

bound. Like its predecessor, it will find a place in every metallurgical laboratory.

GEORGE AUCHY.

LES CARBURES D' HYDROGÈNE, 1851-1901. RECHERCHES EXPERIMENTALES, par M. Berthelot. Three volumes. VOL. I.—ACETYLENE AND THE TOTAL SYNTHESIS OF HYDROCARBONS. VOL. II.—PYROGENIC HYDROCARBONS; VARIOUS SERIES. VOL. III.—THE COMBINATION OF HYDROCARBONS WITH HYDROGEN AND OXYGEN, THE ELEMENTS OF WATER. Paris: Gauthier-Villars. 1901.

The classic researches of Marcellin Pierre Eug. Berthelot upon the total synthesis of carbon compounds from their elements constitute the chief cornerstones of the beautiful and elaborate structure of modern synthetic organic chemistry. The appearance of the present publication, therefore, from the hand of the master, should be welcomed with deepest gratitude by every organic chemist. It is as unnecessary to recommend such a book to the student of organic chemistry, as it would be to recommend Shakespeare to a student of literature.

The work is not in any sense a treatise embodying all that is known about the hydrocarbons, but a collection and republication of the author's researches in this particular field. All of these investigations were conducted in the laboratory of the Collège de France, where the author made his début as "preparateur" (1851-1859), and where he has occupied a professorial chair since 1864. For over half a century he has made a study of these compounds, especially in the direction of their synthesis from the elements and of the effect of high temperatures upon them, publishing many hundred memoirs, notes, and notices, which are scattered through various scientific journals, more having appeared in the *Annales de Physique et de Chimie* than in any other single journal. These scattered articles have been gathered together and properly classified in the present work, so as to show clearly just how far each leading thought has been carried out experimentally.

The subject-matter is arranged in seven books which are bound in three volumes.

Book 1 (263 pages) is divided into sections as follows: Section 1 (18 chapters) contains a description of the synthesis of acetylene from carbon and hydrogen; the details of its preparation and properties; its synthesis by the action of electric sparks upon simple gaseous compounds; studies of electrical equilibrium be-

tween carbon, hydrogen, acetylene; the various conditions for the formation of acetylene by incomplete combustion, by the action of red heat upon other hydrocarbons, etc.; its formation by the action of potassium hydroxide upon sulphonates; and, finally the synthesis of ethylene from acetylene. The recent work of Bone and Jerdan (*Proc. Chem. Soc.*, No. 240, page 162), is interesting in this connection. These authors find that in the electric arc, at a temperature of about  $1200^{\circ}$  C., carbon and hydrogen unite with the production of small amounts of methane and ethane in addition to acetylene. Section 2 (6 chapters) is devoted to the polymers of acetylene, including the synthesis of benzene, styrene, and of the hydrides of naphthalene and of anthracene. Section 3 (8 chapters) contains the experiments made, mainly in collaboration with M. Vieille, upon the detonation of acetylene, a subject which is now one of considerable importance on account of the use of acetylene for illumination. Section 4 (4 chapters) describes the author's first experiments, begun in 1857, upon the synthesis of hydrocarbons, which were conducted before the discovery of the synthesis of acetylene, such being the production of methane from carbon bisulphide, the conversion by heat of methane into ethylene, ethane, propylene, etc., and the preparation of hydrocarbons from haloid ethers. Section 5 (2 chapters) records the synthesis of formic acid from carbon monoxide, and the resulting synthesis of hydrocarbons by the dry distillation of formates.

Book 2 (147 pages) treats of the derivatives of acetylene; its combinations with nitrogen, including the synthesis of hydrocyanic acid; its combinations with oxygen, resulting in the synthesis of acetic, glycollic, and oxalic acids, as well as phenol; its combinations with halogens, leading up to the synthesis of hexachlorobenzene; and, finally, certain of its metallic compounds.

Book 3 (352 pages). Section 1 (7 chapters). "The action of heat upon isolated hydrocarbons" begins with a table of the heats of formation of various hydrocarbons from their elements, the data which govern all transformations, and then records investigations of the action of heat upon methane, ethylene, benzene, and their homologues. These experiments form the sequel to the syntheses accomplished by the polymerization of acetylene. Section 2 (17 chapters). "The action of heat upon mixed hydrocarbons." This includes the action of

acetylene upon benzene, styrene, ethylene, and propylene, and pyrogenic synthesis of benzene homologues; the discovery and synthesis of acenaphthene; the study of various hydrocarbons contained in coal tar and of the styrene series; also, the first researches (1851) upon the pyrogenic products obtained from alcohol and from acetic acid, the first rough investigation of facts which found their interpretation in the light of experiments executed fifteen years later; the results obtained in 1858 upon the formation of hydrocarbons by the distillation of salts of the fatty acids, and containing more carbon than the fatty acid from which they were obtained, thus forming the sequel to the synthesis of hydrocarbons by the dry distillation of formates, the direct derivatives of carbon monoxide. The results of all these experiments are marshalled in support of a hypothesis upon the origin of hydrocarbons in the mineral kingdom, such, for example, as petroleum, which assumes the production of metallic carbides within the earth's crust, which then are decomposed by water, the hydrocarbons evolved being polymerized and reduced. This is essentially the hypothesis which has been favored by Moissan and by Mendeléeff. The theoretical laws governing the action of heat upon hydrocarbons, pure or mixed, are reviewed and deduced thermochemically. Section 3 (3 chapters). "The study of illuminating gas." The natural consequence of the foregoing investigations, which it corroborates in many points. Section 4 (6 chapters) deals with the analytical processes used in these investigations. Section 5 (1 chapter) considers the action of heat upon carbon monoxide; while Section 6 (2 chapters) records experiments made as to the action of the electric discharge upon carbon monoxide, pure or mixed with other gases, and upon hydrocarbons.

Book 4 (202 chapters). Section 1 (3 chapters), the production of allyl iodide by the reduction of glycerine, and the preparation from this of allyl isothiocyanate and sulphide. Also the preparation of propylene. Section 2 (5 chapters) treats of the isomerism of trimethylene and propylene, a type of what the author calls "dynamic isomerism." Section 3 (10 chapters) deals with the camphenes and their derivatives, showing their fundamental types, their synthesis and that of camphor, as well as the phenomena of dynamic isomerism which characterize the oil of turpentine.

Book 5 (288 pages) deals mainly with the reduction of hydrocarbons and includes the action of free hydrogen upon hydrocarbons, the retrosubstitution of halogen derivatives, and the general applicability of concentrated hydriodic acid as a powerful reducing agent for carbon compounds of all kinds, a method which was discovered by the author in 1857 and particularly investigated and developed by him in 1868.

Book 6 (80 pages) is devoted to studies upon the oxidation of hydrocarbons. It treats of the following topics: the oxidation of hydrocarbons in general; new methods for the synthesis of organic acids; the oxidation of allylene and of other hydrocarbons; the limited oxidation of hydrocarbons; the synthesis of bibasic acids from hydrocarbons; the oxidation of organic acids and of the benzene hydrocarbons; the use of potassium permanganate as an oxidizing agent; closing with a discussion of the camphors and the true function of ordinary camphor.

Book 7 (87 pages) is taken up with the experiments upon the synthesis of alcohols from hydrocarbons. It includes the synthesis of ordinary alcohol from ethylene, of isopropyl alcohol from propylene, of ethyl iodide from ethylene; the history of the synthesis of alcohols; the direct combination of olefines with hydracids; the synthesis of methyl, normal propyl, and isoamyl alcohols, and the isomerism of alcohols. Also, the characterization of alcohols by the direct formation of their esters, a method first applied successfully to borneol and cholesterine, whose structure was then unknown, and later to glycerine and the various saccharine principles, leading to the discovery of polyatomic alcohols and the establishment of the general system of classification for organic chemistry.

MARSTON TAYLOR BOGERT.

THE ELEMENTS OF QUALITATIVE ANALYSIS. BY W. A. NOYES, PH.D.  
Fifth Edition. New York: Henry Holt and Company. 1901. iv + 101 pp.  
Price, 80 cents.

The fifth edition of this book is practically the same as the fourth with the exception of that portion in which the detection of acids is considered. This part has been rewritten according to the methods proposed by Abegg and Herz, but their methods have been systematized, elaborated, and extended.

The book consists of an introduction dealing with the general