of p as high as the limit 99, 989. Similar tables are also given for the smallest values of y satisfying the congruence

$$\frac{y^{3n}+1}{y^n+1} \equiv 0 \pmod{p}$$

for various values of n and various limits of p. Volume IV also contains tables of roots (x_1, x_2) of $x_1^n + x_2^n \equiv 0 \pmod{p}$ for various values of p and n.

The first volume contains also factorization tables giving the factors of a vast number of numbers of special forms. They will be found somewhat difficult to use on account of the new names that confront the reader on every page. One meets here not only "Pellians" with new and strange prefixes, but also "Aurifeullians" of various families. One stands a bit daunted before a "Dimorph-Bin-Aurifuellian". Out of this rather confusing mass of computation emerge, however, some usable tables giving values of y which make y^2+1, $(y^2+1)/2$, $(y^3-1)/(y-1)$, etc. take on prime values. There are also tables giving values of x, y which make x^n+y^n a prime or twice a prime. These tables go much beyond the limits of available factor-tables.

There is no room for doubt that Lt.-Col. Cunningham has undertaken and carried out an immense task, of value in the problem of identifying large primes, and in the breaking down of numbers of special forms into their prime factors.

D. N. Lehmer

The Calculus of Observations. A Treatise on Numerical Mathematics. By E. T. Whittaker and G. Robinson. London, Blackie and Son, Ltd., 1924. 16+395 pp.

"The present volume represents courses of lectures given at different times during the years 1913—1923, by Professor Whittaker to undergraduate and graduate students in the Mathematical Laboratory of the University of Edinburgh, and may be regarded as a manual of the teaching and practice of the Laboratory, complete save for the subject of Descriptive Geometry."

To the teacher of mathematics, in this country at least, a mathematical laboratory will be apt to suggest graphical and nomographical methods. In this book the work is almost entirely arithmetical, and we are told that in the University of Edinburgh graphical methods have almost all been abandoned "as their inferiority has become evident". This result of actual experience covering some ten years will perhaps come as a surprise to many teachers and practical computers to whom such methods appeal especially where great speed is very desirable and only rough approximations are necessary.

The first four chapters deal with the theory of interpolation, and are obtainable in a separate issue entitled *A Short Course in Inter-*

polation, published in 1923. They furnish a practical reference book on interpolation with equal and with unequal intervals, central difference formulas and applications. These four chapters are followed by a short one on Chio's method of computing the numerical value of a determinant.

The chapter on the numerical solution of algebraic and transcendental equations describes, illustrates and compares the more important methods. One might wonder if the value of an up to date calculating machine is fully appreciated at the Laboratory. The computation of the successive values satisfying a difference equation is especially well adapted for machine computation, and the successive values of S_p (the sum of the pth powers of the roots of an equation) can be ground out with uncanny readiness by one who has had a little experience. Then, using Bernoulli's method, the quotient S_{p+1}/S_p can be obtained to as many decimals as may be desired. The computing machine is also invaluable in constructing tables of differences.

There are also chapters on Numerical Integration, Normal Frequency Distributions, Least Squares, Fourier Analysis, Smoothing of Data, Correlation, Search for Periodicity and the Solution of Differential Equations. These subjects are all given with satisfying clearness and detail with plenty of examples, and sample solutions. The whole book presents evidence on every page of sound scholarship and good practical judgement. The authors call attention to the opportunities for research in the subject of numerical mathematics. "There is an evident need for new and improved methods of dealing with many of the problems discussed in the later chapters".

D. N. Lehmer

Les Lieux Géométriques en Mathématiques Spéciales avec Application du Principe de Correspondance et de la Théorie des Charactéristiques à 1,400 Problèmes de Lieux et d'Enveloppes. By T. Lemoyne. Paris, Vuibert, 1923. 146 pp.

This little pamphlet summarizes Chasles' theory of characteristics together with the extensions which the author (with Brocard) developed in volume I of *Courbes Géométriques Remarquables,* and gives 1400 problems by way of illustration. It will be recalled that the characteristics μ, ν of a system of conics refer to the number of conics which pass through an arbitrary point, and are tangent to an arbitrary line, respectively. The characteristics of 170 systems of conics, and of 41 systems of circles are listed. Fundamental theorems give formulas for the order or class of many loci or envelopes connected with these systems in the form $\alpha\mu + \beta\nu$. Chasles gave 32 such fundamental theorems for the values of α and β; Lemoyne adds about 50 more, either with proofs or with references to the *Courbes Géométriques*