Science in Nineteenth-Century America

A Documentary History. Edited and with an Introduction by Nathan Reingold. (American Century Series.) Pp. xii + 339. (New York: Hill and Wang, 1964.) Cloth 5.95 dollars; Paper 2.45 dollars.

THIS collection of documents from nineteenth-century America is designed to help us understand the "present American eminence in the sciences".

The documents are, for the most part, private letters and personal records not intended for public consumption. They begin with the writings of Benjamin Silliman, sen., and Nathaniel Bowditch—both essentially popularizers with an eye to the practical application of science.

A majority of the American scientists during the nineteenth century were natural historians and explorers. Their work was inspired by the needs of a new continent and of a young country. Geophysics and meteorology thus became established as separate disciplines. With the advent of Darwinian evolution, however, the natural historians turned into biologists. With the rise of modern physics towards the end of the nineteenth century in Europe, the American explorers changed their interest from the physical world to the world of physics.

The founding of the National Academy of Sciences in the middle of the Civil War was undoubtedly a main event in the scientific life of the country. The Academy never played as important a part as the Royal Society did in Britain; its difficult origins may have held back the growth of the Academy.

Apart from Agassiz and Asa Gray, few of the American scientists were of international stature. It is only at the end of the century that native genius made itself felt. The physicists Newcomb, Rowland and Michelson were undoubted leaders in their field. Charles Sanders Peirce and J. Willard Gibbs are the two scientists who are outstanding in the originality and universality of their minds. Their genius has become recognized only in recent years. Peirce's contribution to a wide range of knowledge is not yet sufficiently appreciated, at least in Europe.

There was a prevalence of practical and a dearth of theoretical scientists during the earlier period. The flowering of American science at the turn of this century—and ever since then—was caused by the fertilizing contact with European science. It would be wrong to be blind to the fact that science is, and always has been, international. The present success of American scientists is built on, and impossible to divorce from, the achievements of the scientists of Western Europe and, indeed, of every part of the globe.

E. H. HUTTEN

Recent Advances in Selenium Physics

Edited by European Selenium–Tellurium Committee. (A Symposium on Solid and Liquid State Selenium Physics arranged by the European Selenium–Tellurium Committee and held at the Chemical Society, London, June, 1964.) Pp. vii + 160. (London and New York: Pergamon Press, 1965.) 80*s*. net.

SELENIUM is the oldest of semiconductors and is still widely used as a rectifier material, in spite of the success of silicon and germanium diodes. One would imagine that the physical properties of selenium would have, by now, been fully understood but, in fact, they are still being actively investigated and it appears that much work remains to be done. The symposium which is reported in this book allowed a large proportion of those who are engaged in selenium research to meet one another, relatively few of the participants having less than a direct interest in the material. Not unexpectedly, the discussion was particularly lively, and forms a most valuable part of the report.

Most solid-state physicists nowadays are unhappy if they cannot work with single crystals, and four of the papers are devoted to the growth of crystals of hexagonal selenium; the work of D. E. Harrison in this field has been exceptionally successful. Most of the remaining papers discuss transport and optical measurements and their interpretation. It is quite clear that many of the established semiconductor concepts must be discarded for selenium, because of its very low carrier mobility. However, it is probably an example of a wide class of materials, and, being an element, may make an excellent prototype for testing theoretical ideas. In summarizing the symposium, H. Gobrecht points out some notable deficiencies in the work to date. Most important, the selenium used in the experiments has often been of doubtful purity. Surprisingly also, the atomic weight of selenium is known only to two decimal places.

Although the sub-title of the book mentions liquid selenium, there is only one paper devoted specifically to it (other than the consideration of its properties as relating to the growth of crystals). Only two of the papers discuss applications of selenium (in xerography and thermoelectricity, and in the latter field selenium is important only in compound form). It would not be unexpected, however, if the commendable encouragement of selenium research by the European Selenium–Tellurium Committee were to lead to new applications of a fascinating substance.

H. J. GOLDSMID

Evolution of Mathematical Thought

By Prof. Herbert Meschkowski. (The Mathesis Series.) Pp. 157. (San Francisco, London and Amsterdam: Holden-Day, Inc., 1965.) 6.55 dollars.

THIS translation of *Evolution of Mathematical Thought* adds to the number of books which attempt to explain the spirit and aims of modern mathematics to the intelligent layman.

The Greeks began the search for a discipline which should be abstract and general, but Prof. Meschkowski takes a long stride from Greek mathematics to the next significant stage, the discovery, early in the nineteenth century, of the plurality of geometries by Gauss, Lobachevski and the Bolyais. Curiously, he scarcely notices the sequential but equally important work of Grassmann, Hamilton and Boole, on the plurality of algebras—so seminal for modern formalist developments. The antinomies and paradoxes of Cantor's theory of sets, and Brouwer's dismissal of the law of the excluded middle, lead to problems of mathematical logic, which Prof. Meschkowski approaches from the geometrical side by a study of Hilbert's axiomatic construction. The formalism which dominates so much of present-day thinking about mathematics demands discussion of the consistency and completeness of an axiomatic system, and presents the 'undecidable' problems of mathematical logic, with Gödel's proof that the consistency of the formal number system cannot be established by means of the system alone, and Skolem's theorem that a finite system of axioms cannot uniquely characterize the set of natural numbers. The account of this rugged domain is as clear as we could hope for; many readers will appreciate the quotation from André Weil: "God exists since mathematics is consistent, and the Devil exists since we cannot prove it".

A further chapter on operative mathematics, based on papers by P. Lorenzen, will prove a severe test of the sophistication of even the most intelligent layman. In an appendix, the author suggests that there are educational possibilities in modern mathematics which were only latent in the classical nineteenth century developments, and that these could be made to lead to a new unity in our educational system. He remarks that the liberal arts might be better served if students in technical institutes, instead of being compelled to attend lectures on literature, were encouraged to reflect seriously on the fundamentals of their own subjects. Thus they would be led to see that poets, philosophers and scientists may indeed all have the same goal.

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