OBITUARY NOTICES.

ARTHUR WILLIAM CROSSLEY.

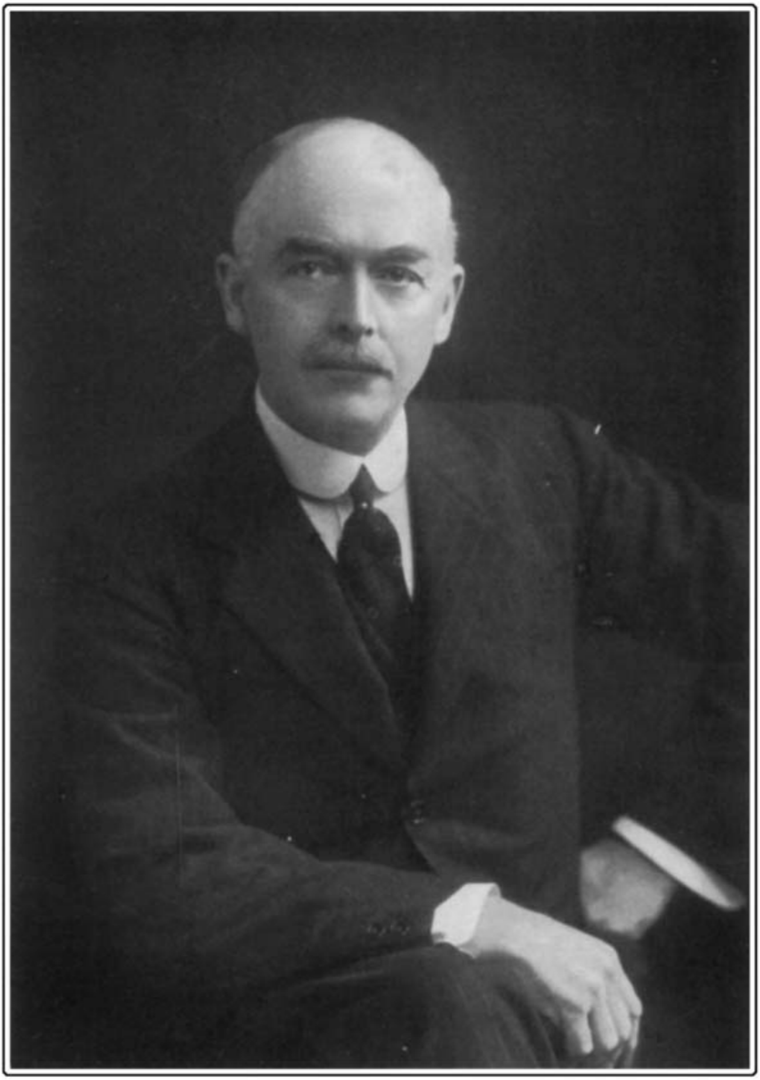
BORN FEBRUARY 25TH 1869: DIED MARCH 5TH 1927.

ARTHUR WILLIAM CROSSLEY was born at Bentcliffe, Accrington, on February 25th 1869. His father, Richard Crossley, was a man of unusual qualities who after returning from America with ample means and losing the greater part, moved into Accrington in 1864 to make what amounted almost to a fresh start as manager to the firm of F. W. Grafton & Co., well known as calico printers. If Crossley owed his quiet, reserved disposition to his father, his tenacity and resolution were inherited from his mother, a Bissett of Aberdeen and a woman of remarkable energy and force of character. Of his boyhood little of interest can be recalled : it seems to have been uneventful and happy. From preparatory school he went in 1881 to Mill Hill—chosen for its nonconformist tradition—where he stayed until Easter 1885. The next three months were spent in Paris. In the following October he entered Owens College, but owing to an illness which caused the loss of a year, he did not obtain his Honours degree of B.Sc. until 1890.

After a session spent in Professor (now Sir Arthur) Schuster's laboratory, which led to the joint publication of a paper on the electro-deposition of silver (*Proc. Roy. Soc.*, 1892, **50**, 344), Crossley went to Emil Fischer at Würzburg in October 1891, stayed there until Fischer was translated to Berlin in succession to A. W. von Hofmann in the autumn of 1892 and remained with him in Berlin until the Christmas of that year. Before leaving Würzburg the degree of Ph.D. was conferred on him for his thesis entitled "I., Ueber die Oxydation einiger Dicarbonsaüren; II., Ueber das optische Verhalten des Dulcits und seiner Derivate."

Returning to Owens College early in 1893 to undertake research work with W. H. Perkin, junr., he was elected to a Bishop Berkeley research fellowship in the following year and became President of the College Union, revealing in the conduct of its affairs thoroughness and a sanity of judgment that later came to be recognised as characteristic. This admittedly was one of the happiest periods of his

A. W. CROSSLEY.



A. W. CROSSLEY.

[*To face p.* 3165.]

life: he widened his social circle, was an active member of many college societies and, freed at last from the tyranny of examinations, gave regular hours to the cultivation of his singing voice—a baritone of fine quality and wide range. But for its uncertainty, he might have chosen the concert platform as a career rather than chemistry which, until devotion to experimental work came to possess him, was more his father's choice than his own. In April 1895 he was appointed teacher and demonstrator in physics and chemistry at St. Thomas's Hospital Medical School, where he succeeded Professor (now Sir Wyndham) Dunstan as chemical lecturer and consulting chemist in October 1900. Four years later he became Professor of Chemistry at the Pharmaceutical Society's School of Pharmacy, Bloomsbury Square. As the outcome of Crossley's research work at Owens College, two papers were published jointly with Perkin, the first in 1894 under the title " Substituted pimelic acids," (J., **65**, 987) and the second in 1898, nearly three years after his departure from Manchester, entitled " Decomposition of camphoric acid by fusion with potash or soda," (J., **73**, 1). Dihydrocamphoric acid, one of the products mentioned in the second paper, was the starting point of the series of investigations which occupied his attention until the outbreak of the War and led to the publication of some 40 papers in the Journal. With some of the early communications from St. Thomas's Hospital, the late Dr. H. R. Le Sueur was associated and in many of those from the School of Pharmacy, Miss Nora Renouf was his collaborator.

The earliest papers of the series dealt with attempts to synthesise $\alpha\alpha_1\beta\beta$-tetramethyladipic acid on the assumption that dihydrocamphoric acid had that constitution. Of the intermediates examined, 1 : 1 : 2-trimethyldihydroresorcin, obtained for the purpose by the condensation of mesityl oxide and ethyl sodiomethylmalonate, and 1 : 1-dimethyldihydroresorcin, its lower homologue, which had been made slightly earlier by Vorländer, proved so unexpectedly reactive that the original quest was abandoned. In its place, the detailed study of these hydroaromatic compounds and of their reduction, halogen and ketonic derivatives was pursued with ardour, leading as it did to the production of *o*-xylene derivatives by the migration of one of the members of the *gem*-dimethy group.

In the papers many indications of the care taken to check the occurrence and course of these transformations can be found. These led incidentally to the production of mono-, di- and tri-nitro-*o*-xylenes and to the preparation of all the isomeric forms of these substances. Further, a contribution to the loosening effect of nitro-groups situated in the *ortho-* or *para*-position relatively to a given nitro-group arose out of the conversion of certain trinitro-*o*-xylenes into dinitro-*o*-xylidines by interaction with ammonia. And the emergence of halogenated *o*-xylenols in the later stages of the investigation showed the interest of the subject to be far from exhausted, when the War brought the work to an end.

Much attention was paid to the exact characterisation of hydrocarbons of the di-, tetra- and hexa-hydrobenzene series isolated in the course of the work, as troublesome obstacles were encountered owing to the frequent occurrence of mixtures of isomerides, closely similar in properties, in the synthetical products. As serving to connect these products with camphor and the terpenes, the synthesis of *iso*laurolene and of *cyclo*geraniolene may be noted. From the manner in which each experimental difficulty was attacked and solved, the whole investigation affords a good example of the art of scientific discovery.

It was especially during his tenure of the Chair at the School of Pharmacy, which lasted from 1904 to 1914, that Crossley found scope for the exercise of those qualities of organisation, tact and driving power which later were to be of inestimable service to the State. To him fell the completion of the scheme initiated by his predecessor for remodelling and re-equipping the Chemistry Department, aided as he was by the cordial co-operation of the veteran Michael Carteighe who, far-seeing and insistent, laboured to the end of his life for the advancement of the scientific side of pharmacy.

In his inaugural address at Bloomsbury Square, Crossley made it clear to the students that in his view pharmacy is " a great applied science " and also " a great profession " (*Pharm. J.*, 1904, **73**, 497). Imbued with this conception of the dignity of their calling, he set them a high standard of duty by the conscientious performance of his work as professor. No external interest, not even the fascination of research, was allowed to interfere with his weekly tour of the laboratory or that personal contact with each student to which he attached the utmost importance. But it was in his research laboratory—a curious, octagonal room, by no means well lighted or equipped for advanced work—that his devotion to chemistry found its outlet. There, too, by his example he inculcated thoroughness, careful observation and an ordered use of all laboratory hours, and, always open to suggestions or ideas from his fellow workers, he never failed to show appreciation of their share in bringing a research to a successful conclusion.

Naturally, all through this period, Crossley looked to a University Chair as his ultimate aim. When, therefore, he was appointed

Professor of Organic Chemistry in King's College, London, in June 1914, the wider opportunities for teaching and research that he coveted seemed at length to be his. But Fate willed otherwise. Within little more than a month, the Great War broke out and—save that he gave lectures during the session 1914/15 and returned to the College for a few months after the Armistice—his work as a Professor was done. Henceforward his energies were to be absorbed first in the country's defence and later in the effort for reconstructing industry that has followed the Peace.

Never one to wait, in an emergency, for employment fitting his attainments, Crossley in the earliest days of the War cheerfully undertook arduous clerical work as a volunteer in the War Office under Colonel (now Sir John) Pringle who was engaged in organising railway transport for troops in the Home Defence, Eastern Command and London District areas. Then, after aiding in the large-scale production of salvarsan under the name kharsivan, he became secretary of the War Committee appointed by the Royal Society to organise the production in universities and kindred institutions of local anaesthetics such as novocaine and β-eucaine and of other drugs hitherto obtainable only from enemy sources.

The bitter cry for shell in the spring of 1915 led to the establishment of the Ministry of Munitions. Of its Departments, that dealing with Trench warfare had for one of its functions the provision of all material required for the offensive in chemical warfare, rendered necessary by the introduction of gas as a weapon by the Germans on the western front on April 22nd of that year. As part of the organisation, two Committees termed Scientific Advisory and Commercial Advisory were set up in June * and of each Crossley was appointed secretary. The early days of chemical warfare were for him full of anxiety and incessant toil. The Scientific Advisory Committee sat almost continuously during each day; at night steps had to be taken to carry into effect its decisions. Crossley, as secretary, stood between the military in urgent need of new weapons the nature of which, perforce, they could not describe, and the Advisory Committee, faced with utterly new problems vitally important but requiring time, of which there was all too little, for their solution. In these early days, the contact between those in the fighting line and those working at home to provide the sorely-needed chemical weapons was small. To enable the latter to form some conception of the conditions at the front, Crossley was

* The Scientific Advisory Committee was a body of distinguished scientists charged with the duty of devising and investigating methods of prosecuting chemical warfare, the Commercial Advisory Committee a group of leading men in the British Chemical Industry in a position to advise upon and assist in the production of the necessary chemical materials.

given the additional appointment of Liaison Officer for Chemical Warfare in November 1915 with the rank of Lieutenant-Colonel and in this capacity made several visits to the battle areas in France.

Only slowly did the authorities at home realise that for the successful development of chemical warfare it was essential there should be available a large experimental ground where trials could be carried out on a scale approaching that of actual warfare. Space was required for testing under varying meteorological conditions both the methods of producing and the lethal or visual effects of toxic " gases " and smokes distributed from cylinders, by artillery fire, or otherwise. Eventually a large tract of bare land was acquired at Porton, east of Salisbury, and to Crossley in June 1916 was entrusted the task of converting it into a suitable experimental ground, of staffing and equipping it and of supervising the experimental work undertaken at the instance of the Army or the Committee. Thereupon, he ceased to be secretary of the Committee,* but was retained as a member and also as liaison officer.

How great the difficulties were and how he overcame them may be understood at least in part from the following appreciation most kindly furnished by Lieutenant-Colonel (then Major) R. M. Rendel, R.A., a regular officer who served under Crossley for two years—for the first three months as his adjutant and afterwards as one of his experimental officers.

" When Crossley arrived at Porton he found two small Army huts, each 30 feet by 15 feet, in the middle of Salisbury Plain, with no roads leading to them, no water, and no equipment of any kind. He was, with the exception of one subaltern R.E. and one warrant officer, quite alone. His first move was to get himself appointed to the military command of the Experimental Station; his second to collect the nucleus of a staff. By the end of June he had a chemical laboratory running in one of his Army huts, and by the end of the year detachments of Artillery and Engineers under their own officers had been posted to the Station. He was now in a position to begin the preliminary experiments, which were necessary for the solution of the hundreds of questions that had to be answered before the British Armies in the field could undertake chemical warfare.

" It would take too long to sum up the work done by Crossley

* The Scientific Advisory Committee was modified and re-named in successive reorganisations. Eventually it became the Chemical Warfare Committee, a body of enlarged constitution responsible for scientific investigations on the defensive as well as the offensive side of chemical warfare. Throughout its transformation and afterwards, Crossley continued to be a leading member.

during his two and a half years at Porton. It is doubtful whether anyone realises the immense volume of work actually achieved. Crossley himself wrote a summary for the War Records, a copy of which is filed at Porton, but it is both much too long and much too official to reproduce here. It may be of interest, however, to consider that at the time of the Armistice, little over two years after the beginning of the Experimental Station, Porton was staffed by 47 officers, 700 N.C.O.'s and men and 800 civilian workmen. Of the 47 officers roughly half were trained scientists, principally chemists and physiologists, several of them very eminent men. The two original Army huts had been replaced by large laboratories, workshops, gunsheds, magazines, barracks and canteens. Permanent roads were in existence over the ground; telephones, electric light, and water had been laid on. Large stores of shell, gas and so on, were situated on the ground and about 40 pieces of ordnance of all natures, from 9·2 howitzers downwards, and trench mortars of every description, were under Crossley's command. Over 40,000 rounds of ammunition had been fired, thousands of experiments had taken place and some of the results of Crossley's work had been embodied in over 800 reports. Chemical warfare was already highly developed.

" During those two years or more, from the moment Crossley came to the Station, work was carried on all day and during most of the night. Such was his driving power that lack of facilities never seemed to matter. It was one of Crossley's outstanding merits that, although he himself fully realised the difficulty of working without proper tools, yet he never allowed the lack of them to become an excuse for doing no work.

" Apart from the fact that it was wartime, work at Porton was carried on in a very pleasant atmosphere. There were no jealousies or bickerings between those engaged on the experiments. Whatever the differences of opinion between individuals, once a report had been issued it was always accepted as the official Porton view. It was always signed by Crossley, unless it were purely physiological, so that the Station did actually achieve an entity of its own. If reference were made to Porton, whether as regards some chemical question or as regards the functioning of a particular fuze, the reply was the Porton reply, the opinion the Porton opinion, the work was the work of Porton and Crossley signed the report. The physiologist was proud of the work done by the chemist, the chemist recognised the achievements of the gunner. A most valuable corporate feeling was thus created; it was entirely due to Crossley, and it was only possible because, while he always took responsibility for all that was said or done, he never took to himself credit which was really due to others. All his staff were well aware of this.

"His position as commanding officer was a very real one. He was in actual military command of nearly 1,000 men, almost every one of whom had more military experience than he had. The type of man serving at Porton during the War was very good, but it is certainly to the credit of Crossley that serious military crime, both during the War and after the Armistice, was non-existent at Porton.

"He was the most hardworking of men. Sometimes severe, he very seldom praised; but he was absolutely fair-minded and all the time he was at Porton I never heard him criticised by any one of his staff. We were all devoted to him. Crossley was the best Commanding Officer I ever served under."

In September 1918, Crossley was appointed Daniell Professor of Chemistry and Director of the Chemical laboratories in King's College on the resignation of Sir Herbert Jackson, and after demobilisation returned to the college in October 1919. In common with many of those engaged in the big enterprises of the War, he found the routine of post-war days irksome, although with undiminished vigour he set himself to rebuild his department and revive academic research under the difficult conditions then prevailing. Soon the call came to him to undertake the organisation of the British Cotton Industry Research Association founded by the Lancashire cotton trade with the co-operation of the Department of Scientific and Industrial Research. Appointed Director on November 4th 1919, and leaving King's College in March 1920, it was on his recommendation that the house at Didsbury, now known as the Shirley Institute, was purchased. While it was being adapted to its new use and extended by the erection of a large block of laboratories and workshops, a beginning was made with cotton research in laboratories lent for the purpose by the University and by the Technical College in Manchester. To the Institute, the research staff was transferred early in 1922, the buildings being opened formally by H.R.H. the Duke of York on March 28th of that year. By the autumn of 1926, the research staff (including those of its members engaged in the workshops) which in 1921 numbered 28, had increased to 92 of whom 44 were university graduates. An account of some of the investigations in progress at the Institute formed the subject of a discourse given under the title "Science and the Cotton Industry," by the Director at the Royal Institution on Friday, January 23rd 1925.

In the autumn of 1923, the initial period of association with the Department of Scientific and Industrial Research drew to its close, and, although little more than a year of normal working had been possible, the results were sufficiently encouraging to warrant a further grant of £45,000, spread over five years in a series of diminishing amounts, being made by the Department, on condition that the total annual income was raised to a minimum of £42,500. It was a source of much satisfaction to Crossley, and an unmistakable proof of confidence in his directorship that an industry hard hit as the cotton trade has been since the Peace, should shoulder the additional burden imposed by this condition. His aim was to make the Shirley Institute the brain of the chief industry of his beloved Lancashire, benefiting alike the cotton trade and all who depend on it for their living and prosperity. That, by his genius in planning and guiding research, he provided a sure foundation for ultimate success is evident from the review of the work of the Association to the end of 1926, recently published by the Shirley Institute under the title " Research in the Cotton Industry." Not improbably his work at Didsbury may come to be regarded as his best.

Crossley served the Chemical Society in many ways. He was an abstractor during the three years 1897–99 and a member of the Publication Committee for a period of twenty years ending in March 1926. From 1906, when he became Honorary Secretary, he held office without a break until his death, becoming Honorary Foreign Secretary in 1913, President in 1925 and on his resignation of the Chair, Vice-President in 1926.

The Annual General Meeting in 1926 was notable as being the first to be held out of London. Early in Crossley's presidency, the Council decided to make the experiment of holding the ensuing annual meeting in a provincial city. Most appropriately, Manchester was the city chosen, and the University the place of meeting. Crossley thus had the gratifying experience of occupying the Chair as President of the Society in the Chemistry lecture theatre in which he had sat as student under Roscoe and afterwards under Dixon, the latter of whom was present and took part in the proceedings. The presidential address was entitled " The Co-operation of Science and Industry," a subject constantly in his thoughts, to which he had also referred in a lecture on " Science and Industrial Problems " at the Royal Institution on February 5th 1915.

By nature Crossley was deliberate, but with his mind once made up resolute. Unfailingly courteous and genial to all in every relation of life, it is probable that comparatively few were admitted to the intimacy of his friendship. His recreations were typical: he played lawn tennis in his student days and golf later in life, but in billiards and fly-fishing—the latter absorbing entire holidays before the War—he found an abiding source of pleasure. To his cultivated taste books, of which at one time he was an eager collector, music and the theatre, made a strong appeal. Without being robust he enjoyed good health until the effect of the strain of the War years began to manifest itself. A voyage to Madeira in the May of 1925, after he had succeeded to the Presidency of the Society, gave a temporary respite, but in the autumn he was less well and early in January 1926 sought to resign office forthwith on medical advice. By relieving him of all work requiring his presence in London, the Council of the Chemical Society rendered it possible for the resignation to be deferred until the Annual General Meeting in March, thus enabling him to complete one year of office.

Before the summer was over, it was evident that his health was failing rapidly. Towards the end of the year he tendered his resignation of the Directorship of the British Cotton Industry Research Association, but by resolution of the Council remained nominally in office pending the appointment of a successor. This appointment had not been made and he was still Director when, on Saturday, March 5th, 1927, he died.

Crossley received many honours: D.Sc. (Victoria University) 1899; F.R.S. 1907; Hon. LL.D. (St. Andrews) 1917; C.M.G. 1917; Longstaff Medallist of the Chemical Society 1918; C.B.E. and Officier de la Légion d'Honneur 1919. In 1901 he married Muriel, daughter of Ralph Lamb of Liverpool, who with their son and daughter survived him. It may be permitted to add that the son, Kenneth Harwood Crossley, to the grief of all who watched his early career and had recognised his ability, tenacity of purpose and faculty for endearing himself to all with whom he worked, was drowned in a sailing accident off Llanddwyn Island, Anglesey, on July 30th, in his 23rd year. W. P. WYNNE.

HILDYARD JOHN EGLINTON DOBSON.

BORN FEBRUARY 18TH, 1902; DIED MARCH 28TH, 1927.

H. J. E. DOBSON, in whom is lost a young physical chemist of high promise, was born on February 18th, 1902, at St. Michael's Vicarage, Southfields, London, where his father, the late Rev. R. A. Dobson, M.A., was vicar for 25 years. His family had a definitely scientific connection, for his uncle, Major George E. Dobson, of Netley, was a Fellow of the Royal Society and was a personal friend of Charles Darwin and of Huxley.

After nine years at school at Monkton Combe, near Bath, Dobson entered University College, London, in 1919, as a student of science. During his undergraduate course he showed great promise in chemistry, sharing the Tufnell Prize, a coveted distinction in these laboratories. His honours degree, of an unexpectedly low class, was no index to his merit; and this he showed at once by the success with which, aided by the Department of Scientific and Industrial Research, he proceeded to tackle research at University College on problems of solubility and activity in aqueous solutions. Papers which were an outcome of this work were published in the *Journal* in 1924 and 1925; and these afford the first accurate data for the partial pressures of water in hydrochloric acid, and of both water and alcohol in aqueous alcohol. He made many invaluable improvements in the technique of vapour-pressure work, of which that recorded in the *Journal* (1924, **125**, 1968) is only one instance.

In October, 1924, he joined, by invitation, the staff of the then new chemistry school at Durham, as lecturer in physical chemistry. Here, in spite of an illness which postponed his beginning duty, he set about his new work with great zest and success. At the same time he carried on energetically his studies of solution, both theoretically and practically; his originality of thought began to develop very markedly; and he has left a considerable volume of data and calculations which, if his health had allowed him to carry them a stage further, would undoubtedly have afforded a valuable contribution to physical chemistry.

Dobson's indomitable gaiety, gentleness, and enthusiasm, which he kept even during the long illness which proved fatal, won him affection from all his associates, both in the laboratories and in the college (Hatfield) of which he was a member at Durham. I. M.

ALBIN HALLER.*

BORN 1849; DIED 1925.

ALBIN HALLER, the eldest of a family of eleven, was born on March 7th, 1849, at Felleringen, a village in the valley of Thann-Saint-Amarin and not far from Mulhouse. From the village school he passed to the higher primary school at Wesserling, and the spectacle presented by the large factories of this busy industrial centre undoubtedly stimulated his imagination. He wished to become an engineer, but, at the age of fourteen, was apprenticed as a carpenter in his father's workshop. Two years later, however, as the result of a conversation with a pharmacist of Wesserling, he was brought into contact with his " bon génie," M. Achille Gault, and this event altered the whole course of his life. Haller loved to

* Based on Madame Ramart's Notice in the *Bulletin de la Société chimique de France.*

recall the period between 1865 and 1870, from the day when he walked over the hill separating his native valley from Mulhouse in order to present himself at the house of his first teacher to the time of his gaining the baccalauréat ès sciences. M. Gault was quick to appreciate the character and rare ability of his pupil; during three years the leisure which the direction of a laboratory allowed was devoted to Haller's scientific education and he then became assistant to M. Gault's brother, M. Léon Gault of Colmar, who instructed him in French and Latin.

The Franco-Prussian war supervened and Haller volunteered at Belfort, but in the sorrowful year 1871 he lost his father and, choosing to remain in France, had perforce to leave his mother and all that he remembered on the other side of the frontier. At Nancy he rejoined M. Gault, who had come to found a pharmacy and now continued to assist Haller in preparing for pharmaceutical examinations. Soon the University of Strasbourg was installed at Nancy and Haller became in succession aide-préparateur (1872), préparateur, and chef de travaux at the École Supérieure de Pharmacie. In 1879 he submitted his thesis for the doctorat ès sciences and from this time his advancement was rapid, so that in 1885 he became a professor in the Faculty of Science of the University. In 1899 he was called to the University of Paris and proved to be a worthy successor of Friedel and of Wurtz, adding fresh lustre to an illustrious record by his numerous researches, by his inspiring teaching and especially by his ability to communicate something of his own enthusiasm to his students. Haller was an able and energetic organiser; in relatively early days he was the prime mover in the creation of the Institut Chimique in the University of Nancy (1890) and, later, of that devoted to the study of physical chemistry and electrochemistry (1897). He was throughout his career actively interested in the co-operation of science and industry, and not least among his many services to his country must be reckoned the important part which he played in developing the teaching of applied science in France. In 1908 he succeeded Berthelot as President of the Commission on Explosives, and both civil and academic honours were showered on the ardent patriot and distinguished savant.

The scientific work of Albin Haller, extending over a period of fifty years, presents a striking example of the achievement that is possible when penetrating vision, amounting to intuition, goes hand in hand with remarkable powers of observation and sustained effort. It is impossible to give in a short space an adequate idea of the ground covered by Haller's original memoirs (of which there are nearly 250), but his researches in the camphor and phthalein groups and on the elegant syntheses with the aid of sodamide must be briefly described or rather indicated. Subjects which cannot even be touched upon are, for example, Haller's work on pseudo-acids, on alcoholysis and on optical rotatory power.

The study of camphor and its derivatives was the object of Haller's earliest researches and he never completely abandoned the subject, since even in 1925 certain of his collaborators were engaged in this fascinating field of enquiry. We owe to Haller the demonstration that camphor is a ketone of the formula $C_8H_{14}<\begin{matrix}CH_2\\ | \\ CO\end{matrix}$ and he also effected the final stages in its synthesis. Haller treated sodiocamphor with cyanogen chloride and thus obtained cyanocamphor, $C_8H_{14}<\begin{matrix}CH\cdot CN\\ | \\ CO\end{matrix}$, which could be hydrolysed with formation either of camphorcarboxylic acid or of homocamphoric acid, $C_8H_{14}(CH_2\cdot CO_2H)(CO_2H)$, according to the experimental conditions. The familiar syntheses of the latter acid and of camphor from camphoric acid through camphoric anhydride and campholide are due to Haller. If we are to appraise these contributions to camphor chemistry at their true value it is necessary to recall that it was Haller himself who demonstrated that camphoric acid is a dicarboxylic acid; Friedel had suggested that it might be a keto-hydroxy-carboxylic acid and Ostwald, from a study of the electrical conductivity of solutions of the acid, was led to concur in this opinion. The preparation of arylidene and alkylidene camphors by the action of aldehydes or ketones on sodiocamphor was of importance not only because it proved that camphor contains the group $\cdot CO\cdot CH_2\cdot$ but also because these substances were found to possess interesting optical properties and could be used as the points of departure in further syntheses.

Haller devoted much attention to clearing up the relations existing between the isomeric borneols, both natural and synthetic, characterising the former by the preparation of the related camphor, bromocamphor and camphoric acid. He concluded that the borneols and *iso*borneols are stereoisomerides to be represented by one and the same structural formula.

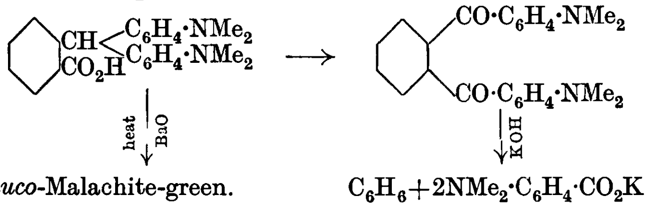
In order to avoid the partial reduction that occurs when sodium is employed in the preparation of sodiocamphor, Haller in 1904 investigated the action of sodamide on camphor and found that the products of a smooth reaction were sodiocamphor and ammonia. Sodamide had previously been used in organic chemistry for different purposes by some chemists, for example, by Titherley, Freund, and Speyer and by Brühl, but in Haller's hands it became a powerful auxiliary and new general synthetic methods were based on its use.

By its means the formation of the sodio-derivatives of ketones is a general reaction (acetone and acetophenone giving rise chiefly to condensation products) applicable to all substances of the forms $R{\cdot}CO{\cdot}CH_2R'$ and $R{\cdot}CO{\cdot}CHRR'$ and these sodio-derivatives may be brought into reaction with substances of various types. An important application is the progressive alkylation of ketones by means of sodamide and alkyl bromides or iodides through such stages as $R{\cdot}CH_2{\cdot}CO{\cdot}CH_2R$, $R{\cdot}CHR'{\cdot}CO{\cdot}CH_2R$, $CRR'_2{\cdot}CO{\cdot}CH_2R$, $CRR'_2{\cdot}CO{\cdot}CHRR'$, $CRR'_2{\cdot}CO{\cdot}CRR'_2$. The substances of the penta-alkylated acetone type are obtained by operating in ethereal solution and of them only pentamethylacetone reacts with hydroxylamine, semicarbazide and phenylhydrazine. The substances of the hexa-alkylated acetone type are obtained by operating in an aromatic hydrocarbon medium and do not condense with the above-mentioned reagents for the carbonyl group. On the other hand, these heavily substituted ketones may be readily and quantitatively reduced to secondary alcohols and, moreover, the ketones $Ph{\cdot}CO{\cdot}CR_3$, which are best prepared by Haller's method from the mono- or di-alkylated acetophenones, form with ease both oximes and semicarbazones. Haller made important applications of the method to the alkylation of cyclic ketones such as *cyclo*pentanone, *cyclo*hexanones, menthone, thujone, camphor, and indanone. He also employed such substances as trimethylene chlorobromide and thus obtained a series of δ-chloro-alkylated ketones. The polyalkylated ketones and their derivatives have naturally been of great service to students of molecular rearrangement and the theoretical interest of the study of their reactions and properties is inexhaustible.

Whilst carrying out experiments on the condensation of benzophenone and its derivatives with sodiocamphor (that is, camphor and sodamide) Haller noticed the formation of aromatic acids and amides. He was able to show that sodamide and benzophenone yield an additive product that is decomposed by water with the formation of benzamide, benzene, and sodium hydroxide. This decomposition was then found to be general for ketones of the form $R{\cdot}CO{\cdot}CR'R''R'''$, yielding either $R{\cdot}CO{\cdot}NH_2$ and $CHR'R''R'''$ or RH and $CR'R''R'''{\cdot}CO{\cdot}NH_2$ according to the nature of the substituents. A careful study was made of the circumstances governing the direction taken by the reaction and many interesting points emerged. Although there are exceptions, it was found to be a general rule that where the decomposition could yield an aromatic or an aliphatic acid amide, the latter course was favoured; *e.g.*, phenyl *tert.*-butyl ketone yielded benzene and pivalamide: $Ph{\cdot}CO{\cdot}CMe_3 + NH_3 \longrightarrow C_6H_6 + CMe_3{\cdot}CO{\cdot}NH_2$. Especially important in view of the use which Bouveault made of the method in connexion with the chemistry of fenchone and camphorone is the extension of the study of this decomposition in the group of the cyclic ketones. Haller showed that fluorenone is changed by sodamide (and subsequent treatment with water) into *o*-phenylbenzamide. Similarly, 2 : 2′-dimethylindanone yields phenylpivalamide, which, like many of the products of these reactions, is difficult to obtain in other ways. As a third example, selected from many, the decomposition of dialkylated camphors by sodamide was found to yield the dialkylcampholamides.

Haller has also employed his method for the synthesis of certain pyrrolidines and tetrahydropyridine derivatives and in many other directions.

Whilst he was still at Nancy, Haller, in collaboration with Guyot, made some extremely interesting studies of certain phthalein, phthalophenone and anthracene derivatives. These were connected with the establishment of the constitutions of chemical individuals and with the mode of occurrence and mechanism of such transformations as those represented below.



Haller obtained the chloride of *o*-benzoylbenzoic acid in a crystalline condition and since it readily condensed with benzene in presence of aluminium chloride with formation of diphenylphthalide, he concluded that it should be formulated as phenylchlorophthalide. Another fruitful investigation was concerned with the preparation of *o*-(*p*-dialkylaminobenzoyl)benzoic acids and their conversion into the hitherto unknown dialkylaminoanthraquinones by successive reduction, cyclisation by condensation, and oxidation. Finally, by applying the Grignard reaction to anthraquinone, Haller made a long series of 9- and 10-arylated anthracenes and dihydroanthracenes.

The illness which proved so rapidly fatal was provoked by a laboratory accident and thus, at the age of seventy-six, Haller was carried away whilst still actively engaged in experimental work. He had expressed a wish that the end might come in this way.

Albin Haller was an inspiring and beloved teacher, a highly successful investigator of world-wide renown, and a great Frenchman, but he was also a man of fine character and as modest as he was distinguished.

R. ROBINSON.

RUDOLPH MESSEL.*

BORN JANUARY, 1848; DIED APRIL, 1920.

RUDOLPH MESSEL was the son of Simon Messel, a banker of Darmstadt. He was the second of five children, of whom four were to make their homes in England; the fifth acquired great distinction as an architect in Berlin. He lost his father when 11, and shortly after was sent to a Huguenot school at Friedrichsdorf in the Taunus, where he remained until he was 15 years old. His schoolmaster, Philip Reis, was the inventor of the first telephone. Messel, in his Presidential Address to the Society of Chemical Industry in New York in 1912, makes reference to the fact that he "assisted Reis in making the mechanical parts of some of his instruments and also repeatedly in his experiments, Reis being at one end of the circuit, speaking or singing, I listening at the other, or *vice versa*." About this time the family circumstances changed, and it was clear that Messel would have to become self-supporting at an early date. It was his intention to become an engineer, and in 1863 he discussed his further course of action with an old friend of his father's, H. Rau, then living in Frankfort. Rau appears to have advised Messel to devote himself to the study of commerce which he said would rapidly lead to independence, and to combine with this the study of Chemistry, Physics and Technology, and so become a manufacturer. It is clear that Messel's whole course of action was influenced by this letter, as not only did he keep it to the last among his rarest letters, but followed the advice it contained almost verbally.

In April, 1863, he became apprenticed to E. Lucius in his wholesale drug and chemical factory in Frankfort, and remained there until September, 1866, leaving to enter the Federal Polytechnic in Zurich, where he followed the regular first-year course. The following winter he spent at Heidelberg, studying physical chemistry under Erlenmeyer. He moved in the spring to Tübingen, where he finished his education, studying chemistry under Strecker, and continuing with him until April, 1870, carrying out work for which he obtained his degree. In April, 1870, he came to Manchester, originally to act as private assistant to Roscoe.

He was recalled to Germany owing to the outbreak of the Franco-Prussian war, where he served as a stretcher-bearer in the army of the Loire and was wounded. When recovered, he returned to England, where he remained during the rest of his life and ultimately became an Englishman.

He entered the service of Messrs. Dunn, Squire & Co., Stratford, as assistant to Dr. Squire. Shortly after, Squire formed with

* Reprinted, by permission, from the *Proceedings of the Royal Society*.

Spencer Chapman the firm of Squire, Chapman & Co., and took Messel with him in his new venture. This change occurred at a time when the growth of the synthetic dyestuff industry was threatened by the excessive price which was charged for fuming sulphuric acid, then produced by the old Nordhausen process in Bohemia. Squire decided to commence the manufacture of fuming acid.

In his New York Presidential Address, Messel tells of a conversation in the beginning of the '70's with his former teacher Strecker, and Brüning of Höchst, on the importance of fuming sulphuric acid in the synthetic alizarin industry. To his question how the acid should best be made, Strecker gave the reply: "That is a problem for you to solve." A few experiments convinced him, he says, that, given pure gases, the catalytic action of platinum was the rational solution of the problem. In April, 1875, a telegram came to him at the laboratory from Squire, asking him to read up that night about Nordhausen acid, as it was wanted by an Alizarin Works. The response was immediate and typical—no reading was necessary. Next day he showed how simple a matter it was to unite sulphur dioxide with oxygen by means of platinum. However, Squire was conventional and thought that the decomposition of acid sulphate would be a simpler method. Experiments were made, as requested, but eventually Messel was told to try his dodge.

Of the work that followed, no permanent record has been published, except in the form of Patents taken out by Squire in 1875. A year later, however, in April, 1876, Squire and Messel described and demonstrated the process before the Chemical Society. This paper was never printed, probably because of the Patent situation, but a paragraph in the "Chemical News" records the meeting. Messel treasured until his last days a document describing the experiments, and the original platinum apparatus used was left by him in his will to his lifelong friend, Professor H. E. Armstrong.

In his Presidential Address, Messel refers to the publication in October, 1875, by Winkler, of a process which was practically identical with his. Both investigators erred at that time in believing that stoichiometrical proportions of the gases were the best to use, and the various similarities gave rise to unpleasant comment. In letters to Messel, however, Winkler freely acknowledges the independence of Messel's work, and only regrets that he had deprived himself of the benefit of the invention by his publication.

The process was established at Silvertown, and in 1878 Messel succeeded Squire as manager of the works, which he only quitted in 1915, when his health gave way under the excessive strain of the times. The firm became Spencer, Chapman & Messel, Ltd., and the factory grew in size and importance.

Messel remained a bachelor and lived on the works. He was an indefatigable worker, and set a very high standard to all those who served under him. His sense of justice and sympathy, and the fact that he lived amongst them, gave him great popularity and power with his workpeople.

In the early days of the industry, the value of the fuming acid was much greater than that of oil of vitriol and the most suitable mixture of sulphur dioxide with oxygen was made by decomposing the latter. As experience was gained, and the difficulty of condensing the anhydride was overcome, sulphur dioxide prepared by burning sulphur and ordinary air were used, and later, excess of air was employed largely as a result of observation by the foreman that the plant worked better under these conditions.

It is a testimony to Messel's remarkable insight that right at the beginning he obtained such a wonderful knowledge of all details of this catalytic process, subsequently developed on a very large scale and in great detail by Dr. Knietsch and his co-workers of the Badische Anilin und Soda Fabrik.

Remarkable as Messel was as an industrialist, he was even more remarkable as a man. A man of astounding vigour and feeling, he had little thought for himself and a hatred of all display. He was essentially an artist, both in his extreme devotion to his own art of chemistry and in his love of the company of artists and other bohemians. He was everything—not only chemist, engineer and business man, but also took care to cultivate the social side of his life, and was almost the only manufacturer of his day who attended regularly at scientific gatherings and showed a real interest in the proceedings. His vigorous frame, black hair and sparkling eyes, his smiling face and peculiar guttural accent will remain in the memory of all who knew him. He never mastered English properly though he spoke it fluently. He was very fond of young people, many of whom rejoiced in his generosity. One of the most lovable of men, his outlook on life was always cheerful and optimistic. The example he set in leaving his fortune to science is a remarkable one and best proof of his considerate outlook. Honest and sincere himself, he hated insincerity and all meanness of spirit.

He played an active part in many scientific societies, particularly the Society of Chemical Industry, of which he was Foreign Secretary for many years and President for 1911–1912—probably the only connection in which he showed vanity, but he was very proud also of his election to the Royal Society in 1912.

His Presidential Address was written to show that science and industry are working hand in hand, and the importance of the results that such co-operation has produced. In discussing the education of a chemist, he stressed the fact that too early concentration on special subjects had a bad effect on the development of the power and habit of thinking independently and on the faculty of imagination in the student. He held that technique is very rapidly acquired in practice by one who has been scientifically trained. With Carlyle he said, " He who has learned how to learn can learn anything," and the best system of education is the system which teaches each man how to educate himself. Gifted with his full share of enjoyment of the good things of this life, Messel nevertheless led a life of great simplicity. His success was due, in the first place, to his thorough scientific training and scientific outlook, but in an exceptional degree to his moral attitude towards his work.

He left four-fifths of his residuary estate to the [Royal] Society and the remainder to the Society of Chemical Industry. Without imposing any trust or obligation, he desired that the capital should be kept intact and the income applied to the furtherance of scientific research and other scientific objects. E. F. A.

IRA REMSEN.*

Two men, Ira Remsen and Wilhelm Ostwald, stand out during the last fifty years as great teachers and as founders of chemical journals which have had a profound influence on the development of chemistry. In these two respects their work is comparable with that of Liebig during the middle of the nineteenth century.

Ira Remsen was born in New York City, February 10th, 1846. His parents were both descended from the early Dutch settlers of New York and his mother had also Huguenot blood in her veins. For two years, from eight to ten, the boy lived in the country and had that intimate contact with nature which is impossible for a lad who spends his life exclusively in a city. A part of his early education was received in country schools. After further study in the public schools of New York City he entered the Free Academy, now the College of the City of New York, where he studied Latin, Greek, mathematics, history and a very little science. He did well in Latin and Greek and it was doubtless during those years that he laid the foundation for that perfect command of accurate English which has made it such a delight to read his books and to listen to his lectures. His interest in science seems to have been awakened at this period by the popular, illustrated lectures given by Dr. Doremus at the Cooper Institute.

He did not, however, complete the four years of work required

* Reprinted, by permission, from *Science*.

for graduation at the Free Academy. Many years later he received the bachelor's degree from the College of the City of New York, as of the class of 1865. He was accustomed to say, with some pride, that he was one of the few men who had received the rank of M.D. from the College of Physicians and Surgeons without having received the bachelor's degree. He also said, at one time, that he thought he was the only university president in America who had not completed a four years' college course

After a few years in the Free Academy, Remsen's father decided that he should become a physician and apprenticed him to a doctor who taught in a homœopathic medical college. Here he read some chemistry and tried some chemical experiments for himself, sometimes with disastrous results to his fingers and clothing, as he told his students in recalling those days. He attracted the attention of his preceptor, however, and was made lecture assistant and quiz instructor in the college.

He soon revolted at the inefficient instruction and induced his father to send him to the College of Physicians and Surgeons of Columbia University. At the age of twenty-one he graduated and was supposed to be ready for the practice of medicine.

Once more he refused to be guided by the wishes of his father and, instead of entering a desirable partnership, which was offered him, with a well-known physician, he set out for Germany to study chemistry.

Liebig's name had attracted him to Munich and he had not learned that the great master had given up the direction of students some time before and had gone to the Bavarian University with the understanding that he could devote his time to his own studies and writing and that his duties should consist in giving a single course of lectures in inorganic chemistry. Remsen was forced to study with an able *Privatdocent*, Jacob Volhard. From him he received his first systematic laboratory instruction. Before that he had never performed the simplest analysis. Thorough training in analytical chemistry was, at that time, considered to be the only routine laboratory work necessary for the preparation of a chemist to begin research, and we may be sure that the fundamental basis for his career was well laid during this year of intimate association with Volhard.

During the summer of 1868, Wöhler made one of his friendly visits to Liebig and, through Volhard, Remsen was introduced to him and arranged to go to Göttingen in the fall. There he began research work under the direction of Fittig and two years later received his degree of Ph.D. at the age of twenty-four. When we remember that Remsen spent only one year in the systematic study of chemistry and two years in research in earning his degree, we are tempted to question whether the long years of routine instruction which are required of young chemists to-day do not tend to dim that eager enthusiasm and repress the initiative so invaluable for a successful career.

It does not follow, however, that because Remsen did not take the varied courses of routine lectures which we expect of students to-day he failed to become very thoroughly acquainted with the chemistry of his times. He once told me that during his stay in Germany he read the volumes of Liebig's *Annalen*—150 volumes had been published in 1870—until he was acquainted with all the important papers published in that journal.

The same year that Remsen received his doctor's degree, Fittig was called to the professorship at Tübingen and he asked Remsen to go with him as his lecture and laboratory assistant. He continued in this position for two years and in this way, for five years in all, he drank in the spirit of the German laboratories.

It was a fortunate time for the eager, enthusiastic young man. In 1858 Cannizzaro had shown the importance of Avogadro's principle and laid the foundation for a system of true atomic weights. The same year, Couper and Kekulé extended Frankland's doctrine of valence to explain the structure of carbon compounds, and hundreds of professors and students were working together, after the model of Liebig's laboratory, in the fascinating world of organic chemistry.

It was at Tübingen, too, that a young Scotchman rang at the door one day and asked, in broken German, for the "Vorlesungszimmer." Remsen answered, "Oh! I guess you want the lecture room." So there was begun the life-long friendship with Sir William Ramsay. Only a few months before his death, Sir William wrote to Remsen, "Well, I am tired and must stop. I look back to my long friendship with you as a very happy episode in a very happy life; for my life has been a very happy one." When Remsen helped with the plans of the Kent Chemical Laboratory of the University of Chicago, he provided few rooms for isolated students and he made the remark that students learn more from each other than from their teachers. When two such students as Ramsay and Remsen met, we can well believe that this was true.

Remsen returned to America in 1872 and, after some delay, was appointed professor of chemistry and physics at Williams College. When he assumed his duties he found no laboratory and scant encouragement to teach science other than as a small element of general "culture" in an old-fashioned classical college. After a year, he was furnished a laboratory for his own use and there he carried on researches on the action of ozone on carbon monoxide—a subject to which he returned some years later—and on *p*-sulphobenzoic acid. The latter led to an attempt to oxidise *o*-sulphobenzoic acid and its sulphamide and this, in turn, led to a long series of investigations carried out with students at the Johns Hopkins University. These studies finally established "Remsen's Law" that groups in the ortho-position interfere with the oxidation of alkyl groups of aromatic compounds by means of chromic or nitric acid.

As an illustration of the spirit of the New England colleges of that day, the following incident related by Professor J. M. Kingsley is illuminating :

"In the autumn of 1874, together with the rest of the junior class in Williams College, I began the study of chemistry under Professor Ira Remsen. After a few days I asked him for the privilege of carrying my studies farther in his private laboratory, as there was no laboratory work connected with the regular course. He replied to the effect that he would have to lay my request before the faculty, as there was no provision for such work in the curriculum. A few days later he asked me to stop after the class was dismissed, and then he informed me, in the most disgusted tones, that 'The Faculty, *in their wisdom*, have decided that you would break too much glassware and waste too many chemicals to allow you to work in my laboratory.'"

Kingsley became a zoologist of note instead of a chemist.

Shortly after his return to America, Remsen published a translation of Wöhler's "Organic Chemistry." He also published a beautifully written "Theoretical Chemistry." These books, and still more his persistence in research under discouraging conditions, attracted the attention of President Gilman, who was seeking men for his faculty at the Johns Hopkins University. He had already secured Gildersleeve for Greek, Rowland for physics and Sylvester for mathematics. Remsen was invited to Baltimore to meet the Board of Trustees and was entertained at a dinner at which he was seated beside one member of the board after another. In this way Professor Remsen became one of that galaxy who worked with President Gilman to organise the first genuine university in America, where more than half the students were graduates of other colleges and where the purpose was not so much to teach what is already known as to develop men into productive scholars and add to the world's knowledge. President Gilman had the somewhat rare quality of fully trusting the men he selected and allowing them to develop the work of their departments without interference. His injunction to Remsen was, "Do your best work in your own way."

Professor Remsen followed rather closely the models with which he had become so familiar in Germany. He gave lectures on inorganic chemistry during the first semester and on organic chemistry, the second. These were well illustrated with experiments and he had a crystal-clear, masterful method of presenting his subject. Once a week there was a meeting of graduate students for reports on current literature.

But the most important and vital part of his instruction was the daily visit to the desk of each research student. Often, at critical points, he would stop and work for minutes or for an hour or more with the student, and the product, in the end, was the joint work of professor and student, as it had been in Liebig's laboratory. Most of the topics studied grew, directly or indirectly, from his investigation of the oxidation of *p*- and *o*-sulphobenzoic acids and the law of the protection of ortho-alkyl groups from oxidation.

Quite early in the course of these studies, Fahlberg, working under his direction, discovered that the *o*-sulphamide of benzoic acid may be easily oxidised by potassium permanganate in a neutral or faintly alkaline solution. The product was called by Remsen benzoic-sulphinide. It is several hundred times as sweet as sugar and some years later Fahlberg developed the commercial production of the compound under the name of saccharin.

The discovery of benzoicsulphinide naturally led to the investigation of many other similar compounds. This also led, rather directly, to the discovery of the sulphonephthaleins and the study of the chlorides of sulphobenzoic acid. Professor Reid reports how he came to study the decomposition of diazonium compounds with alcohol. The laboratory book said "add alcohol and smell the aldehyde." A student came to him and said he did not smell aldehyde. Remsen took the tube and could not smell aldehyde either. He made this into a good story, telling how stubborn the student was who wouldn't smell aldehyde when told to do so.

The work of Professor Remsen and his students never degenerated into the mere preparation of new compounds. He always endeavoured to establish some general principle in relation to the substances prepared.

In 1883 Professor Remsen came back to the action of ozone on carbon monoxide and a very careful investigation demonstrated that the latter is not oxidised when the mixture with ozone is heated to 300° and the ozone is completely decomposed. He also, in an investigation which proved that phosphorus usually contains a little carbon, demonstrated that carbon monoxide is not oxidised when mixed with air and passed over moist phosphorus, although ozone is formed in quantities. A satisfactory theoretical explanation of these remarkable results is still to be found.

In 1889 Professor Remsen made an exhaustive study of the literature of the double halides and found that, with very few exceptions, the number of molecules of an alkali halide combined with one molecule of another halide is equal to or less than the number of atoms of chlorine in the other halide. A considerable number of experimental investigations were carried out with his students to test the validity of this generalisation. The conclusion that two chlorine atoms unite to form a bivalent group has not been generally accepted and does not agree well with the more recent electronic theories of chemical combination.

When Remsen went to Johns Hopkins University in 1876, there was no satisfactory medium in America for the publication of an account of his researches. A few of his articles were published in *The American Journal of Science,* but Professor Dana, the editor of that journal, soon decided that researches in organic chemistry did not furnish material of sufficient interest to his readers and advised publication abroad. Professor Remsen was not satisfied with this and, with the aid of other chemists, he established *The American Chemical Journal.* With far-sighted vision, he made this a medium of publication for American chemists and not an organ of the Johns Hopkins University. For thirty-five years this journal was a very important agency for the promotion of genuine chemical work. It was the first American journal in this field which secured wide-spread recognition abroad and it would be difficult to overestimate its value in stimulating chemical work and in placing Americans in their rightful place among the chemists of the world. At the close of the fiftieth volume President Remsen decided that publication in America would be better served by incorporation of *The American Chemical Journal* with *The Journal of the American Chemical Society.* This was done and the latter journal carries on its title page a record of the consolidation of the two journals.

Remsen's first book was a " Theoretical Chemistry," written while he was at Williams College. It passed through five editions and was translated into German and Russian. His " Organic Chemistry " was published in 1883 and has been the medium through which many chemists, physicians and others have been introduced to the subject. His text-books of " Inorganic Chemistry," both elementary and advanced, are characterised by a logical, lucid style which has made them very popular and widely used. The " Organic Chemistry " was translated into many foreign languages and several of the other books were also translated.

A long series of students, trained in intimate association with Professor Remsen, are now widely scattered and many of them hold important positions as teachers and in the industries. They look back to him as to a father, who always required high quality in their work, who was wise in his advice and helpful in their difficulties.

Professor E. E. Reid writes, " It is impossible to characterise or describe Remsen. He had a keen sense of humour and a ready wit, a personality in the fullest sense of that term. He drew people to him but always kept them in their place."

In 1881 Boston had trouble with her water supply and Professor Remsen was called upon for his advice. He was fortunate enough to discover the cause of the difficulty. On many other occasions he was called upon for public services to Baltimore, Maryland, and the United States. He was for some years a member of the Good Roads Commission of the state.

In 1901 Remsen succeeded D. C. Gilman as president of Johns Hopkins University. The resources of the university had been depleted by the depreciation of some of its securities and the period of his administration was a difficult one. In spite of this, the university continued its steady and satisfactory development. The school of engineering was founded and the cramped quarters in the heart of the city were exchanged for the magnificent campus which the university now occupies in the outskirts of Baltimore.

President Remsen retired in 1913. After that he spent his time in travel, in revising his books, in work for the Government as chairman of the Referee Board organised during Roosevelt's administration to consider questions pertaining to the law for the control of food products and their adulteration, and in consulting work for one of our largest industrial corporations. He died at Carmel, California, in 1927, at the age of eighty-one.

He was the recipient of many honours. The degree of LL.D. was conferred by Columbia, Princeton, Yale, Toronto, Harvard and Pennsylvania. He was a foreign fellow of the London Chemical Society and foreign member of the French Chemical Society. In 1902 he was president of the American Chemical Society; in 1903, of the American Association for the Advancement of Science. During 1907—13 he was president of the National Academy of Sciences. In 1908 he was awarded the gold medal of the Society for Chemical Industry and in 1910 was president of that society. In 1914 he received the Willard Gibbs medal of the Chicago Section of the American Chemical Society.

In his boyhood Remsen was reared in a very strict, religious atmosphere and he retained a simple religious faith throughout his life. In his address " On the Life History of a Doctrine," delivered as president of the American Chemical Society, after pointing out that " faith is called for at every turn in scientific matters as well as spiritual," he said, " It would be as illogical to give them (atoms) up as it is, in my opinion, to deny the existence of a power in the universe infinitely greater than any of the manifestations familiar to us; infinitely greater than man; a power that 'passeth all understanding.' "

WILLIAM A. NOYES.

EDWARD HENRY RENNIE.

BORN 1853; DIED JANUARY, 1927.

THE intellectual life of Australia suffered a heavy loss early last January, when Dr. Edward H. Rennie, Angus Professor of Chemistry in the University of Adelaide since 1885, died suddenly from heart failure at the age of seventy-four. Though he had long earned retirement, he remained in active work to the last, devoted, as always, to the promotion of education and of science in Australia.

His affection for that sunny land was native—not acquired, as it has been by so many of those engaged in University work there; for he was born and educated in Sydney, where his father, E. A. Rennie, was Auditor-General of New South Wales. His urge towards an academic life is, no doubt, to be traced back to his grandfather, James Rennie, who was Professor of Zoology at King's College, London, nearly a century ago. After graduating in Arts at the University of Sydney, he spent a few years as a school teacher there and in Brisbane; but in 1877 he went to London, bent on pursuing the study of chemistry. Before returning to Australia in 1882, he had obtained the London D.Sc. and had published a number of papers in the *Journal* of the Chemical Society. Some of these were on work done conjointly with Alder Wright, whose assistant he was for a time at St. Mary's Hospital Medical School. He came also under the influence of Professor H. E. Armstrong (the stimulating effect of which so many young chemists then and later could testify to), and the friendship thus formed lasted through his life, maintained by correspondence and revivified in 1914, when the British Association visited Australia.

Apart from certain investigations with Alder Wright in chemical dynamics (a subject then in a somewhat embryonic state), Rennie's researches at this time were organic and for the most part dealt with the chemistry of various Australian plants. His special interest in this field was to remain with him always. During the first ten years of his tenure of the Adelaide chair he contributed to the Society's *Transactions* seven papers on various Australian plant products; but thereafter he had but little leisure from teaching and administrative duties, and some of it was given to inorganic and physical work. More recently, however, he took up the investigation of the resins of *Xanthorrhœa*, a peculiar and characteristic Australian plant.

As a teacher, Rennie was exceptionally conscientious and thorough. He had but little assistance, for it is only of late that the Australian Universities have been able to indulge in elaboration of staff (still very incomplete), and he found it necessary personally to teach chemistry in all its branches, organic, inorganic, physical, and analytical. The writer, who saw as much of him as was compatible with residence five hundred miles apart, can testify to his zeal in keeping abreast of modern advances, even in fields that did not specially appeal to him.

As a member of his faculty and of the governing council, frequently as acting Vice-Chancellor, and as chairman of the affiliated School of Mines, he did invaluable work for his University. In wider fields too his wise judgment, experience, and authority were of service to the country. He was the chairman of the South Australian branch of the Commonwealth Council of Science and Industry. In the last year of his life—perhaps the busiest—he was President of the Australian Chemical Institute and also President of the Australasian Association for the Advancement of Science; and his address at the Perth meeting of the Association included a valuable survey of Australian plant chemistry, past, present, and future.

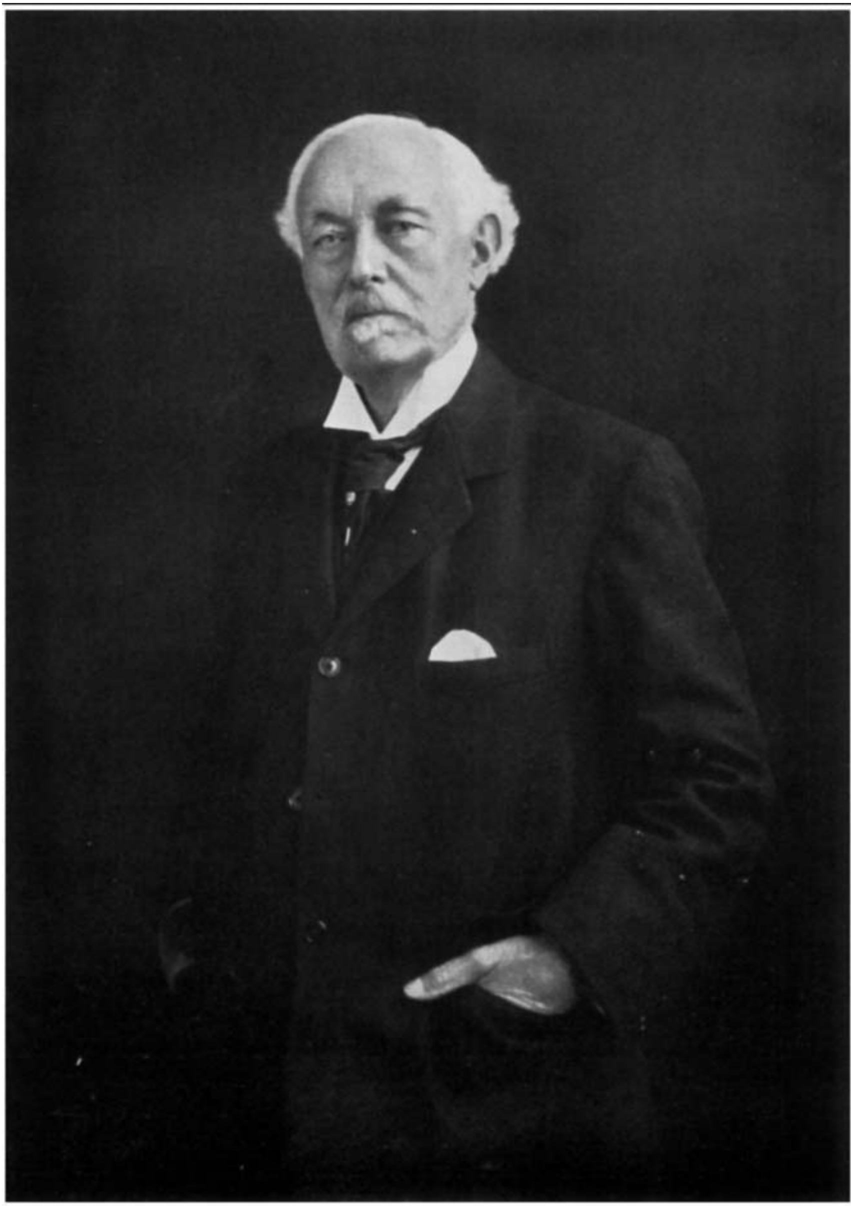
As a man, Rennie was of simple tastes and rather austere habit of life, and there was an orthodox side to him best known to his fellow elders of the Chalmers Church in Adelaide. But his warmth of heart and human sympathy endeared him also to others. And the writer is among these; for Rennie, then a stranger, was the first to welcome him on Australian soil in 1886, and forty years of friendship followed.

D. O. M.

SIR WILLIAM AUGUSTUS TILDEN.

BORN AUGUST 15TH, 1842: DIED DECEMBER 11TH, 1926.

HASTED'S History of Kent states that John Tilden purchased Ifield Court, Northfleet, in 1766; the grandson of John Tilden was Augustus and had two sons, the elder being William Augustus, born in the parish of St. Pancras on August 15th, 1842. The brothers were unfortunate in their schooling. In 1845 their father had exchanged a clerkship in the Bank of England for the managership of the Kidderminster bank, but retiring from this post in 1852 he remained without business occupation until his death at Bedford



SIR WILLIAM AUGUSTUS TILDEN.

[*To face p.* 3190.]

in 1879; it thus happened that the boys were never kept for long at any one school. Their mother, however, was a woman of strong character and marked ability, devoting herself unreservedly to the care and instruction of her children during their early home-life; this benefit was uniformly recognised with affection by her sons, and having passed her concluding ten years in the household of William Augustus, she died in 1900 at the age of 94.

When eight years old the boy was placed as a boarder with Rev. Edward Brine, second master at Kidderminster Grammar School, remaining only two years because the family moved to Bedford. Here he was entered at the Commercial School, now called the Modern School, but after three years was transferred for one year to the charge of Mr. George Vasey, who limited his pupils to five, imposed upon them a vegetarian diet, and taught them the rudiments of anatomy, physiology, botany, zoology, mechanics and optics illustrated by diagrams which the lads were required to copy. Another break occurred in April, 1856. The boys' maternal grandfather, Mr. Henry Balls of Cambridge, had now undertaken responsibility for their education and he sent them to East Dereham, where Rev. Joseph Thompson kept a school of about 70; here William Augustus received his first contact with chemistry, and the demonstrations of a visiting master from Norwich inspired him with a desire to experiment on his own account.

Animated by the vague ambition to become a chemist, young Tilden was almost inevitably projected into pharmacy. His friends of that period would naturally reach a conclusion which remains, even after seventy years, a widespread popular superstition; and although the College of Chemistry was already operative under the direction of Hofmann, they cannot be blamed for what would then appear to be the normal procedure. So, in August, 1857, the lad was apprenticed for five years to a pharmacist of Barnsbury, Mr. Alfred Allchin.

This association was propitious, for Mr. Allchin took a liberal view of the relation between master and apprentice. He had been laboratory assistant at the Pharmaceutical Society, had worked for a short period in Paris with Pelouze and had joined the Chemical Society. Appreciating these advantages, he encouraged young Tilden to attend the Pharmaceutical Society's lectures on chemistry, pharmacy, botany and materia medica, permitting him to spend the whole of his fifth year in the laboratory of the School. Allchin's generosity was not limited to these benefits. He entered his apprentice for Hofmann's course of lectures at the Royal College of Chemistry, and this period was a critical one in the history of chemistry; for students were perplexed by the novel notation and modified atomic weights introduced by Gerhardt and Cannizzaro. Hofmann's lectures were Tilden's compass, and in October, 1861, the young pharmacist gained the first Bell scholarship.

Another favourable influence on young Tilden was the friendship of Dr. John Stenhouse. Ill-health had led Stenhouse to relinquish his lecturership at St. Bartholomew's Hospital and equip a laboratory in Rodney Street, Pentonville, whence issued the series of investigations into natural products distinguishing the joint authorship of Stenhouse and Groves. Stenhouse frequently visited Allchin's pharmacy, greatly to the encouragement of young Tilden, whose preparative work he often commended, and whom he subsequently admitted to his laboratory as a junior assistant on sixty pounds a year. In 1863 Tilden became demonstrator at the Pharmaceutical Society under Attfield, who was then professor of practical chemistry while Redwood continued to give the lectures; and here he remained until 1872.

These nine laborious years encircled the transformation of a pharmacist into the chemist. In this development the London University system of graduation played an important part. Although no "cobbler from Cornwall," Tilden was one of an abundant upward-struggling community to whom the prospect of a definite academic hall-mark offers an elevating incentive to self-improvement. He toiled at French, German, Greek and Latin for matriculation, and in 1868 graduated B.Sc. with honours at an age which disqualified him from gaining the university scholarship. This was followed in 1871 by the D.Sc., in those days attainable by examination only; Tilden's examiners were Debus and Odling. Meanwhile, in the scanty leisure snatched from these pressing demands, he began publishing papers in the Journal of the Chemical Society, his first contribution (1865) dealing with periodides of organic bases.

A new chapter opened in 1872, when Tilden was appointed senior science-master at Clifton College, under the headship of Dr. John Percival, afterwards Bishop of Hereford. At that date the school was ten years old, and was directed by a remarkable man. Percival had proceeded from Rugby to Oxford (1854—58) and there took firsts in classics, mathematics, and physics; he aimed at moulding Clifton as an all-round school, a breakaway from the purely classical tradition, and his first group of assistants included A. Leipner, afterwards professor of botany at University College, Bristol. Later teachers of chemistry and physics were A. W. Reinold, John Perry, Tilden, and Shenstone, the first laboratories being opened in 1866 and followed by those for biology and zoology in 1869. The standard of effort appears to have been high. Laboratory classes, lecture courses and private coaching could not have left much time for his own experiments, but somehow Tilden found it, and found also a valuable collaborator in W. A. Shenstone. The partnership was happy for both. Tilden had married before leaving London, and Shenstone was one of the household during the two years preceding his transference to Taunton in 1875. A joint paper on aqua regia and the nitrosyl chlorides appeared in that year, and work there described was the progenitor of pinene nitrosochloride. With exacting enthusiasm, for he was not physically strong, Shenstone went over to Clifton for the long vacation following his transfer, and the friends occupied their holiday in rectifying such essential oils as were then available, separating the terpenoid components and converting these into nitrosochlorides by the new agency. The results were published in 1877, and came to be recognised as a turning-point in the path of terpene chemists, leading to a fresh view of the hydrocarbons themselves and providing a trustworthy means of identification.

Meanwhile, an important municipal development had proceeded in Birmingham. Sir Josiah Mason (1795—1881), having amassed a fortune from humble beginnings, had the noble ambition to provide for others the educational opportunities denied to himself, and allocated £180,000 to the foundation of Mason College. The new institution was opened in 1880 and Tilden was appointed the first professor of chemistry in association with J. H. Poynting (physics), M. J. M. Hill (mathematics), and T. W. Bridge (biology). It may be readily imagined that the task of building up the organisation and tradition of Mason College would evoke physical and mental resources of a high order, and the success with which this early work was accomplished is reflected in the great midland university at Edgbaston representing the modern response of Birmingham to its largely augmented educational demands. The part which Tilden played in this constructive labour merits the fullest possible recognition. In addition to high professional competence early marked by election to the Royal Society (1880), he was endowed with a social quality which is unhappily rare. It has been said that the really well bred man is he who can enter —and leave—any mixed company of people to whom he is unknown without necessarily revealing his occupation in life. The searching requirements of such a specification were engagingly met by Tilden, whose conversation and appearance would have puzzled a casual acquaintance to decide whether he was an army officer, Indian civil servant, artist, metropolitan magistrate, man of leisure, or even an ambassador.

Adaptability so wide and graceful was particularly valuable in a society of the complexity comprised in Birmingham of the eighties. To harmonise aspirations of prosperous young amateurs with more serious ambitions of the needier students; simultaneously to convince the Birmingham citizens that a man of science is not necessarily an eccentric anchorite, but that in belonging to their own world he might add to its attractions; withal to develop an ever-widening grasp of a rapidly growing science, were tasks which few chemists of his generation could have accomplished so successfully. At the beginning of his tenure, moreover, Tilden found that provision for instruction in metallurgy had not been made, and being without practical knowledge of the blast-furnace and steel manufacture, he became indebted to several of the large ironmasters, including Mr. Robert Heath, then M.P. for North Staffordshire, and Sir Isaac Lowthian Bell for the privilege of admission to their works. Soon afterwards, however, this branch of the curriculum was entrusted to Mr. Thomas Turner, who subsequently became the professor of metallurgy. In spite of these demands, Tilden continued the research on terpenes which had begun so auspiciously at Clifton. The first completed work dealt with decomposition of the hydrocarbon vapours by heat, and it was during a study of isoprene produced in this manner that its transformation into caoutchouc was discovered. Thus, both scientifically and socially, Tilden's life in Birmingham was a full and active one. He occupied a pleasant house in Harborne Road, took interest in his garden and continued to enjoy lawn-tennis until well past his fiftieth year. This may not appear unusual to a generation witnessing that indefinite extension of youthful activities engendered by golf, automobiles and jazz-discords; but post-war youth, rivalled in its thirst for amusement by a crowd of age-defying seniors, cannot be expected to realise that in those days men were "too old at forty," while coeval women wore caps.

Tilden's life was now widening its boundaries, for his reassociation with London grew considerably during the last few years of his Birmingham connection. He had executed several examinerships, including that in chemistry for the Science and Art Department; he sat in the council of the Royal Society (1892—4), and a continuous adherence to the Institute of Chemistry had culminated in his election to the presidency (1891—4). This office in particular made heavy calls on Tilden's time and attention, for the period was a critical one in the history of the Institute. Much controversy centred in the question of admission and the type of training which might most appropriately lead thereto. Several conferences took place; regulations were finally accepted in October, 1893, and remained the basis of those controlling admission during the twenty years following. The two main requirements were (1) three years of systematic training in chemistry, physics, elementary mathematics and an optional other branch of science, associated with (2) three examinations, preliminary, intermediate (in general theoretical and practical inorganic and organic chemistry), leading to the final, in a branch of chemistry elected by the candidate from a prescribed list. Concurrently with this consolidation, an important geographical change occurred. Since 1884, the Institute had been a tenant of the Royal Statistical Society at 9, Adelphi Terrace, depending on the hospitality of the various London laboratories for examination facilities. At the beginning of 1893, however, the Institute moved to 30, Bloomsbury Square, thus for the first time enjoying dignified and ample premises of its own. Having acquired the remaining twenty-two years of lease, it seemed justifiable to build and equip the laboratories necessary for conducting practical examinations, and they were formally opened by the president on December 8th, 1893. In the same year the bye-laws were revised, and authority was given to an important definition by the censors concerning professional conduct; a seal was designed, incorporating the figure of Priestley as represented in Williamson's statue viewed from the old Mason College windows.

In the autumn of 1894, Tilden succeeded T. E. Thorpe as professor of chemistry in the Royal College of Science, London, and was destined to remain at South Kensington until 1909, when Sir Edward Thorpe returned for three years on retirement from the Government Laboratory. The period of Tilden's occupancy was important in the college history, covering the transference of the chemistry department from the conspicuous red building on the eastern side of Exhibition Road to its present domicile. Moreover, the change was concurrent with a modification in status effected by incorporating the Royal College of Science and the Royal School of Mines with the Central Technical College of the City and Guilds of London Institute: this occurred in 1907, when the two royal colleges were detached from the Education Department and united with the Guilds' Engineering College to form the Imperial College of Science and Technology. In prospect and achievement this transformation threw much extra work on Tilden and his physics colleague, A. W. Rücker, the consequent interruption to their systematic duties beginning about 1899, when Sir Aston Webb was commissioned to prepare the plans.

These last fifteen years of Tilden's professorial career were crowded ones. Interwoven with his college duties were the periodical demands of the Board of Education examinations and the continuous attention he gave to the Chemical Society. The Royal Society, which he served as a Vice-President during 1904—6 was another time-absorbing interest, and for a brief term he joined the Senate of

London University, having been elected a Fellow in 1899. Although these various legitimate distractions inevitably diminished the time given to research, he nevertheless maintained an interest in the field which had brought him fame, and broke new ground by a systematic study of specific heat; this work was continued for several years, and the earlier results were assembled in the Bakerian Lecture to the Royal Society for 1900. It was not surprising that about the time he was due by age to retire, Tilden incurred a slight breakdown in health; his friends had sometimes wondered at the unfailing regularity with which he had fulfilled his duties, because he did not give an impression of robust physical condition at any period of his later life. In view of the difficulty found in replacing him, however, Tilden was persuaded to remain until a suitable successor (Sir Edward Thorpe) could be found, and this arrangement was facilitated by delegating the lectures to his trusted colleague, Dr. G. T. Morgan.

Liberation from official duties in 1909 was accompanied by the distinction of knighthood and the title of Emeritus Professor, but only changed the form of Tilden's mental activity. He had intended to continue the experimental work which had been so much interrupted in later years, and for this purpose retained the use of a laboratory at the Imperial College; but his physical condition precluded sustained bench-work, and the project was necessarily abandoned. His retirement to the home he had already made at Northwood was therefore devoted to literary pursuits which took shape in four books, " The Elements " (1910), " Chemical Discovery and Invention in the Twentieth Century " (1917), " Life of Sir William Ramsay " (1918), and " Famous Chemists " (1921).

These volumes represent a substantial achievement indeed for the eighth decade of any man's life, and bear testimony to the unabated ardour with which he assembled and imparted knowledge. They involved frequent and sustained consultations in the Burlington House libraries, and scarcely diminished the regularity of his attendance at scientific meetings. In fact, it may be stated here that among the many claims of Sir William Tilden's life to the respect and admiration of younger chemists was the devotion he showed to the Chemical Society by his constant attendance at its meetings. He became a Fellow on June 1st, 1865, joining the Council as an ordinary member thirteen years later. Thereafter, in one capacity or another, he served as councillor thirty-seven years, comprising twenty-eight as Vice-President and four as Treasurer (1899—1903), occupying the presidential chair in the period 1903—5; his last appearance in Burlington House—and he seemed to know it would be the last—was on March 27th, 1924, when he spoke to a resolution at the annual general meeting. Thus, in various ways and always disinterestedly, he well and truly served the body which assembled most intimately his professional friends and their joint scientific interests. The Annual Reports on the Progress of Chemistry, inaugurated in 1905, will remain a lasting memorial to this loyal devotion, being the concrete feature of his presidency.

Before the foundation of the Imperial College, Tilden was appointed Dean of the Royal College of Science and the Royal School of Mines. He was awarded the Davy Medal (1908), received honorary degrees from the Victoria University, from Dublin and from Birmingham, and was elected a member of the Athenæum under Rule II (1907). In 1869 he married Miss Charlotte Pither Bush of St. Heliers, Jersey, who died in 1905 leaving one son, Mr. Philip Armstrong Tilden, the architect. His second marriage took place in 1907, Lady Tilden having been Miss Julia Mary Ramié, also of St. Heliers, and in the knowledge that his twilight years were happy, peaceful and well-ordered his friends too have been happy. His death occurred on December 11th, 1926.

Tilden's active participation in chemical research continued throughout a period of more than forty years, during the earlier part of which, as might have been expected from the contemporary chemical atmosphere and his association with pharmacy, his experiments dealt with natural products. Thus his first paper (1865) described periodides of caffeine, strychnine and brucine, and his next inquiry (1872) related to the crystalline substances obtainable from aloes, to which he returned several times (1875 and 1877); comparison was made between Barbadoes, Natal, Socotrine, and Zanzibar aloes, from which a derivative of methylanthracene, oxygenated to the composition $C_{15}H_{10}O_6$, was obtained with chromic acid. An early paper displaying keen chemical insight and skilful technique was that on aqua regia and nitrosyl chloride (1874), showing how the latter substance may be obtained as an individual and proving the composition of its molecule to be NOCl; at the same time, it was established that the supposed nitrosyl dichloride and dinitrosyl sulphate of Gay-Lussac were actually fortuitous mixtures.

It was a natural consequence that the new agent should be applied to organic substances, and a beginning was made with phenol (1874) which gave chloranil, followed by turpentine (1875) giving the subsequently famous nitrosochloride of pinene, from which "nitrosoterpene" was prepared by the action of alcoholic sodium hydroxide. It was at this period that Shenstone had joined Tilden, and the two young men were quick in recognising that the confusion prevailing in essential oil chemistry might be dispersed by the new weapon;

but it is evident from the title of their paper, "Isomeric Nitroso-terpenes" (1877) and the procedure therein described, that at this stage of the inquiry they expected the nitrosochlorides to be less important means of identification than the nitroso-derivatives obtainable from them by removing the elements of hydrogen chloride. Thus the nitroso-derivative made from turpentine (American and French), oil of sage and oil of juniper was found to be identical in each case, and was distinct from that formed when the nitroso-chloride of hesperidine, caraway, and bergamot oils is heated. The authors, however, already believed that "the result of the further application of this method will be to show that a great many of the natural terpenes are merely physical isomerides not differing from one another in chemical constitution."

During the two following years (1878—9) the terpene-alcohol terpineol was characterised. Earlier workers (Wiggers, List, and Oppenheim) had found that dilute acids convert the crystalline terpene hydrate into an oil which they called terpinol and believed to have the composition $C_{20}H_{34}O$. Tilden's investigation showed the oily product to consist principally of terpineol, $C_{10}H_{17}{\cdot}OH$, associated with a hydrocarbon, $C_{10}H_{16}$, afterwards identified with dipentene. At the same period he studied the hydrocarbons of Russian turpentine oil, and published the views he had been led to form regarding the constitution of camphor and the terpenes.

After an interval of about five years there appeared his well-known paper "On the Decomposition of Terpenes by Heat" (1884). The process therein described is a fore-runner of the modern operation of "cracking" petroleum, and allowing for difference in the starting-materials, the products of the two changes correspond. It was found that when the vapour of turpentine oil is passed through a heated iron tube on which redness is just visible in darkness, gaseous and condensable hydrocarbons are produced in great variety. Dipentene, *p*-cymene and colophene, with smaller proportions of benzene, toluene and *m*-xylene were isolated, but the most important and interesting product was the volatile hydrocarbon, isoprene, C_5H_8, obtainable also by the dry distillation of caoutchouc. In this connexion it may be claimed that the earliest production of synthetic rubber was in the hands of Tilden (1892), because a few years after the foregoing investigation he noticed that in a closely sealed bottle containing a specimen of purified isoprene there had appeared a sticky product which, when withdrawn and manipulated, showed those properties of rubber subsequently associated with sodium-polymerised isoprene. Although aware of what had occurred, and displaying this rubber as an object of interest to his friends, Tilden did not standardise the conditions of transformation, and it is not difficult to reconstruct his probable attitude of mind by remembering that automobiles were not even threatening to arrive, and that the " synthesis " was virtually a passage from one tree-juice to another by de-polymerisation *cum* re-polymerisation. Moreover, in spite of all the attention directed to this matter in the pregnant thirty-five years intervening, the exact conditions of transformation remain obscure.

Tilden reviewed at some length the confused ideas then (1888) current on the constitution of terpenes and later (1893) showed that dipentene does not give toluic acid on oxidation; he proved that the hydrocarbon recovered from dipentene dihydrochloride must be a mixture, because it yields over 27 per cent. of toluic acid. In the next few years (1893—1895) he resumed attention to nitrosyl chloride, preparing phenylazoimide by its action on phenylhydrazine in acetic acid and incidentally discovering an alternative method of preparing hydrazoic acid by hydrolysing *p*-nitrophenylazoimide. These experiments embraced a very wide range of typical unsaturated compounds in a study of nitrosyl chloride with reference to its additive capacity. Its action on amides was then surveyed, and while oxamide, oxanilide, succinimide, and phthalimide were indifferent, other amides were found to undergo loss of nitrogen and, in the case of asparagine and aspartic acid, chlorination; lævo-rotatory asparagine gave lævo-rotatory chlorosuccinic accompanied by fumaric acid.

About 1890, Tilden had received from the West Indies a butterlike solid occurring as a by-product in the manufacture of Montserrat lime-juice. Isolation and characterisation of limettin, so named from *Citrus limetta*, gave much trouble, and the investigation remained unfinished in Birmingham; but later (1902) he was able to show that limettin is 4 : 6-dimethoxycoumarin, $C_{11}H_{10}O_4$, giving phloroglucinol with concentrated potash, and undergoing chlorination, bromination, and nitration.

The concluding papers dealt with carbon compounds all related to the nitrosochlorides of pinene and limonene, thus providing a seemly epitaph to Tilden's early chemical interest. By the simple device of using an inactive mixture of American and French turpentine in place of an optical individual, the yield of nitrosochloride was greatly improved (1904), and was brought to the 55 per cent. obtainable from the inactive pinene produced when methylaniline or dimethylaniline acts on the nitrosochloride. This, and the two nitrosochlorides of limonene, were then found to exchange their chlorine atom for the cyano-group when heated with alcoholic potassium cyanide (1904—5), the products being unimolecular: the compound thus obtainable from limonene β-nitrosochloride was identified with cyanodihydrocarvoxime. The corresponding pinene derivative is also a cyano-oxime, and undergoes hydrolysis in successive stages to an aminodicarboxylic acid which remained (1906) unidentified. A curious difference between pinene and limonene nitrosochlorides in action with magnesium methyl iodide revealed itself (1905—6), for while the bimolecular pinene nitrosochloride yields two unimolecular compounds (1905), in one of which the chlorine atom survives, the two products from limonene nitrosochlorides (1906) are still bimolecular and isomeric, having lost one atomic proportion of oxygen. At the same time it was found that the process of reducing nitrosopinene to pinylamine may be carried to the further stage of dihydropinylamine, identical with the base arising from the oxime of pinocamphone on reduction (1906).

The second main division of Tilden's researches has been summarised in contributions to the Philosophical Transactions of the Royal Society, and arose from the conflict of opinion regarding the atomic weights of nickel and cobalt; it deals with the specific heat of metals, and the relation of specific heat to atomic weight. Tilden's original purpose, conceived about 1895, developed into the wider field of testing further the law of Dulong and Petit, and the opening experiments on cobalt and nickel were subsequently extended to gold, platinum, copper, iron, silver and aluminium. Great care was exercised in purifying the metals initially used, and a long series of experiments with them was made in the Joly differential steam-calorimeter. As the inquiry widened, however, the range of temperature was extended through that of solid carbon dioxide to the boiling point of oxygen, and the research owed much to the patient and assiduous co-operation of Mr. Sidney Young. It was found that the influence of temperature effects great alterations in the specific heat of different metals, and the assumption of a constant atomic heat at the absolute zero had to be abandoned. The concluding section of this inquiry, published in 1904, was directed to testing the validity of Neumann's law which assumes that when an atom undergoes chemical combination it retains that capacity for heat which is displayed in the elemental state, and for this purpose the tellurides of nickel, tin and silver were examined, along with silver–aluminium alloy. The results were interpreted as indicating that Neumann's law may be regarded as approximately valid for specific heats at all temperatures, and that specific heat is not a measure of work done in separating the molecules of a substance, but is determined almost entirely by the nature of the atoms composing the physical molecules. A final summary of contemporary knowledge relating to this field was made the subject of Tilden's second presidential address to the Chemical Society (1905).

In this division also must be grouped the paper on "Molecular Weight and Formula of Phosphoric Anhydride and of Metaphosphoric Acid" (1896), in which it was shown that these familiar derivatives of phosphorus are P_4O_{10} and $H_2P_2O_6$. Thus it will be recognised that the scope of his research was wide and that, in common with those of other active workers at a time when boundaries between the organic and inorganic branches were less rigid, and when physical chemistry was unknown, his interests embraced a variety of topics. This was reflected in the freedom he ungrudgingly gave to his staff and students in choosing their own subjects for research, leading to a great diversity in production from the department under his control. Until a late period of his life he remained unreconciled to such divisions of classification and technique as had then inevitably asserted themselves, and he continued to be a true chemical philosopher to the end. His earlier books, "Introduction to Chemical Philosophy" (1876), "A Manual of Chemistry" (1896), and "A Short History of the Progress of Scientific Chemistry" (1899), were characteristic of this attitude, which appeared also in the Cannizzaro Memorial Lecture delivered on June 26th, 1912, and the first presidential address of March, 1904, when he reviewed the state of knowledge and theory during the early years of the Chemical Society. A chemist with these tastes, present at scientific meetings with regularity since his first attendence in 1862, and recalling a lecture by Berthelot on "Synthetic Methods in Organic Chemistry" (June 4th, 1863), had indeed a mine of material upon which to draw.

A dispassionate survey of Sir William Tilden's life leads easily to the conclusion that he was a self-made man in the finest interpretation of the title: and the product was fine. Hampered by early disadvantages, he overcame them by determination and industry. Without useful friends in early life, he made them; and made them by those qualities of character that make the best. Threatened by submergence in a humdrum occupation, he looked below the surface of his materials and found that which enabled him to rise high above their surface, and to vivify the materials themselves. Becoming a teacher through the chance by which science-teaching is almost the only shelter for the potential investigator, he remained faithful to the calling which gave him that shelter, continuing as an active and conscientious teacher during forty-six years. Imbued with a profound interest in all aspects of chemistry, historical, human, and philosophical, but free from ostentation or flamboyance, his teaching prospered more by graceful and accurate presentation than by personal magnetism. Drift of circumstances involved him in two pioneer movements, the foundation of a modern side to a great public school, and the construction of a science-school which became a great university: both movements were substantially furthered by his personality and persistence. These qualities he devoted also to the service of chemistry as a profession, in a degree which few chemists have attained, his association with the Chemical Society and the Institute of Chemistry bearing witness to this loyalty. Throughout a laborious career, oppressed by early difficulties and clouded at times by domestic affliction, he cherished a fine appreciation of the graces which life offers, and enjoyed their consolations with evident gratitude. Into the common dealings of every day there was woven that shade of dignity which has now become old-fashioned, but remains precious; it was entirely unaffected, and untouched by vanity or coldness; because, underlying it, as his intimates were well aware, ran a strong current of generosity and affection.

M. O. F.

WILLIAM CARLETON WILLIAMS.

BORN AUGUST 17TH, 1850; DIED MAY 25TH, 1927.

TWENTY-THREE years ago W. Carleton Williams retired from the Professorship of Chemistry in the University College, Sheffield, a position to which he was appointed in 1883, in succession to Carnelley, the first Professor of Chemistry in the Firth College, which subsequently became the University College, Sheffield.

Firth College was founded by the munificence of Mark Firth, and was opened by Prince Leopold in 1879. Its history, like that of other similar institutions of that period, was, during the first decade of its existence, an unbroken struggle against financial difficulties and restricted conditions. The Technical Education Act of 1889, and the beginning of the Government grants to University Colleges to enable them to develop also on the side of the humanities and pure science, combined to mitigate the severity of the struggle. The next decade witnessed the development of a movement for co-operation between Firth College, the Medical School, which was founded in 1828, and the Technical School, a rate-supported institution. The incorporation of these three bodies, and the raising of an endowment fund, as a memorial of the visit of Queen Victoria to Sheffield, in the year of the Diamond Jubilee, resulted in the grant of a Charter to the new University College in May 1897. The breaking up of the Victoria University, with the immediate result of the creation of the Universities of Liverpool and of Manchester, and later that of Leeds, resulted, naturally, in the desire for a similar recognition and status on behalf of the University College in Sheffield.

W Carleton Williams

[*To face p.* 3202.]

In addition to the funds already subscribed for buildings, a call was made for an endowment fund of £100,000 to secure the desired recognition. The successful issue of this effort was the grant, in May 1904, of a University Charter.

Carleton Williams' twenty-one years' tenure of the Firth Chair of Chemistry were momentous years in the development of the College; he not only shared to the full in the anxieties and activities of that period, but contributed generously to the funds raised from time to time, and to the University Endowment Fund he subscribed a year's salary.

The advancement of the College to University status and the approaching completion of the Chemical Laboratory in the new buildings, with the design and arrangement of which he had busied himself, appeared to Williams a suitable opportunity to put into effect his contemplated resignation, thus giving his successor a perfectly free hand. The College Council on receiving his resignation passed the following resolution: "That in accepting with great regret the resignation of Professor W. Carleton Williams of the Firth Chair of Chemistry, the Council desires to place on record its appreciation of the valuable services which he has rendered to the College during his 21 years' connection with the College."

Carleton Williams received his chemical training at the Owens College, Manchester, under Dr. Roscoe (later Sir Henry), entering the College in 1866, in his seventeenth year. His course of study was crowned by the award, in 1871, of the Dalton Chemical Scholarship, for which he presented an account of the results of an investigation on the oxychlorides of antimony (*Mem. Manchester Phil. Soc.*, 1872, 3; 1876, 61). In the same year he was elected an Associate of Owens College. As Dalton Scholar, in accordance with the tradition of those days, Williams went to Germany, where he continued his studies, working first in Bunsen's laboratory at the University of Heidelberg and then, in the second year, at the University of Bonn, where Kekulé directed the Chemical Department. In Bonn he devoted himself to extending his knowledge of organic chemistry, and an outcome of this period was the publication in the *Berichte*, "Ueber Terebinsäure und Pyroterebinsäure" (1873, **6**, 1094). Amongst his fellow students at Bonn were van 't Hoff, Claisen, Königs, Bernthsen, and Wallach, who became *Privat-docent*, then Extra-ordinary Professor, and later Professor of Chemistry in the University of Göttingen.

Returning to Manchester in 1873, Williams was appointed Demonstrator in Chemistry, thus commencing his teaching career in the first session in the new buildings, to which the Owens College had been transferred from the original quarters in Quay Street.

At this time the staff of the Chemical Department consisted, in addition to Professor Roscoe, of C. Schorlemmer, as Lecturer in Organic Chemistry, W. Dittmar as Lecturer in Chemistry, and W. Carleton Williams and H. Grimshaw, Demonstrators. The ten years spent at Owens College were years in which, with laboratory teaching, day and evening classes, and tutorial classes, "full-time" was literally interpreted, and time for research was only to be secured in snatches and by dedicating portions of the vacation to such work.

During this period Williams published the following papers: The Derivatives of Di*iso*butyl (J., 1877, **31**, 541; 1879, **35**, 541); Stannic Arsenate (*Mem. Manchester Phil. Soc.*, 1876, 67); On some Compounds of Antimony Pentachloride with Ethyl Alcohol and with Ether (J., 1876, **29**, 463). With Carnelley he conducted an investigation, the results of which were communicated to this Society, *viz.*: On the Determination of High Boiling Points (J., 1878, **33**, 281); On the Boiling Points of Certain Metals and Metallic Salts (J., 1879, **35**, 563); The Melting and Boiling Points of Certain Inorganic Substances (J., 1880, **37**, 125); and in conjunction with the writer a paper "*Ueber die Bestimmung des specifischen Brechungs-Vermögens festen Körper in ihren Lösungen*" (*Ber.*, 1881, **14**, 2549), which formed part of the report of the British Association Committee on Refraction of Solids: Determining Specific Refractions of Solids from their Solutions.

In the course of an investigation on the sulphides of phosphorus Williams met with a serious accident due to an explosion, in which he was badly burnt on the face, head and hands; fortunately the eyes were not permanently affected.

After the granting of the Charter creating the Victoria University, Williams was made a Lecturer in Chemistry in the University, and in recognition of his standing as an Associate of Owens College, was admitted to the degree of B.Sc. at the first graduation ceremony of the University in 1882.

The translation of Lothar Meyer's "*Die Modernen Theorien der Chemie*," undertaken by Williams in association with the writer, was published in 1888, and was followed in 1892 by the translation of Lothar Meyer's "*Grundzüge der theoretischen Chemie*."

At Sheffield, Williams devoted himself to teaching and the development of his department. An epidemic of lead poisoning in Sheffield led to an investigation of the action of water on lead, and to the volume published to commemorate the incorporation of the University College at Sheffield he contributed an account of his extensive examination of the distribution of carbonic acid in the air.

Further, the results of his examination of methods for the determination of zinc formed part of the Report of the British Association Committee on Electrolytic Methods of Quantitative Analysis, published in 1898.

On leaving Sheffield Williams moved to the south and settled at Goring-on-Thames, where Mrs. Williams and he found congenial occupation in tending and developing their garden. Archæology claimed his interest, and he became a member of the British Archæological Association and of the Berkshire Archæological Society, the meetings of which and the Summer Congress he attended regularly. In fact a fortnight before his death he took part in an excursion of the Association to Dunstable. He served for some years on the Council of the British Archæological Association.

In his earlier days Williams found considerable pleasure and recreation in tramping, and thus acquired an intimate knowledge of the Lake District, North Wales and other parts of the country, and in like manner gained an acquaintance with the Rhineland, Switzerland, the Bavarian Alps, the Dolomites and other districts in Europe. The writer retains pleasant recollections of many such tramps, made in his company. Travel always appealed to Williams and he had visited most of the capital towns of Europe, and also Canada and the United States of America. From early manhood he was liable to attacks of gout and it was during one of these attacks that he passed away on May 25th of this year.

William Carleton Williams was born at Salford on August 17th, 1850; in 1883 he married Miss S. E. Andrews, who with their daughter, Ethel Carleton, survives him. Miss Carleton Williams graduated in the History Schools at Oxford and is the authoress of several clever and interesting books dealing with her experiences and travels.

The Jubilee of Williams's Fellowship of the Chemical Society occurred three years ago, for he was elected in 1874; he served for many years on the staff of Abstractors for the Journal; in 1894 he was elected a Fellow of the Institute of Chemistry, and since 1877 was a Member of the British Association. Under his will the Chemical Society is a beneficiary, as are also the Faculty of Science of the University of Sheffield, the Chemical Department of the University of Manchester, and the Benevolent Fund of the Institute of Chemistry.

P. PHILLIPS BEDSON.
