one that the deductions depend upon. To illustrate, one may prove the theorems of geometry relating to the circle by using wire circles just as well as by using a highly artificial definition of an abstract circle, provided that he does not depend upon the copper or silver, or their qualities, nor upon the thickness, or cross-section of the wire. In most work in mathematics we are engaged in finding the deductions that can be drawn from certain features only of a concrete existence and which are not in the least affected by other features of the object. In other words the most highly concrete object is just as good as the most highly abstract object for deductions that are limited to certain characters possessed in common by the two. From this point of view the definition from geometric objects is justifiable. On the other hand the recognition of the non-geometric character of all the numbers deduced is one that if more common would prevent much wasted ink and time. Such a notion as that of the product of two geometric vectors ought to disappear from the field, for instance, save as a phraseology perhaps. The fruitless discussions over the identification of the right quaternion and the vector (geometric) would no longer be heard of, and all vector systems would be recognized as algebras of hypernumbers.

JAMES BYRNIE SHAW.

Napier Tercentenary Memorial Volume. Edited by CARGILL GILSTON KNOTT. London, Longmans, Green and Company, 1915. xi+441 pp. Price, £1 1s.

THIS sumptuous volume compiled by Dr. Knott is made up of the addresses and essays communicated to the International Congress held in Edinburgh in 1914 to commemorate the tercentenary of the publication of Napier's epoch-making Mirifici Logarithmorum Canonis Descriptio.

The papers are both historical and mathematical, the former dealing with the life and works of Napier and of his contemporaries, immediate predecessors, or followers, and the latter part of the work treating of the modern progress in calculation, in the preparation of tables, and the like. There is also an account of the Edinburgh meeting, with the addresses of a formal congratulatory nature, a list of members, and two indexes, one of subjects and the other of names.

The historical papers are as follows: "The invention of logarithms," by Lord Moulton, a careful study of the working

of Napier's mind in the development of his theory, made with all the acumen of one of the best legal minds of the present time; "Merchiston Castle," by George Smith, then the headmaster of Merchiston Castle School, the best description of the building that has been published, illustrated by a colored print; "Logarithms and computation," by Dr. J. W. L. Glaisher, partly historical but chiefly given to the post-napierian development; "The law of exponents in the works of the sixteenth century," by the present reviewer; "Algebra in Napier's day and alleged prior inventions of logarithms," by Professor Florian Cajori, a careful and scholarly investigation of the claims of others with a judicial decision against such claims; "Napier's logarithms and the change to Briggs's logarithms," by Professor G. A. Gibson, a critical study of the important question of the relation between Napier and Briggs in the introduction of the base 10; "The introduction of logarithms into Turkey," by Lieut. Salih Mourad, wherein it is shown that logarithms found their way into Turkey in 1714, and that they were explained in the Turkish language in 1765, through the efforts of Ismail Effendi; "A short account of the treatise 'De arte logistica,'" by Professor J. E. A. Steggall, with a facsimile of one of the pages; "The first Naperian logarithm calculated before Napier," by Professor G. Vacca, in which it is shown that Pacioli (1494), in a problem on compound interest, gave a rough calculation of log 2 in solving what is practically $(1 + r/100) = 2$; but that Pacioli had any real conception of logarithms is not asserted; "The theory of Naperian logarithms explained by Pietro Mengoli (1659)," by Professor G. Vacca, in which it is shown that Mengoli, a pupil of Cavalieri, set forth his explanation in the Geometria Speciosa which was published in Bologna in 1659.

One of the most important articles in the book is the bibliographical chapter by Professor R. A. Sampson on the books exhibited at the time of the meeting. Professor Sampson has given a careful description of each of the early editions, with numerous facsimiles, including two pages from the Aritmetische vnd Geometrische Progress Tabulen of Jobst Buergi, printed in Prague in 1620. These facsimiles show the title page and also one page of the tables. Since this was lent by the Town library of Dantzig, and was to have been returned early in August, 1914, it would be interesting to know where it has been stranded during the last two and a half years.

The mathematical articles include a study of Napier's rules, by Professor Somerville; a consideration of fundamental trigonometric and logarithmic tables, by Professor Andoyer; a description of the work of Edward Sang, by Professor Knott; a study of formulas used in calculation for the development of a function of two variables in spherical harmonics, by Professor Bauschinger; a study of nomograms and of the early calculating machines, by Professor d'Ocagne a new table of natural sines, by Mrs. Gifford; a consideration of the arrangement of tables, by Dr. J. R. Milne; a note on 'critical' tables, by Mr. T. C. Hudson; a study of economy of entries in tables, by Professor J. E. A. Steggall; the graphical treatment of crystallographic problems, by Dr. A. Hutchinson; a method of computing logarithms by simple addition, by Mr. Schooling; a question as to reducing to a minimum the mean error of tables, by Mr. Erlang; a study of the extension of accuracy of tables by improvement of differences, by Dr. W. F. Sheppard, a paper of unusual interest; a method of finding antilogarithms without tables, by Dr. Artemas Martin; the approximate determination of the functions of an angle, by Mr. H. S. Gay; and a study of life probabilities on the Goldziher criterion, by Mr. Quiquet.

The work is illustrated with great care. The colored portrait of Napier, from the original painting in the University of Edinburgh, is a very welcome addition to the list of portraits of mathematicians now available for study, and the fascimiles from early printed works are of great value.

It is impossible within the limits of a review of this nature to enter into an extended description of the articles. Suffice it to say that there has never appeared a work on the history of any single mathematical discovery that has been so sumptuously published or that contains so much valuable material for the student of the history of mathematics. May we not hope that the forthcoming two-hundredth anniversary of the death of Newton may see a similar meeting in Cambridge, with the result of the publication of a similar volume relating to the life and works of the world's greatest mathematical physicist?

DAVID EUGENE SMITH.