...rdinates are carried out with the aid of an automatic ...ording microphotometer (Rigaku-Denki MP-3). The ...e profiles of the various ellipses of a family are traced ...t along the major axis and the peak-to-peak distances ...f the profiles, measured with an accuracy of $\pm 5\,\mu$, de... ...e the end-points of the corresponding y_n coordinates.

The x_n coordinates are controlled by fixed precision ...acers which define the discrete film positions and ...hich span the range of specimen-to-film distance from ...5 mm down to virtually zero. The size of the ellipses ...hich can be recorded is limited by the dimensions of ...he film and the existence of a hole at its center. There...re, the selection of the discrete film positions will be ...verned by considerations pertaining to the completion ...f the elliptical patterns. For large values of y_n some ...rtions of the ellipses may fall outside the film area and ...nsequently the selection of x_n will depend principally ...n crystal orientation, wavelength used, and lattice ...acing of planes which are being measured.

To insure accurate determinations of the x_n coordi...ates it is necessary to satisfy two requirements: (1) the ...m should be perfectly flat and (2) the film surface ...ould be maintained normal to the direction of its dis...acement. The first requirement was fulfilled by ...achining grooves in the backplate of the film cassette ...that a vacuum could be applied. Only when the film ...d been flatly pressed to the backplate through the ...plication of the vacuum was the clamping frame ...htened. The second requirement is satisfied by ac...rate machining of the cassette. Special care must be ...ken in mating the cassette base with the spacers to ...uce errors in the determination of the discrete film ...sitions x_n.

It was observed that the precision of measurements of ...e d spacings increases with decreasing α, that is, with ...reasing θ values. Consequently, it is highly desirable ...record a great many complete ellipses in the vicinity ...the center of the film. To minimize the interception ...the diffracted x rays at small α values by the x-ray ...e itself, a long, tapered tip was fitted to the tube. ...s tip may be described as a truncated cone having a ...apex angle of 7°, a circular tip surface of 0.16-cm ...16-in.) diameter and a height of 4.45 cm (1.75 in.)

b. Photographic Technique

A number of precautions in photographic processing ...ve to be taken to achieve a high degree of precision. ...s, for example, absolutely imperative that the film ...nkage be uniform (isotropic) if the differences in ...acings between various (hkl) reflections of a single ...are to be utilized as a basis for a subsequent strain ...ysis After long experimentation it was found that ...Pont Cronar base, single-coated, graphic arts film ...×12 in.) satisfied the requirements for isotropic film ...kage. Correction for film shrinkage is made by ...essing a standard scale on the exposed film and ...suring it after photographic processing.

In order to minimize film shrinkage and background scattering, and thereby produce maximum contrast, the following photographic processing practice was adopted. All the films were developed for 2 min in Kodak HC110 developer diluted 5:1, followed by fixing in Kodak x-ray fixer for 6 min. Washing for six minutes and then immersion in Photoflo solution for 30 sec was followed by natural drying of the film. In this way it was possible to reduce film shrinkage to a minimum and also to insure that any dimensional change was uniform over the whole film.

c. Computer Programming

A computer program was written to expedite the repeated computation of d spacings. The input to this program was: coordinates (x_i, y_i), shrinkage factor, and wavelength used. The output was: d spacings and their corresponding standard errors.

In addition, a program was also written for the computation of the lattice parameter based on the method of weighted least squares. The input to this program was: d spacings, standard error of d spacings, and Miller indices of planes. The output was: the parameters of the weighted least-squares line and their associated standard errors. Mathematical details for the computation of the d spacings, lattice parameter, and respective errors are given in Appendix A.

The output of d-spacing computations was used for the computation of the stress–strain configuration of the strained crystals.[1,2] Indeed, it is primarily for reasons of attaining the highest degree of precision in the stress–strain analysis of crystals that the precision measurements by the divergent beam method were developed here in such detail.

4. EFFECT OF HOMOGENEOUS AND INHOMOGENEOUS STRAINS ON THE PSEUDO-KOSSEL PATTERN

If the crystal is subjected to long-range elastic strains or to homogeneous internal strains (residual strains), the shape of the pseudo-Kossel lines will be significantly altered. The homogeneous strains are then manifested by changes in the length of the major axis of the elliptical patterns. These changes in turn affect the slope parameters m_1 and m_2 and consequently the strain fluctuation can be recorded in terms of the changes of the d spacings of various (hkl) planes. Thus, if the changes of d spacings of more than six independent (hkl) planes are recorded, the complete strain distribution of the crystal can be obtained.[1,2] However, if the strains are inhomogeneous, then in addition to dimensional changes of the elliptical pattern local line broadening, kinking or displacement of line segments will occur. The effect of such strains on the pseudo-Kossel lines is shown in Fig. 4. From the schematic drawing of Fig. 1 it may be seen that adjacent areas on the specimen surface give rise to adjacent segments of