summation, approximate integration, pure endowments, life annuities, premiums on various kinds of life insurance, joint life and survivorship problems, loading of premiums. This is all done in much the usual way, but more attention is paid to the elegance of the mathematical arguments and the calculus is used more freely than in many books on actuarial mathematics. A feature of the book is the discussion of the errors involved in the calculation of endowments, annuities, policy premiums, and so on. Along with average rates he computes a sort of safe rate which will cover all but one percent of the possible cases which may arise. In places, the methods used in the book will lead to much more arithmetic drudgery then is necessary, but on the whole it is a thoroughly readable and scholarly book on that part of actuarial mathematics which it covers.

A. R. CRATHORNE

Leitfaden zum Graphischen Rechnen. By Rudolf Mehmke. 2d edition. Leipzig and Vienna, Franz Deuticke, 1924. viii+183 pp.

Whether one does or does not believe in the practical value of graphic methods one must take seriously this guide to the subject. It is a mine of ingenious devices. Here are not only the usual graphic constructions for expressions of the form $\sum ab/c$ together with solutions of linear equations in two, three, four and more unknowns, with logarithmic scales for the more complicated functions, but exhaustive discussion of methods for integrating differential equations and the determination of moments of various sorts. In connection with logarithmic methods is a description of a "logarithmic compass" devised by Professor E. A. Brauer which has three points, the distance between two of which is a function of the distance between any other pair. Interesting use is made of this device.

As to the practical use of graphical methods one may be permitted to have serious doubts. Professor E. T. Whittaker, in his preface to his *Calculus of Observations*, remarks: "When the Edinburgh Laboratory was established in 1913 a trial was made, as far as possible, of every method which had been proposed for the solution of the problems under consideration, and many of these methods were graphic. During the ten years which have elapsed since then, the graphic methods have almost all been abandoned, as their inferiority has become evident, and at the present time the work of the Laboratory is almost exclusively arithmetic. A rough sketch on squared paper is often useful, but (except in descriptive geometry) graphic work performed carefully with instruments on a drawing-board is generally less rapid and less accurate than the arithmetic solution of the same problem."

With this judgement those who have learned to use a computing machine will be apt to agree. However, the subject of graphic computation is in itself a very interesting one, and there is also the chance that certain problems in geometry and mechanics which are too complicated for arithmetic analysis may yield to some such methods as we have here. It is important that every method be as fully developed as possible whether it may compare favorably or unfavorably with other methods. This has been done for the method of graphic computation in this book with scholarly thoroughness.

D. N. LEHMER

From Determinant to Tensor. By W. F. Sheppard. New York, Oxford University Press, American Branch, 1923. 127 pp.

This is an excellent little book the aim of which is to familiarize the student with tensors and to give an idea of their applications. It is, perhaps, not sufficiently realized that tensors are not merely a part of "relativity", the fact being that they permeate almost all mathematics.

Professor Sheppard gives illustrations of the applicability of tensor algebra to statistical theory and this chapter of his book is the most novel. The fact that tensor theory would be useful in this theory is à priori evident from the prominent position given in statistics to a quadratic form.

What caught the reviewer's attention first, on reading the book, was that Professor Sheppard had a happy thought when he tried to introduce the beginner to tensors by starting with determinants. The connection between alternating tensors, which are those that occur naturally in the study of geometrical figures and their attached integrals, and determinants is a deep-lying one and it is in some respects a good plan to reverse the process and obtain the principal results on determinants from very elementary theorems of tensor algebra. A very good account of determinants and their uses is given in the first few chapters of the book.

We wish to recommend this book heartily, but we must refer briefly to a point in it which we regard as unfortunate. Reduced to ordinary vector symbolism, the writer says that we can write the scalar product idea in the form $m/\overline{A} = \overline{B}$ this being understood as equivalent to $m = (\overline{A} \cdot \overline{B})$ where m is a scalar quantity and $\overline{A}$ and $\overline{B}$ are two vectors. If we also have $n/\overline{C} = \overline{B}$ the author equates $m/\overline{A}$ to $n/\overline{C}$ and says that $m/\overline{A} = n/\overline{C}$ is a way of stating that m is the same linear function of $\overline{A}$ as n is of $\overline{C}$ (p. 75). But $\overline{B}$ is not determined by $m/\overline{A}$, as we can write $m/\overline{A} = \overline{B} + \lambda \overline{X}$ where $\overline{X}$ is any vector perpendicular to $\overline{A}$. We do not, therefore, follow the author in his discussion of the