text useful for teaching. It would perhaps have been more appropriate to have used the title "Introduction to Modern Optical Engineering". D. J. BRADLEY

SCANNER FOR SURFACES

Scanning Electron Microscopy

By P. R. Thornton. Pp. xv+368. (Chapman and Hall: London, 1968.) 80*s*.

IT is now more than fifteen years since the first practicable scanning electron microscope began to produce micrographs, and some four years ago a commercial model, the 'Stereoscan', came on to the market. Since then it has made a considerable place for itself as a research tool for studying surfaces at a resolution an order of magnitude beyond that of the optical microscope. Yet the subject has had to wait until now for a comprehensive treatment. It is reasonable to assume that Professor Oatley's team at the Engineering Laboratory, Cambridge, where the instrument was developed, have been too busy perfecting it to do much writing.

Dr Thornton, who has been applying the 'Stereoscan' to the study of microelectronic materials and devices, has filled the gap with the present text. A physicist by origin, he pays thorough attention to the principles as well as to the construction and uses of the scanning electron microscope. Stemming as it does from a series of lectures, the treatment is well arranged and logically developed. The electron optical basis of the instrument is briefly described, to make clear the factors limiting the current which can be focused into an electron probe of given diameter. The major part of the book is about the interactions of the electron beam with the specimen and their influence on the various modes of operation of a scanning microscope. As the author recognizes, this is a most complex subject involving not only electron scattering (single, multiple and diffuse) and energy loss, but thermal, electrical and radiation effects, as well as secondary electron emission and true backscattering. In surveying this wide range of phenomena, the author has succeeded in compressing the essential information without losing readability. Where elaboration of a topic had to be curtailed, references to the literature are liberally given. The only significant omission seems to be any mention of Spencer's detailed calculations of the dissipation of electron energy with depth in a metal target.

The second half of the book is about the three main ways in which images can be formed with the instrument: by collecting the electrons scattered from a surface, the current passing into it or the visible radiation excited from it (cathodoluminescence). The physical basis and practical procedure for each mode are discussed, with particular attention to the detection systems. The last three chapters describe the applications of scanning microscopy in great variety and its extension to the fabrication of microcircuits.

The wide scope of the book must prompt the question, however, as to whom the author is addressing it. It would seem to be most useful to the type of audience that heard the original lectures—postgraduate students engaged in research and development of the instrument and its uses. Not many routine users will want to take the trouble to master the physical background in this detail, but it may fairly be said that the more they do so the better results they are likely to get out of their expensive microscope.

As a comprehensive exposition of this new research technique, Dr Thornton's book is timely. My welcome to it would be warmer if it did not show such obvious signs of being put together in haste. Lax proof-reading is perhaps a minor sin. My own name is correctly spelt in one reference but wrongly in the next line (and elsewhere), Wehnelt appears in two variant forms but never in the right one, reference (8) in the third chapter is attributed to Liebmann and Liebermann on the same page, both k and K are used for Boltzmann's constant within a few lines, Schroeder turns out to be Schrödinger, and so on. But no proof-reader should have let the author get away with an ampersand on page 63. More seriously, the equation on page 48 has $\sqrt{e}/2$, apparently in the denominator, in place of $\sqrt{(\varepsilon/2)}$ in the numerator. Again, in Table 4.5 a factor of 10^4 has been omitted and in the relevant equations it is not made clear that E_0 should be in eV whereas the limits of validity are given in keV.

This slackness undermines the reader's confidence in the rest of the text, which is in fact quite sound. The errors should be corrected in a second edition. Until then, this is the best account of scanning electron microscopy we have. If read critically, it provides a useful survey of an important and rapidly expanding research technique. V. E. COSSLETT

OBITUARIES

Dr F. M. Trotter

FREDERICK MURRAY TROTTER, DSc, FGS, died on July 24 at his home at Awre in Gloucestershire. He was an outstanding geologist of the school which applied to all geological problems careful mapping and skilful evaluation of sub-surface information. He was keen to find an explanation of the geological processes involved and much enjoyed debating his findings with conspicuous vigour. He did much to augment the reputation of the Geological Survey of Great Britain, of which he was a member for 42 years, among executives of industries dependent on the winning of natural mineral resources. His lively mind and critical faculty inspired and encouraged his colleagues especially those whom he helped to train.

Trotter was a Tynesider, born on April 19, 1897, and educated at Rutherford College, Newcastle upon Tyne and at Armstrong College, then part of the University of Durham. His university career was interrupted by war service with the Royal Engineers in France where in 1918 he lost an eye from enemy action near Vimy. His geology teachers at Armstrong College were Lebour, Sibly, Woolacott and L. Hawkes.

After graduating he joined the Geological Survey in 1921 at its newly established Whitehaven office; there he served under B. Smith working first on the Carlisle Longtown and Silloth one-inch sheets and then with S. H. Hollingworth in the Brampton area. This provided fruitful research subjects for both Trotter and Hollingworth with the naming of the Alston Block (1928) and the detailed study of the rocks comprising it (1932). Both men were interested in glacial phenomena and each gained a DSc degree for glaciation studies, respectively, of the eastern and western sides of the Eden valley. When in 1927 the Whitehaven office closed, Trotter continued mapping first around Cockermouth and then around Gosforth, where he gained acquaintance with problems concerning the origin of hematite ore deposits, a subject that he was to take up again when in 1933 he was transferred to work on the Monmouth sheet in which lies the Forest of Dean coal and iron-ore field. To broaden his coalfield geological experience, in 1939 he was posted to South Wales and this resulted in his novel explanation of the origin of the coalfield's anthracite in that he connected high-rank coal with major Earth movements.

In 1941, as district geologist, Trotter was given charge of the survey's North-west England and North Wales field unit based on Manchester. There, among other duties, he gave help to two sectors of industry. First of the National Coal Board in its geological exploration to the coal reserves of south-west Lancashire where he found