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The Proportional Counter in X-Ray Diffraction Work

RECENT work, for example, that by Curran *et al.*[1], has shown how the proportional counter can be made a reliable tool for measuring the energies of soft radiations. Used as a detector for measuring the intensities of diffracted X-rays, it possesses many advantages over the Geiger counter. With the proportional counter, counting losses are entirely negligible for all X-ray intensities likely to be realized with conventional X-ray generators and diffraction techniques. The possibility of discriminating against unwanted radiations of wave-lengths other than that of the characteristic radiation used for diffraction purposes enables diffraction records of greatly improved quality to be obtained, especially when the specimen gives rise to appreciable fluorescent radiation. Particularly valuable is the ability to cut out radiation the wave-length of which is a submultiple of that of the characteristic radiation. The life of the proportional counter is practically infinite, and so it is much more economical than the organic-vapour quenched Geiger counters commonly employed as X-ray detectors.

A cylindrical brass-bodied proportional counter has been used mounted with its axis at right angles to the diffracted X-ray beam, which enters by a thin beryllium window. The counter was filled to atmospheric pressure with argon plus ethylene. Amplified counter pulses pass through a variable-width single-channel pulse analyser the output of which feeds a scaling unit and/or rate-meter with graphical recorder.

Fig. 1 shows that radiation of wave-length $\lambda = 1 \cdot 54$ A. and energy $8 \cdot 05$ keV. (copper $K\alpha$) is completely separated from the harmonic wave-length of $\lambda = 0 \cdot 77$ A. and energy $16 \cdot 1$ keV. Curve (*a*) was obtained with characteristic radiation reflected by plane 200 of a lithium fluoride plate set at the appropriate glancing angle, the X-ray tube being run at 30 kV. Curve (*b*) shows radiation of wave-length $\lambda = 0 \cdot 77$ A. obtained by reducing the glancing angle, increasing the X-ray tube voltage to 50 kV., and doubling the X-ray tube current. On curve (*a*) a low peak at 16 keV. is due to the presence of radiation of wave-length $\lambda = 0 \cdot 77$ A. from the second-order reflexion, 400. The harmonic is thus present in noticeable amount even at the low X-ray tube voltage of 30 kV. The small peaks on the low-energy side of both the 8 keV. and 16 keV. peaks are due to

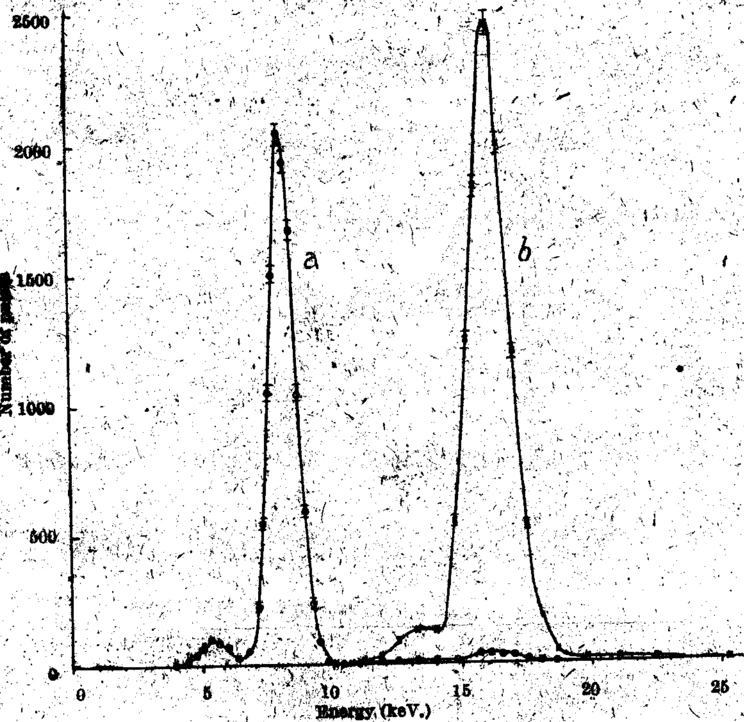

Fig. 1

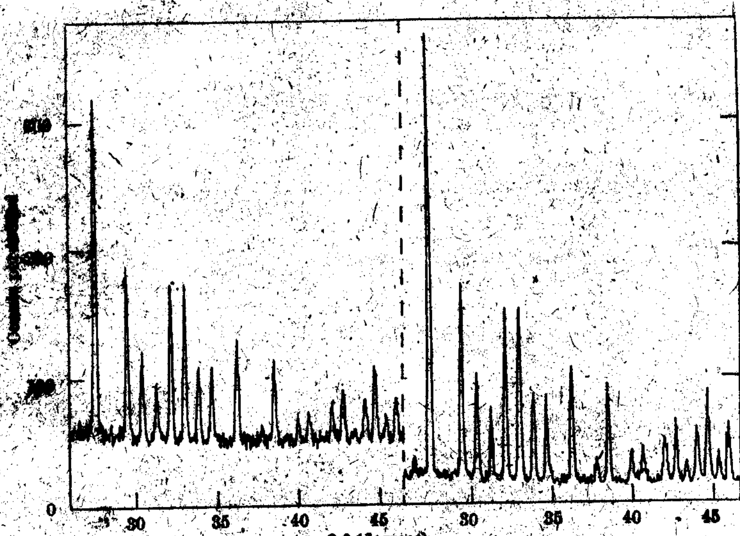

Fig. 2a

Fig. 2b

a small fraction of energy being lost as argon fluorescent K radiation which was not absorbed in the counter gas.

Figs. 2*a* and *b* show counter spectrometer records of part of the diffraction spectrum of powdered chrome alum taken by Geiger counter in Fig. 2*a* and by proportional counter in Fig. 2*b*. Copper $K\alpha$ radiation was used, and in each case a nickel β filter was placed in front of the counter window. The two runs were made under identical conditions, only the counters being changed. It will be seen that the background in the proportional counter record is only about one quarter of that in the Geiger counter record. Several weak lines that can be barely distinguished above the statistical fluctuations of the high background in the Geiger counter record stand out clearly in the proportional counter record and allow reasonable estimates to be made of their intensities. Comparison of peak heights in the two curves shows that the proportional counter has a higher sensitivity for copper $K\alpha$ radiation than the Geiger counter used, which was the best commercially available type. The natural background-rate of the proportional counter falling in the channel used for copper $K\alpha$ radiation measurements was 15 counts per minute, only a quarter of that of the Geiger counter.

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[1] Curran, S. C., Angus, J., and Cockroft, A. L., *Phil. Mag.*, (7), 40, 36 (1949).

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