

were consistent with each other when rounded off to the nearest integer. Having identified  $m$  for a given band at room temperature, the value of  $m$  at a different temperature was determined with a visual spectrometer by counting the bands that move by the cross hairs as the crystal is heated. The bands were then photographed with a ten foot diffraction grating spectrograph.

Figure 2 is a reproduction of spectrograms obtained with a crystal plate 9.58 mm. thick held at two different temperatures. An iron arc comparison spectrum was used for plate calibration.

The measurements on some of the bands are summarized in Table I. The values of  $(n_\gamma - n_\alpha)$  recorded were checked by measurements on a crystal plate 12.27 mm. thick. The values obtained from a single spectrogram are self consistent to the fourth significant figure, but they differ slightly in the third figure from one determination to another. Probably one reason for this lack of adequate temperature control. Although the temperature indicated by the thermocouple did not fluctuate more than  $0.5^\circ$  C. during a run, the temperature error is probably greater than this because the thermocouple was not imbedded in the crystal.

Figure 3 shows  $(n_\gamma - n_\alpha)$  plotted as a function of wavelength over the range 3600 Å to 7200 Å for temperatures of  $25^\circ$  C. and  $85^\circ$  C. The mean value of the temperature coefficient of birefringence over this range is  $-1.00 \times 10^{-5}/^\circ$  C. with an estimated uncertainty of 8 per cent.

#### REFERENCE

- (1) A. E. H. TUTTON (1922), *Crystallography and practical crystal measurement*, Macmillan and Company, Ltd., London.

THE AMERICAN MINERALOGIST, VOL. 44, JANUARY-FEBRUARY, 1959

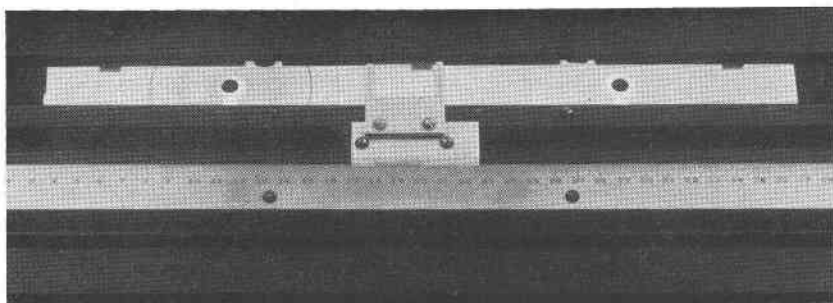
#### CALIBRATION SIGHTS FOR X-RAY POWDER CAMERA

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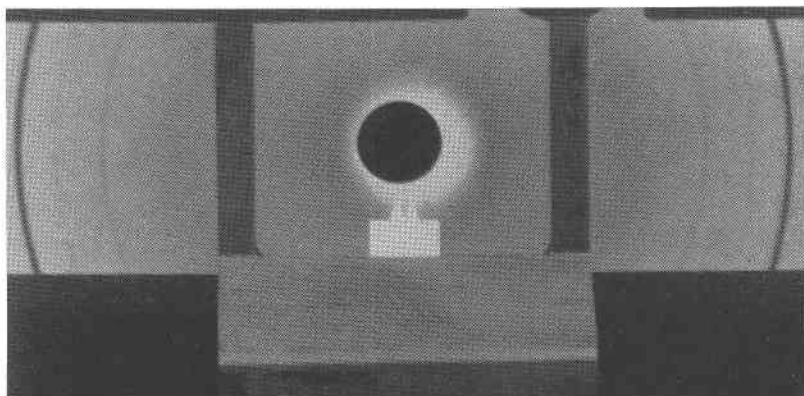
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The calibration sights have a twofold purpose. They permit determination of film shrinkage by direct measurement, provided the film has been developed with care so that film shrinkage will be uniform. They permit centering the film on the measuring device so that the midpoint of the x-ray diffraction rings comes at a convenient reading, say 100.00 mm. (Fig. 1). This procedure eliminates the need for finding the midpoint by reading ring positions on both sides of the punched hole. It simplifies the



(a)



(b)

FIG. 1. (a) Calcite powder pattern (FeK  $\alpha$  radiation), placed on viewing box so that reading is 100.00 mm. when hair line is centered (b) on M of forward reflections; reading at back-reflection M is 279.65 mm. Fiducial distance between M's in this camera: 180.12 mm.; shrinkage correction factor: 0.26%.

arithmetic of subtracting the midpoint reading from the reading of each ring.

The calibration sights are attached to a flat ring  $\frac{1}{8}$ " thick (Fig. 2), made of aluminum alloy and of such size as to fit against the shoulder on the inside of the Buerger-type powder camera. A tight fit is assured by four fingers,  $90^\circ$  apart, which press against the shoulder with spring action. The two sights are M-shaped, made of brass, 8 mm. in height; they are mounted on the ring at the ends of a diameter. The M's are centered in the path of the  $x$ -ray beam by rotating the ring while sighting through the collimator. The ring is rotated by means of a punch placed into one of four blind holes drilled in the ring. Once the exact position is found, a hole previously drilled through the thickness of the ring is extended into the bottom of the camera and a pin is pushed into it.

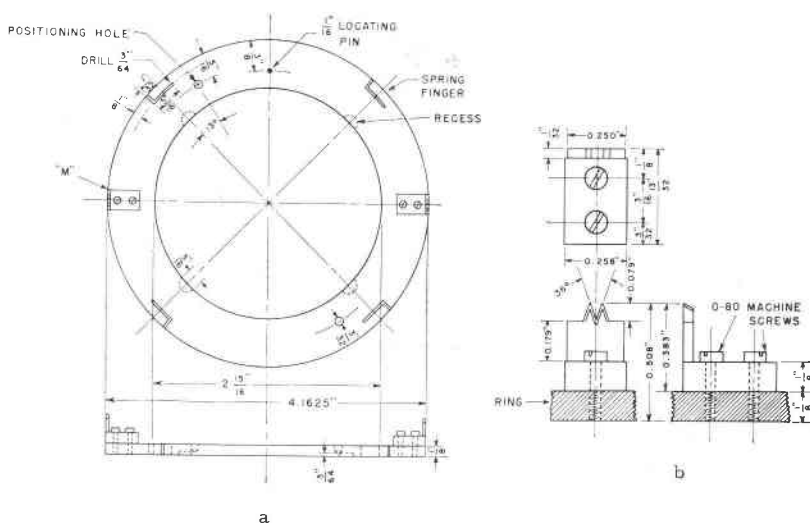


FIG. 2. (a) Top and front view of ring with "M's" mounted in position. Material used for ring: 24 ST aluminum alloy.

(b) Top, front, and side view of "M." Front and side view show "M" mounted on section of ring. Note chamfering of "M's" to give sharp shadow on film. Material used for "M": brass.

The ring can be lifted out of the camera by fitting a thin "L" shaped bar into a recess which is cut into the underside of the ring. The ring can be transferred to another camera of the same diameter. A slight difference in the size of the shoulder can be compensated for by appropriate bending of the spring fingers.

The fiducial distance between M's is obtained by exposing the loaded camera to a sun lamp. Both collimator and beam catcher are removed. The light is allowed to enter first from one side and then from the other side of the camera. After about an hour the shadows of the M's stand out on the undeveloped film with sufficient contrast. The positions of the M's can then be measured on a travelling microscope to  $\pm 0.005$  mm., which gives the fiducial distance to  $\pm 0.01$  mm.

Measurements on developed films were made on an electronic comparator (Dieke, Dimock, and Crosswhite, 1956) kindly placed at our disposal by Drs. Dieke and Crosswhite of The John Hopkins University. The instrument reads to  $0.5 \mu$ . This is more accuracy than we need for the readings of the calibration sights can be reproduced only to  $\pm 0.002$  mm.

The centering of the M's in the x-ray beam is checked with the help of a calcite pattern. The calcite lines can be measured with a reproducibility of  $\pm 0.01$  mm. in the forward-reflection region and  $\pm 0.02$  mm. in the

back-reflection region. The midpoints are of course known to the same accuracy. A comparison of the midpoints with the positions of the M's yields the permanent corrections  $\Delta_1$  and  $\Delta_2$  to be applied to the latter. It is convenient to set the M of the forward-reflection region at the reading  $100.00 - \Delta_1$  mm. on the film reader.

It might be argued that because the position of the M's is found with the help of a powder pattern, the accuracy with which it is known is no better than that with which the midpoints are measured for each film in turn using the customary procedure. This is not the case because for calibration we can choose a powder sample that gives sharp lines to high  $2\theta$  angles, whereas with the usual procedure one has to take the pattern as it comes. We have, for example, found the reproducibility of the readings to be no better than  $\pm 0.03-0.05$  mm. on several patterns of organic compounds.

If one does not wish to assume uniform film shrinkage, additional calibration sights can be mounted on the ring and fiducial distances determined as described above.

## REFERENCE

1. DIEKE, G. H., DIMOCK, D. AND CROSSWHITE, H. M. (1956), *J. Opt. Soc. Amer.*, **46**, 456

THE AMERICAN MINERALOGIST, VOL. 44, JANUARY-FEBRUARY, 1959

## BRANDTITE AT THE STERLING HILL MINE, NEW JERSEY

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Brandtite has been identified among specimens collected at the Sterling Hill mine, New Jersey, in 1940. So far as is known, this marks the first time that brandtite has been recognized from a United States locality, and adds one more mineral to the ever growing list of species that have been found at the Franklin and Sterling Hill mines.

The brandtite was found at Sterling between the 1400 and the 1500 foot levels. This portion of the orebody contained ore of two distinct types, which were mined and processed separately: the "black willemite" and the "brown willemite" ores. The former is a very fine-grained intergrowth of franklinite and willemite; the latter is coarse grained and consists essentially of brown willemite and calcite, with some franklinite. Sphalerite is also usually present up to several per cent, as an ore constituent. The brandtite-containing vug was found in the hanging wall of a black willemite stope, at a point where over-breakage had trespassed slightly into the adjacent brown willemite orebody. The cavity was a crack about two feet long lined with drusy and hairlike crystals of several