# *Preliminary Note on an Improved Form of Three-Circle Goniometer.*

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In a previous paper[1] the author pointed out the advantages of a three-circle form of goniometer in the determination of the morphological characters of crystals; the crystal is adjusted once for all, and measurements may be made in any desired zone. A description was added of such an instrument, which had resulted from the addition of a two-circle apparatus to an ordinary Fuess goniometer with a single horizontal circle. This instrument has been in almost daily use since the end of June, 1899, and the author is, therefore, in a position to appreciate the ease and celerity with which crystals, however small, may be in this manner measured. As was remarked in the paper quoted above,[2] the adapted instrument has the disadvantage that measurements can only be made through little more than a right angle from the pole in which the zone to be measured and the zone of reference intersect, and, therefore, only half a zone can be measured without readjustment of the circles $B$ and $C$.[3] To complete the zone, it is necessary to rotate $C$ through a half-turn and to turn $B$ till the axis of $C$ makes the same angle with the vertical as before, but on the other side of it. If the crystal is morphologically perfect and the faces at the intersections of the two zones are present and give good reflections, the necessity for readjustment causes merely a little inconvenience; but, since crystals are seldom so complete and the particular faces may not be present, it will not be possible to obtain by direct measurement the angle between two faces which do not make angles of less than a right angle with the same pole of intersection of the zones,

[1] This Magazine, 1899, XII, 175-182; a translation appeared in Zeits. Kryst. Min. 1900, XXXII, 209-216.

[2] Ibid. footnote on p. 179.

[3] The same notation is employed here as before: $A$ is the horizontal circle whose axis is fixed in space, $B$ the vertical circle whose axis lies in a horizontal plane, and $C$ the third circle.

and further it will not be possible in general to determine by observation whether three faces lie in the same zone.

The author has now devised a way of overcoming this difficulty by means of a change in the optical arrangements. Since the crystal is supported from underneath, we require the possibility of measuring through 180° from a pole in the zone of reference over the upper half of the crystal to the diametrically opposite pole ; in other words, we must be able to obtain reflections from both the faces parallel to $B$ without rotating $C$. To effect this, the telescope and collimator are combined into an autocollimating telescope,[1] the tube of which is bent through a right angle in the horizontal plane, so that on rotation round the axis of $A$ the circle $B$ and the crystal lie on opposite sides of the object glass, and thus a reflection can be obtained from the face nearest the circle $B$, as well as from the parallel face. The author hopes in a future paper to describe in detail an actual instrument of this kind.

[1] If preferred, the telescope and collimator may have separate tubes, but both must lie in a *vertical* plane and be turned through a right angle.