MICROSCOPE WITH UNIVERSALLY MOVABLE TUBE

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INTRODUCTION

A microscope with universally movable tube has been designed in order to facilitate the examination of crystal grains of varying orientations for the determination of their refractive indices, using the dispersion method.[1] The Fedorov universal stage, which is extremely useful for the examination of mounted mineral sections, is not suitable for the examination of mineral grains immersed in a liquid[2] as the liquid will flow and the grains shift their positions upon inclining the stage. The device of a movable microscope tube aims primarily to apply the methods of the universal stage to grains immersed in a liquid.

CONSTRUCTION OF THE INSTRUMENT

The main parts of the instrument are as follows:

(A) Main circle, 29 cm. in diameter, carrying the microscope tube with its optical parts attached, and the illuminator.

(B) Semi-circle, within which the main circle (A) rotates.

(C) Horizontal stage.

(D) Supporting base.

(A) The main circle is graduated on the side and reads with the aid of a vernier to tenths of a degree. About 5 cm. of the circle is cut away, and in this space is placed a semi-circular arc (a_1), which carries the microscope tube. Opposite to (a_1) is fastened a support (a_2) with an adjustment screw for the illuminating apparatus. Below the polarizer is a cylindrical case with a lamp. This can be replaced with a mirror by means of which light from an outside source (e.g., from a monochromator) may be used.

(B) The main circle (A) is supported by the semi-circle B, and is rotated within it by means of a rack and pinion. Also the semi-circle B can be rotated about the horizontal axis d_1d_2.

(C) The circular stage, 12.5 cm. in diameter, is graduated and reads with the aid of a vernier to tenths of a degree. The central portion, about 5.5 cm. in diameter, can be removed when the hemi-spherical glass segment is used. The center of rotation of the stage can be made to coincide with that of the main circle ring (A) by adjusting screws.

[1] Merwin, H. E., and Ponsjak, E., *Jour. Am. Chem. Soc.*, vol. **64**, p. 1965, 1922.
Tsuboi, S., *Mineral. Mag.*, vol. **18**, p. 108, 1923.
Tsuboi, S., *Japanese Jour. Geol. and Geography*, vol. **3**, p. 19, 1924.
Tsuboi, S., *Jour. Geol. Soc. Tokyo*, vol. **37**, p. 37, 1930.

[2] Emmons, R. C., *Am. Mineral.*, vol. **14**, p. 441, 1929.
Lindley, *Min. u. Petr. Mitt.*, vol. **41**, p. 58, 1930.

(D) The base is constructed with stout vertical arms, which carry the above mentioned parts A, B, and C at d_1 and d_2.

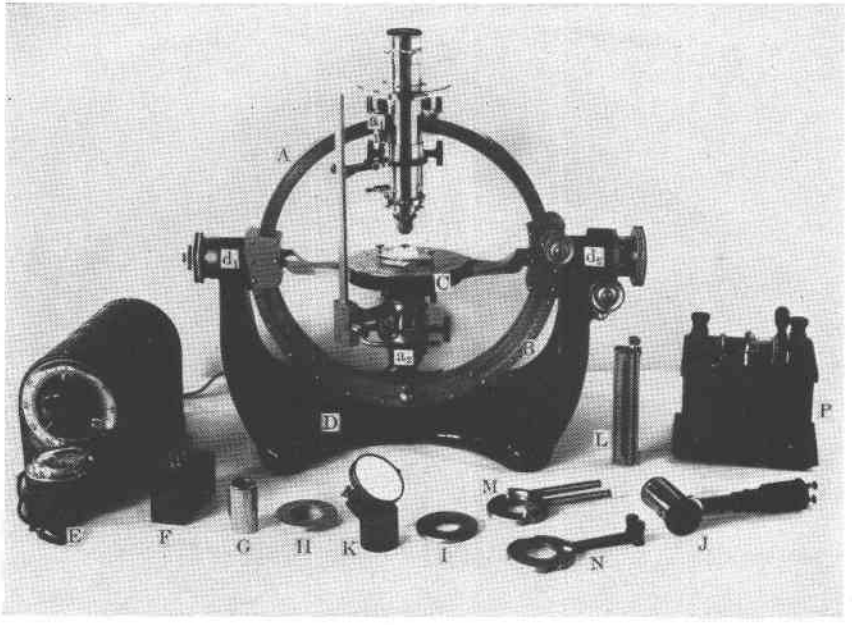

FIG. 1. Front view of the instrument and its accessories. A, Main ring. B, Semi-circle. C, Objective stage. D, Supporting base. E, Resistance coil for illuminator. F, Filters. G, Condenser for monochromator. H, Objective stage attachment for goniometer. I, Objective stage attachment for ordinary observation. J, Autocollimator ocular. K, Mirror for monochromator. L, Attachment to mount ordinary tube, A.M., C.M., Leitz microscope. M, Water cell for stage to be connected in series with the refractometer, and to be used for controlling the temperature of the immersion liquid. N, Electric heating ring for stage, to give controlled temperature to the immersion liquid. P, Variable resistance for electric heating ring.

MANIPULATION OF THE INSTRUMENT

The manipulation of this instrument is rather simple compared with that of ordinary universal stage.[3] The tube is movable in two different directions. One movement is brought about by rotating the ring A, in the semi-circle B, and the other movement by rotating the semi-circle B (with the ring A), about the horizontal axis d_1d_2. The tube may be brought to any desired position by the proper combination of the two sets of movements. The first of the two corresponds to the movement

[3] Berek, M., *Mikroskopische Mineralbestimmung mit Hilfe der Universaldrehtischmethoden. Berlin*, **1924.**

Reinhard, M., *Universal Drehtischmethoden*, etc., *Besel*, **1931.**

along the great circle, and the second to that along the small circle in Wulff's stereographic net.

Furthermore the stage can be tilted by rotating it about the horizontal axis d_1d_2. This movement, though not needed for the purpose for which the instrument was primarily devised, may be useful in certain cases.

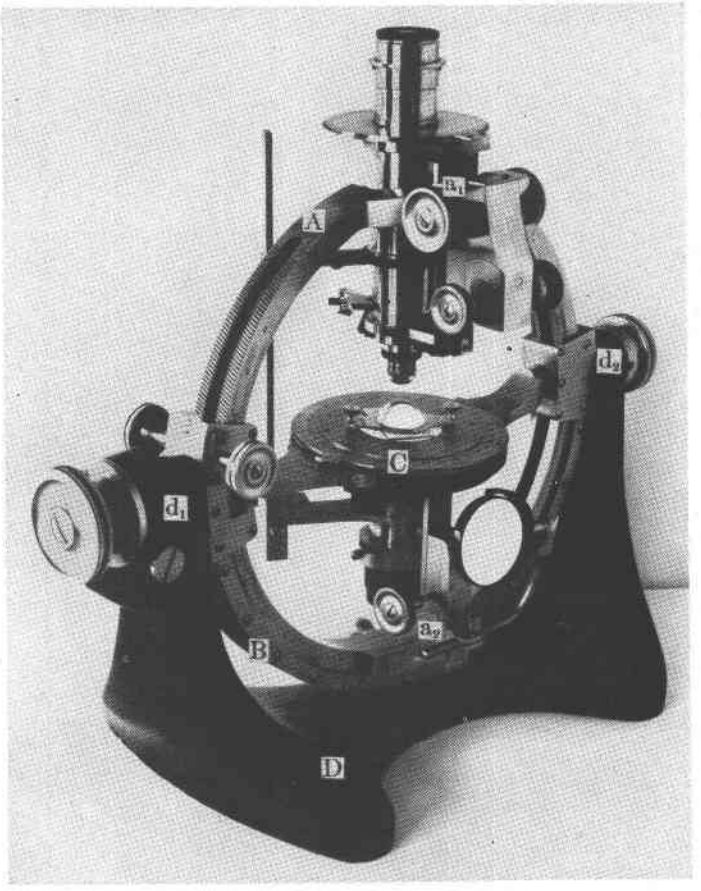

FIG. 2. Diagonal view of the instrument.

USE OF THE INSTRUMENT

While the present device is primarily for observing mineral grains immersed in a liquid, it may also be used for several other purposes.

In determining the principal refractive indices of biaxial crystals by the dispersion method, the tube is to be oriented so that its axis is parallel

to one of the optical elasticity axes X, Y, or Z of the crystal. To bring the tube to the proper position, it is convenient to use the lamp, enclosed in the cylindrical case, below the stage. Then the case is replaced by the reflecting mirror which reflects light from a monochromator to the object. To determine the indices of a mineral when very few crystal grains are available, the double-variation method[4] is preferred, and furthermore the use of standard glass powders[5] may also be found very advantageous.

The instrument may be used likewise as an optic axial angle goniometer. Then objective 2, U. M. 3 or 5 (Leitz) and the Bertrand lens are used.

Also when it is used as a goniometer, an autocollimator ocular is to be attached. With this apparatus the measurement of the interfacial angles is not as accurate, and does not cover such a wide range as that of a goniometer, but this is not the main function of this apparatus. In some cases, however, such as with electrolytically deposited crystals on a plate, this apparatus may serve for rough measurements.

Acknowledgments

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[4] Emmons, R. C., *Am. Mineral.*, vol. **13,** p. 504, 1928; vol. **14,** p. 441, 1929.
[5] Sueno, T., *Am. Mineral.*, vol. **18,** p. 421, 1933.