⁶ J. B. Hess and C. S. Barrett: Structure and Nature of Kink Bands in Zinc. *Trans. AIME* (1949) **185**, p. 599; *JOURNAL OF METALS* (September 1949).

⁷ W. A. Wood and R. F. Scrutton: Mechanism of Primary Creep in Metals. *Journal Inst. Metals* (1950) **77**, p. 423.

⁸ J. Hino, P. G. Shewmon, and P. A. Beck: Effect of Simultaneous Strain on Subgrain Growth. *Trans. AIME* (1952) **194**, p. 873; *JOURNAL OF METALS* (August 1952).

⁹ J. Washburn and E. R. Parker: Kinking in Zinc

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¹⁰ I. S. Servi and N. J. Grant: Structure Observations of Aluminum Deformed in Creep at Elevated Temperatures. *Trans. AIME* (1951) **191**, p. 917; *JOURNAL OF METALS* (October 1951).

¹¹ I. S. Servi, J. T. Norton, and N. J. Grant: Some Observations of Subgrain Formation During Creep in High Purity Aluminum. *Trans. AIME* (1952) **197**, p. 965; *JOURNAL OF METALS* (September 1952).

Technical Note

Modifications of the Schulz Technique for The X-Ray Determination of Preferred Orientation in Rolled Metal

by M. L. Fuller and George Vaux

AN apparatus and procedure for the determination by X-ray reflection of preferred orientation of crystals in rolled metal with the Geiger counter X-ray spectrometer was described by Schulz.¹ This

¹ L. G. Schulz: *Journal of Applied Physics* (1949) **20**, pp. 1030-1033.

is an excellent procedure and we have used it continually for several years. In our use of the procedure, two modifications have been made and used during most of this period. One of these provides for automatic scanning and recording of the reflections, and the other makes possible the application of the procedure to coarse-grained specimens and permits measurement of almost all orientations without resort to the transmission technique.

The automatic scanning and recording are accomplished by a motor drive of the inner ring of the Schulz apparatus (see R_2 in Fig. 2 of his paper and R_2 in Fig. 1 of this note) in synchronism with the chart recorder of the North American Philips 90° X-ray spectrometer. A rate of 10° per min is used. A scan of 180° is obtained corresponding to poles on the stereographic projection whose locus is a great circle.

The modification for coarse-grained material is accomplished by allowing a larger area of the specimen to contribute to the X-ray diffraction. In the Schulz apparatus the incident X-ray beam is confined by a slit system to rays in the plane of the spectrometer. Schulz demonstrated that this restriction of the X-ray beam permits a survey of the X-ray reflections without correction up to about 80° on either side of that specimen position in which the specimen is perpendicular to the plane of the spectrometer. This is the angle ϕ of rotation of the inner ring R_2 . One of these slits is horizontal and extends across the X-ray source side of the specimen. In the modification this slit is removed, thus permitting greater divergence in the X-ray beam and the irradiation of a larger area of the specimen surface. Fig. 1 shows the apparatus with the motor drive and with the slit removed. Discontinuities in the recorded X-ray intensity plot due to the few

Fig. 1—Preferred orientation apparatus.

participating crystals in coarse-grained metal are much lessened. The increased divergence does not cause reflections from other crystal planes to enter the Geiger counter slit.

An important advantage of the original Schulz scheme is thus lost and a system for correction is required. To do this, a compact of atomized copper powder was prepared and tested by the original Schulz method for the absence of preferred orientation. The horizontal slit was then removed and a curve recorded showing the variation of intensity with angle ϕ . In our arrangement the intensity was uniform within the range ϕ equals $\pm 30^\circ$. Beyond this the intensity fell off rapidly reaching zero at $\pm 90^\circ$. The curve thus produced is then used to correct measurements made on preferred orientation specimens. In practice this is accomplished by constructing from this calibration curve a family of curves which, as a transparency, can be superimposed on the recorder chart to read corrected intensity directly. Not only does this method permit the handling of coarse-grained material but it also makes possible the plotting of intensities almost to the circumference of the stereographic pole figure projection. Thus, nearly the entire pole figure can be plotted without the necessity of using the transmission technique. Moreover, intensities are much greater, an advantage when surveying crystal planes of poor reflecting power.

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