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A New Bent-crystal X-ray Monochromator.

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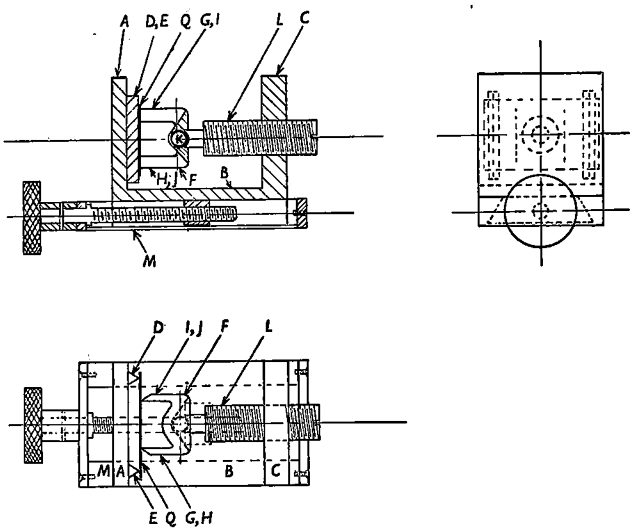
In various investigations in X-ray crystallography it is often necessary to obtain a collimated beam of monochromatic radiation. There are two extreme conditions to which any given monochromator may tend: one, a nearly parallel beam with any desired area of cross-section and the other, a converging beam in which the X-rays come to a focus at a line or a point. The first type of monochromator is needed for work where the divergence of the rays must be small; the second type can conveniently be used where a large surface of crystalline material is irradiated and the reflected rays are required to be as intense as possible. The parallel beam is best realized by using a plane and nearly perfect crystal surface as monochromator. If quartz is used a divergence of no more than 5′ to 10′ is found with a good crystal, even if the surface is ground to increase the intensity of reflexion. A converging beam is obtained by using a bent crystal either according to the scheme of Johansson(1) or that of von Hámos(2). Johansson clamped a thin crystal plate between cylindrical surfaces of given radius, and von Hámos plastically deformed rock-salt so as to have the desired curvature.



Bent crystal X-ray monochromator

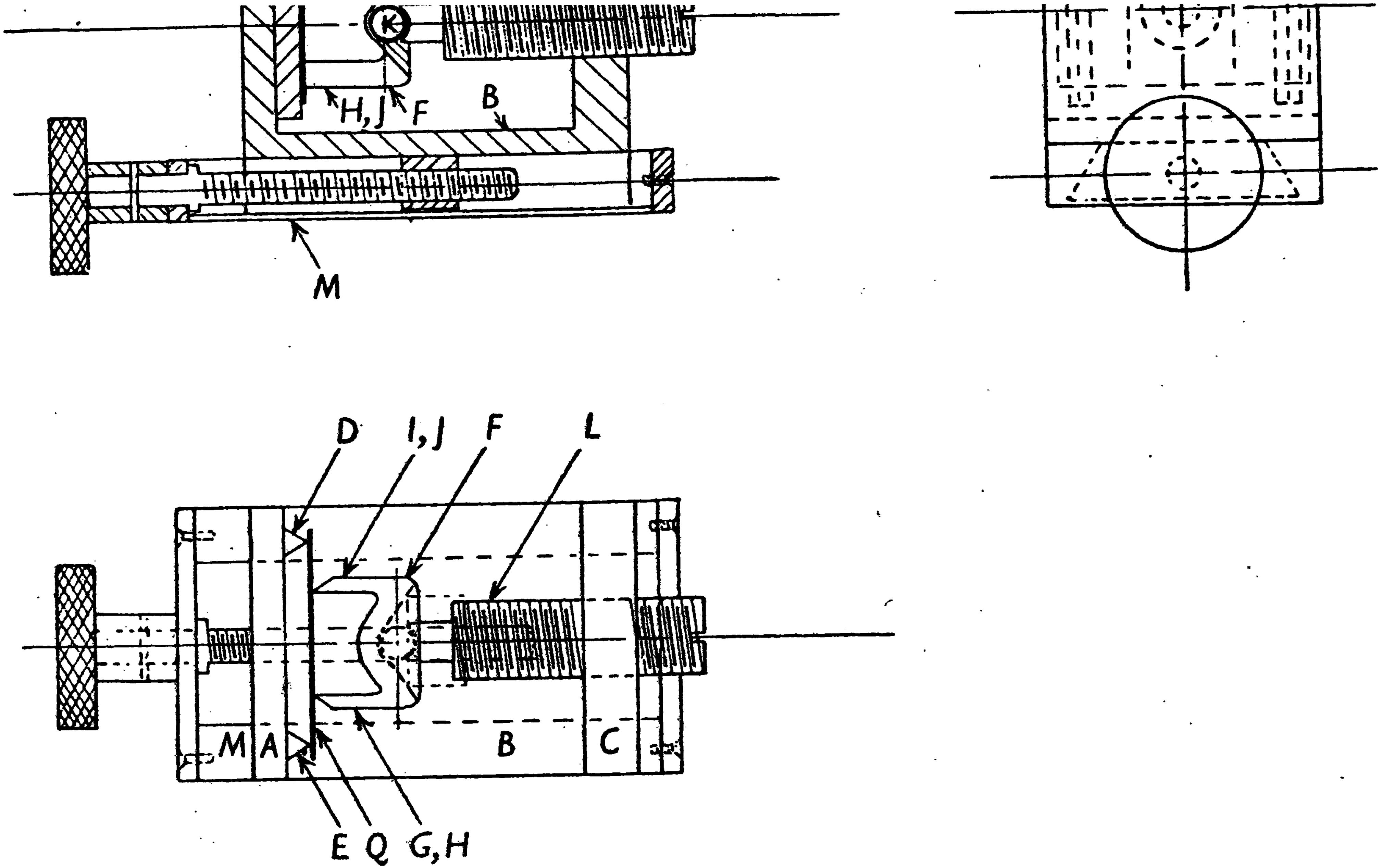
The monochromator described below was designed to be used with an ionization spectrometer(3) in which the divergence of the beam could not conveniently exceed 40′ and the relative positions of the X-ray tube and spectrometer made it difficult to calculate the optimum radius of curvature of the bent crystal. For this reason the monochromator was designed so as to obtain a range of curvatures by the turn of a screw. The diagrams show in plan and in elevation the disposition of the component parts of the apparatus. A U-shaped piece of brass *ABC* supports on the limb *A* two knife edges *D*, *E* on which rests the quartz plate *Q* (25 × 11 × 0·3 mm.), cut parallel to $(10\bar{1}1)$. The piece of brass *F*, which presses the plate *Q* against the knife edges *D*, *E*, is fashioned from a solid block. It was cut first so that it had two parallel knife edges approximately half as far apart as *D* and *E*. The centre parts of these knife edges obstructed the passage of the X-rays and were cut away leaving four knife-edge feet *G*, *H*, *I*, *J*. A conical depression in the block contains a steel ball, and a screw *L* presses the feet *G*, *H*, *I*, *J* gently against the quartz. Only a very light pressure is required to produce the necessary curvature on the centre half of the crystal. To bring the crystal into the correct position with regard to the slit system of the spectrometer, the monochromator is mounted on an axis of rotation intersecting the line of the slits, and also on a slide *M* which permits translation in a direction perpendicular to the crystal plate.

The X-ray tube was 15 cm. from the monochromatizing crystal, and the collimating slits of width $\frac{1}{2}$ mm. were respectively at 10 and 20 cm. from it. The crystal under examination on the spectrometer table was 10 cm. from the second slit.

As the screw *L* was gradually tightened and the crystal progressively bent, the intensity of the monochromatized beam was measured as a function of the rotation of the screw. It was found that, starting from the unbent crystal, the intensity increased up to about 4·5 times, and then, with further tightening, it decreased. In the position giving maximum intensity it was found that removing the first slit did not in any way increase the intensity of the beam, showing that the beam was coming almost to a focus near this point. Similarly, on removing the second slit, the intensity increased by only about 10 %, showing that most of the beam was transmitted by this slit. The width at half maximum of the beam coming from the monochromator was measured using a 111 reflexion from a good crystal of fluorite and found to be 30′. Thus, when divergence can be tolerated, this form of monochromator is a suitable means for getting a much greater intensity than that provided by an unbent crystal.

REFERENCES

(1) Johansson, T. *Z. Phys.* **82**, p. 507 (1933).
(2) Hámos, L. von. *Ann. Phy., Lpz.*, **19**, 252 (1934).
(3) Wooster, W. A. and Martin, A. J. P. *Proc. Roy. Soc.* A, **155**, p. 150 (1936).



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