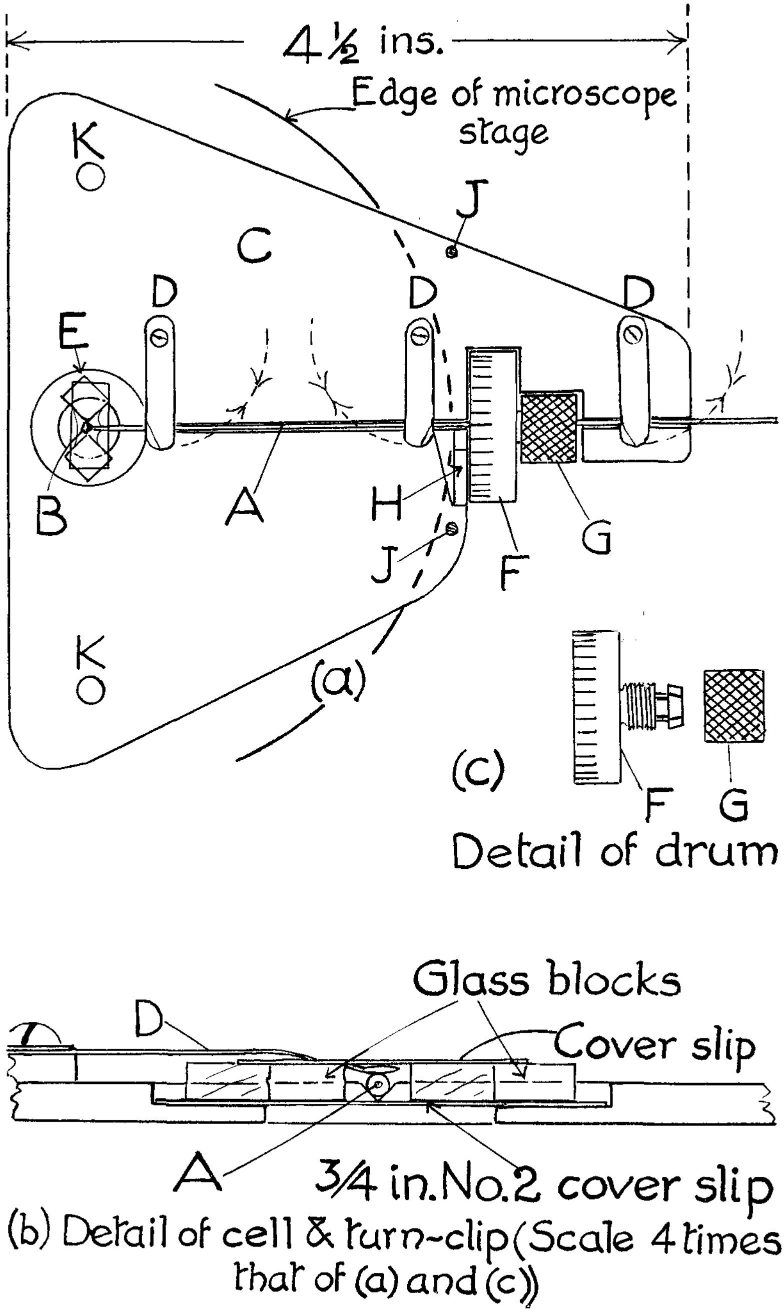

FIG. 1. A simple single-axis rotation apparatus.

needle, the coverslip laid on the glass blocks, and the immersion liquid run into the cell.

The apparatus was first made for the writer in the workshop of the School of Chemistry of the University of Leeds, and his thanks are due to Mr. Fred Lee, the Chief Technician, and his staff. It is now being supplied, in a slightly modified form to suit stages of all sizes, by McCrone Associates, c/o Malies Instruments Ltd., Ann's Place, Albion Street, Southwick, Sussex, to whom further inquiries should be addressed.

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