was born, and made much of it in his Treatise on Algebra in 1842. In the second part of the work the author begins with a dissertation on mathematical logic, a subject that has attracted so many writers in the last half century, and in the treatment of which the influence of Peano and Couturat is manifest. Chapter II treats of geometrography and the straight line, starting with Lemoine's work of twenty-five years ago and closing with the contributions of Poincaré and Russell. Chapter III develops the theory of non-euclidean geometry, and then shows the significance of various historical attempts to demonstrate the Euclid postulate or to found a geometry independent of this assumption. The work closes with a general discussion of the space concept.

Readers will find the chapters on the number concept and the non-euclidean geometry particularly interesting. As a genuine contribution to theory the book will be less regarded than as a résumé of the questions involved.

DAVID EUGENE SMITH.

Encyclopädie der Elementar-Mathematik. Von H. WEBER und J. WELLSTEIN. III Band: *Angewandte Mathematik.* Zweite Auflage. Erster Teil: *Mathematische Physik.* Bearbeitet von RUDOLF WEBER. Teubner, Leipzig und Berlin, 1910. 8vo. xiv+536 pages. 12 marks.

THE first edition of this encyclopedia was reviewed in the BULLETIN, volume 10 (1903–4), pages 200–204. In this second edition of the third volume, on applied mathematics, there are extensive changes. The original volume is divided into two; the present one, a treatise complete in itself on mathematical physics, and one to follow on graphics, probabilities, and astronomy. This modification has been made to satisfy many criticisms of the original, some of which deplored the wide omissions in a work that called itself an encyclopedia.

The present volume has three chapters on mechanics: functions of position and direction that appear in physics, analytic statics, and dynamics; two chapters on electric and magnetic fields: electricity and magnetism, and electromagnetism; two chapters on maxima and minima: geometric maxima and minima, and applications to the theories of equilibrium and of capillarity; two chapters on optics: geometric optics, and plane waves.

The first chapter is on vectors and has been completely rewritten. Two definitions of vector are given, one in substantially the usual terms, the other as follows: A vector $\mathfrak{A}$ is a function which depends not only on a located point, but also has a value for every direction radiating from the point. These values are its *components*, and must be such that any three of them which form a trirectangular system, when added geometrically, produce that one of the components which has the maximum length. This particular component however has no precedence over the others in importance and no one of the components is the vector, but the entire system of values correlated to the directions. Geometrically, the vector is represented by a pair of spheres tangent at the point in question, with the ensemble of chords drawn through the point, which chords are positive in one sphere and negative in the other. Examples of these "physical vectors" are found in forces, displacements, velocities, accelerations, electric and magnetic fields. This conception of vector as a set of function values, rather than as a directed line segment, or as a hypercomplex number, seems to us more like an attempt at novelty than at usefulness. The gain is not evident. In the text following, the analysis goes back practically to the usual mode of development. A section is added on "Tensoren," a name introduced by Voigt, which are the dyadics of Gibbs and the linear vector operators of Hamilton. Examples are the pressure in a deformed elastic body, elasticity coefficients, conductivities of heat, dielectric constants, and other properties of crystals.

The chapter on geometrical optics covers the usual ground. That on plane waves leads up to the electromagnetic theory of light. These extensive additions are an improvement in the original.

Many small changes have been made throughout, but we need not dwell on them. The criticisms made in the first review, referred to above, still hold in large measure.

JAMES BYRNIE SHAW.

Über freie und erzwungene Schwingungen. Von Dr. ARTHUR KORN. Teubner, Leipzig und Berlin, 1910. 8vo. vi+136 pages. M 5.60.

THE title of this memoir is somewhat deceptive, as it does not deal directly with the theory of oscillations, which are