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OF

FRANK AUSTIN GOOCH

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BY

RALPH G. VAN NAME

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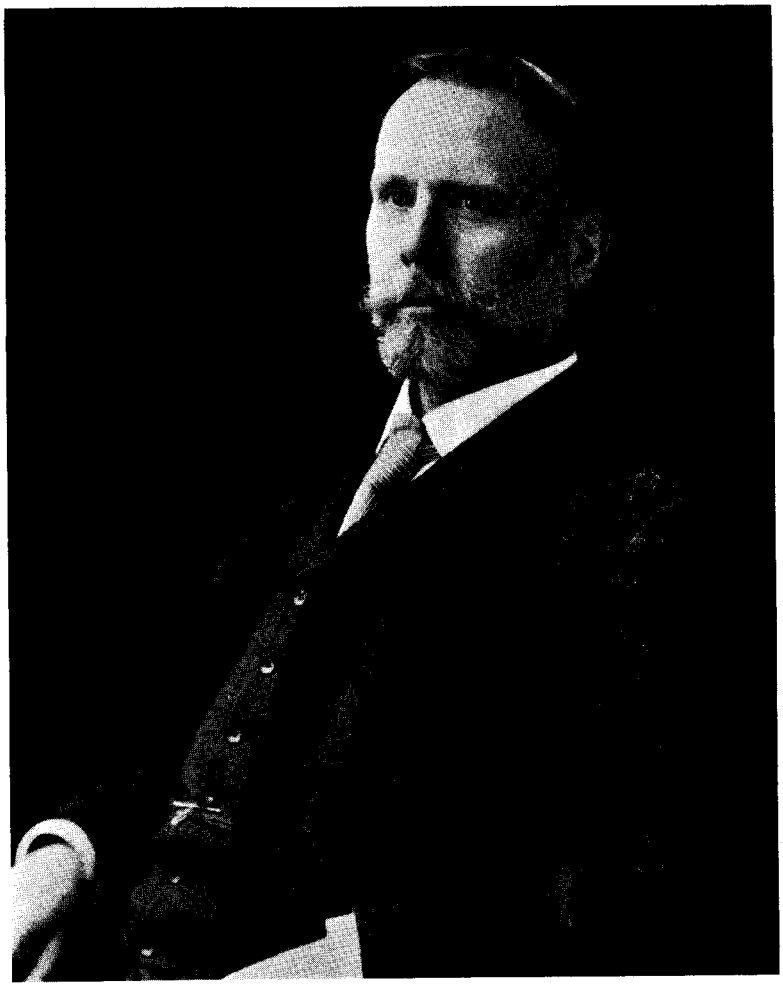


F. A. Gooch

FRANK AUSTIN GOOCH

BY RALPH G. VAN NAME

Frank Austin Gooch was born in Watertown, Massachusetts, a suburb of Boston, on May 2, 1852. He died on August 12, 1929, in New Haven, Connecticut, the city in which he had made his home for forty-three years following a call to Yale as Professor of Chemistry in 1886.

Concerning his ancestry full information is available, largely from his own pen, since he was greatly interested in genealogy, and during the later years of his life compiled and printed an extended work on the Gooch family.[1] He was the elder child and only son of Joshua Goodale Gooch and Sarah Gates (Coolidge) Gooch. The father was a lumber merchant and holder of various town offices, and later, for twenty years, chief assessor of Cambridge, Mass. Both parents came of sturdy New England stock established in this country in the early days of the colonies, his father's line going back through John Gooch, born in England about 1600, who settled in Maine about 1640, and his mother's line through John Coolidge who came from England to Watertown before 1636. The lines of his father's mother (Goodale) and his mother's mother (Hastings) were of similar nature and origin, both established in Massachusetts by 1637. More will be said on a later page concerning the genealogical volume above mentioned, and the light which it throws on the more remote ancestry of the subject of this memoir. So far as his ancestry in New England is concerned, it is sufficient to say that it seems to have included a large proportion of men and women of more than average energy, integrity, and importance in the affairs of their respective communities. From such stock Frank Austin Gooch inherited a keen and active mind, a sound body, and the ideals of service which are reflected so clearly in his own life.

The story of his life, especially the earlier half, has been told by himself in an informal autobiography entitled "Trivial Reminiscences." This was written some five or six years before his

[1] "The History of a Surname, with some account of the Line of John Gooch in New England."

death, not for publication but, according to his own statement, chiefly for the edification of his two granddaughters, both of whom were at that time under fifteen years of age. It dwells chiefly on his boyhood, education, and travels, up to about 1884, while the portion dealing with his subsequent life, including his long and distinguished service as professor in Yale University, is disappointingly brief. The original typewritten copy was very kindly loaned to the writer by Dr. Gooch's daughter, Mrs. John D. Whiting, and has been the main source of information about his earlier life. A carbon copy, differing only in that it lacked the numerous photographs and pictures of persons and places which were bound with the original, was sent by Dr. Gooch, with other material, to the National Academy in 1926, in response to a request for biographical data. Charmingly written, this genial autobiography reflects clearly the kindly nature, modesty, and keen sense of humor of its author. Many passages from it will be quoted in the following pages, and where no source is mentioned, the use of quotation marks alone may be understood to indicate that the passage in question is taken from the Reminiscences.

The first fourteen years of his life were spent, except for summer outings at the seaside, in Watertown, then a suburb in the true sense, with all the attractions of woods, ponds, and open country near at hand, to arouse and foster an innate love of nature and of outdoor life. His formal schooling, begun in Watertown, was transferred when he was twelve years old to Mr. Atkinson's school in Cambridge, later known as the Kendall School, where he completed his preparation for college. Two years later his family moved to Cambridge "for easier accessibility to school, college, church, and the various social affiliations."

At the Atkinson school the curriculum included, in addition to the usual classics, history, and mathematics, a course in natural science illustrated by collections of stuffed birds and mounted insects, and by simple physical and chemical experiments. He writes in the Reminiscences:

"The experiments seen at school were of course incentives to imitation. My father indulged me in the possession of a few

chemicals and some simple apparatus. He personally helped me to make an electrical machine, using a large glass bottle for the revolving cylinder, and from a wide-mouthed preserve jar we made a Leyden jar. My earliest preparation of chlorine gas was made in the laundry, and there I was first 'gassed'—the precursor of many similar experiences.

"That this discursive curriculum was a good thing in my case and probably a determining factor in the subsequent choice of a career, I have no doubt; but I am sure that it interfered somewhat with the concentrated grind which sent boys from the Boston Latin School or from the Phillips Academy at Exeter with a better grammatical outfit for later work in the classical languages."

That his actual experiments in chemistry began some years before the preparation of chlorine above referred to, we learn from an earlier page of the Reminiscences.

"My uncle had dabbled a little in chemistry, as in most matters of intellectual interest, and had a small collection of simple apparatus and chemicals. From that stock my cousin Arthur and I got materials for the first chemical experiment in which I ever knowingly had a part. The day was dull and rainy and we decided that we might brighten things up a bit by making some gunpowder and starting a pyrotechnic display. The mixture of niter, sulphur, and charcoal was accomplished without accident and put in some sort of container inside a house built of billets of wood upon the kitchen floor. A train of powder was laid and touched off with a match while we retired to a distant corner to await the effects, which were perfectly satisfactory. My Aunt Lucy's arrival upon the scene of devastation and incipient conflagration prevented the repetition of my first chemical experimentation—more successful so far as the anticipated results were concerned than many since made—but candor compels the admission that Aunt Lucy's arrival was timely. When I was offered the opportunity some twenty years later to take charge of the manufacture of nitroglycerine at the Torpedo Station of the United States Navy, at Newport, the fondness for pyrotechnics had run its course in my case."

In 1868, at the age of sixteen, he entered Harvard College, and for the first two years followed, in accordance with the requirements, a course of study which consisted largely of the humanities. During junior and senior years, however, he took advantage of the greater freedom of choice permitted, to devote his time almost wholly to science, especially physics and chemistry, with the result that in 1872 he graduated with the degree of A. B. *cum laude,* and with *"summos in Physicis et Chemia honores."*

In the autumn of the same year, he began graduate studies at Harvard, principally in the fields of chemistry, physics and mineralogy. During the first year he served as a special instructor of a class in Chemical Philosophy, and in the next year he became an assistant to Professor Josiah Cooke, a position "which involved aiding in the preparation of Professor Cooke's brilliant and spectacular experimental Freshman lectures upon elementary chemistry and the holding of class-room recitations upon the subject matter of 'The New Chemistry'." In 1874-5 he served as assistant in the laboratory of quantitative analysis, and worked with Professor Cooke in his investigation of the atomic weight of antimony. This year also marked the beginning of his scientific publication, in the form of a paper entitled "On Two New Varieties of Vermiculites," on which his name appears with that of Professor Cooke as a joint author.

That the training which Gooch received from the association with Professor Cooke was of great value to him is certain. It also stimulated still further his interest in chemistry, and was undoubtedly an important factor in his subsequent choice of that science as the field for his life work.

He was also, however, greatly interested in the physics of crystals, and decided to spend the following year abroad in the study of this subject, either with Rosenbusch in Strassburg or with Tschermak and Schrauf in Vienna. In the summer of 1875, in the company of a classmate, Field, he sailed for Europe. The following is quoted, with some omissions, from the Reminiscences:

". . . We landed at Hamburg, . . . passed on to Berlin, where I met Jackson[2] (then an assistant professor at

[2] Loring W. Jackson.

Harvard on leave of absence) and made the acquaintance of Michael,[3] both of them studying with Hofmann, one of whose lectures I had the good fortune to hear. We three are now fellow members of the National Academy of Sciences. There also, I met under somewhat puzzling circumstances Herr Major Gerhardt (a brother of Mrs. Hagen, our neighbor in Cambridge), who held some sort of high position in the War Department. Mrs. Hagen had consigned to me for delivery to her brother a peculiar type of water-faucet in which she thought he would be interested, and she was to write to him of my coming to Berlin. By dint of persuasion I got a somewhat reluctant guard to take my card to the Herr Major and was admitted to his sanctum. The visit seemed to take him by surprise, although he was courteous; and our disadvantage was mutual in that he did not speak English and my knowledge of German was at least as deficient as was his of English. French did not help me much. His surprise seemed to deepen when I took leave of him without taking the device with me, and left no permanent address. Later, the matter was cleared up by a letter from Mrs. Hagen telling me that the arrival of her letter to her brother had been delayed until after my visit to him, and that while he knew I was an acquaintance of hers, he had been laboring under the impression that I was interested in the commercial introduction of a special device into Germany. However, I got away without being arrested as a spy upon the war department; and he got the faucet, which was after all the main object of my call.

* * * * *

"After a month in Dresden for practice in spoken German and another month of walking, mountain climbing and delightful travels in Switzerland, . . . Field and I parted at Strassburg. He went to Berlin, and I, after looking over the situation at Strassburg, decided to take up my work in Vienna."

His life in Vienna is described quite fully in the Reminiscences, for his stay there was made extremely interesting and pleasant by a friendship with Dr. Franz Steindachner, then a director of the Imperial Zoological Museum. Steindachner had

[3] Arthur Michael.

spent several years in Cambridge with Agassiz and having learned in advance, through a letter from a friend in that city, that Gooch was coming to Vienna, received him with the greatest cordiality. It was Steindachner who helped him to find comfortable lodgings, who accompanied him when he presented his letters of introduction to Tschermak and Schrauf, and secured for him the privilege of working on the collections in the Imperial Mineralogical Museum usually accorded only to workers of considerably greater experience, and in many other ways gave him most valuable assistance.

This was the beginning not only of a warm personal friendship with Steindachner, but also "of a long series of hospitable attentions from the entire Steindachner connection," which left Gooch in after years with the pleasantest possible memories of his stay in Vienna.

His work at the University of Vienna included, at first, attendance on the lectures of Tschermak and Schrauf, but as these lectures proved rather elementary after the training in mineralogy which he had had with Professor Cooke, they were soon dropped and the time devoted to laboratory work and research. At the beginning of the second semester he was planning to attend a more advanced course of lectures to be given by Tschermak, but was discouraged by that gentleman himself. At a loss to know the reason, Gooch finally learned from the assistant at the laboratory that the substance of this second course was Dana's System of Mineralogy, upon which he had been "brought up" at Harvard. His time was accordingly spent in studies upon the material at the petrographical institute, or at the museum, where a suitable microscope and a fine collection of rock sections were available, but except for occasional conferences with Tschermak he was left for the most part to books and his own initiative in prosecuting these studies. That his progress was rapid is shown by the fact that Tschermak intrusted him with the investigation of a set of sections of rock specimens from the Galapagos Islands, the results of which were published under Gooch's name in "Mineralogische Mittheilungen." This, and another brief paper in the same journal, his second and third scientific publications, both appeared in 1876. Outside of working hours much of his time

was spent in the congenial company of Steindachner. They were both fond of music and the theater, and frequently went together to concerts, operas, or plays, or visited the art galleries, or museums. Later, with the coming of spring, they made excursions to points of interest in the surrounding country, and once, even went as far as Budapest. Through Steindachner, Gooch was often invited to social gatherings of his relatives or friends, and through him again, had the opportunity to see certain ceremonies to which Steindachner's connection with the Imperial service opened the way. One of these was the formal court ceremonial, the "Fusswaschung," symbolic of humility, which is very graphically described in the Reminiscences.

In June, 1876, Gooch parted with regret from his warm friends in Vienna, and after short stops in Salzburg, Munich, and Paris, and a week in London, sailed for home.

Concerning the subsequent advantage to him of the studies pursued in Vienna, he writes as follows:

"That the work in petrography and upon the physics of crystals proved afterwards to have been but an interesting side issue, and of only occasional use, was determined by the trend of subsequent events. I have never regretted the time thus spent, and the opportunity to make the acquaintance of a charming coterie of associates at the museum—Tschermak, Brezina, von Reyer, Neminar—has left me many pleasant memories."

On resuming his graduate work at Harvard in the autumn, he devoted his time to a study of the action of zirconium tetrachloride upon sodium ethylate, and to work on the preparation of his thesis for the doctorate, which as presented later bore the title "A Treatise on Crystallography on the basis of Miller's System. With other papers." The "other papers" were his first three publications already mentioned, and a progress report on the zirconium work.

Meanwhile, he had been considering the plan of undertaking work in the field of thermochemistry with Julius Thomsen in Copenhagen, and early in June, 1877, having completed his work for the degrees of A. M. and Ph. D. (which at that time were coupled) and obtained permission to receive the two degrees *in*

absentia, he sailed again for Europe. Landing at London with time at his disposal, he took advantage of the opportunity for a three weeks' trip through Ireland, Wales, and England, in the pleasant company of Mr. Grundmann, Director of the Boston Art Museum, who had been a fellow passenger on the steamer. Their itinerary included, among many points of interest, visits to Manchester (Owens College), Oxford, and Cambridge. Concerning his visit to the last place, Gooch writes:

"At Cambridge, I sought out the residence of Professor Miller to whom Professor Cooke had given me a letter, but finding on inquiry at the door that he was ill and saw no visitors I left the letter and my card (without address) as a matter of courtesy. It was a complete surprise when an hour or so later a waiter at the hotel told me that a lady was waiting to see me and I found Mrs. Miller with an invitation to dine and the conditional promise that if it proved to be advisable I might have a few minutes' interview with her husband. So I dined with Mrs. Miller and her two charming daughters, and did get an unsatisfactory glimpse of an elderly, weak, and scholarly gentleman whose brief and concise 'Treatise' and 'Tract' upon Crystallography I had tried to simplify, as well as to extend, in my doctoral thesis. I am glad that I saw him, tho I doubt whether he really understood much more of me and my interest in him than that here was a stranger who desired to pay his respects to him. The kind and under the circumstances really unnecessary courtesy left me with a vivid appreciation of English hospitality."

After a few days in London, Gooch proceeded to Copenhagen. Here he was cordially received by Julius Thomsen, who showed him his apparatus, and some details of its manipulation, but explained that the apparatus was his own property (not that of the University), and that it would be necessary for Gooch to provide apparatus for his own use.

"He added, with a smile, that given the apparatus, he did not see why the work might not be done as well in Cambridge as in Copenhagen, and I was inclined to believe that he was at least half-right. With apparatus and the published papers at hand of Thomsen of Copenhagen and Berthelot of Paris there could

hardly be more difficulty in digging out a mastery of what had been done in their line than in acquiring facility in microscopic petrography with the aid of literature, a microscope, and a collection of Dünnschliffe, as I had had to do at Vienna. Moreover, as to further applications to chemical theory and really worth-while research along the lines opened up by Thomsen and Berthelot I felt skeptical. It looked to me as if the cream had been pretty effectually skimmed from the milk, and I think that the subsequent history of Thermochemistry has substantiated that view. At any rate, I made up my mind that the thing for me to do was to take advantage of the accessibility of the great laboratories, make notes upon the fittings, meet workers, and then get back to the work which I had left unfinished at Harvard. . . . So, the European venture resolved itself into a series of laboratory inspections which proved to have been of great advantage when I came later to make the fundamental plans of the Kent Chemical Laboratory of Yale College."

In accordance with this decision he planned the remainder of his travels in Europe to include stops at the seats of some ten or more universities, and in most cases, perhaps in all, paid visits to their laboratories. Among these were Upsala (Cleve's laboratory), Stockholm, Christiania, Bonn, Heidelberg (Bunsen's laboratory), Amsterdam, Antwerp, Edinburgh, and Glasgow, where he visited both the university and the important Tennant's Alkali Works. A few days also were spent in London, where Gooch had the great pleasure of meeting again (and for the last time) his good friend Steindachner of Vienna, and of visiting a number of points of interest in his company.

Gooch's return to Harvard was timely, for it resulted in his being offered, and accepting, an opportunity to work with Professor Wolcott Gibbs in his investigations of the Complex Inorganic Acids, taking his courses and doing the work of a private assistant. With the approval of the university authorities he also continued to hold during this year the Parker Fellowship to which he had been appointed early in 1876.

There can be no doubt that this association with Dr. Gibbs had the deciding influence in shaping Gooch's future career. He

seems up to this time to have had some leaning toward organic chemistry, but the training which he received under Dr. Gibbs developed in him a great interest in the problems of analytical chemistry, and remarkable ingenuity in devising apparatus and methods of value in analytical work. Here too, he must have acquired much of that skill and deftness in manipulation which enabled him to carry out difficult analyses with a certainty and accuracy which not many have equalled. From this time on, he turned definitely toward analytical chemistry as his chief field of work and of research.

The association with Dr. Gibbs lasted for two years, during the second of which he was "in fact as well as in function" Dr. Gibbs' private assistant. It was during this period that he published an extended paper "On the Estimation of Phosphoric Acid as Magnesic Pyrophosphate," which included a special study of the application of the method to the analysis of phosphotungstates and phosphomolybdates. Another and very important paper was one in which he described a new type of filtering crucible, now well-known under the name of "Gooch Crucible." The great value of this device lay in the fact that the filtering medium was a mat of asbestos fiber, introduced in suspension in water and compacted by suction. Not only does this supply an efficient filtering surface unattacked by most acids and readily adaptable to the needs of precipitates of different degrees of fineness, but precipitates which could not be heated in contact with paper fiber without undergoing decomposition could be collected, ignited, and weighed, in the filtering crucible itself, thus greatly simplifying the procedure. Criticised at first by some who attempted to use it with asbestos of inferior quality, but vindicated by the overwhelming testimony of others, this device soon became, and still is, one of the indispensable tools of the analytical chemist. The only reference in the Reminiscences to this important and useful invention reads as follows:

"It was during this period that I described in a paper 'On a new method for the separation and subsequent treatment of precipitates in chemical analysis,' a device which has proved to be of such general utility in analysis that, dubbed by the craft

with my surname (occasionally reduced to the level of a common noun), it has found its way into the 'Standard Dictionary' (of the English language), dragging me along with it."

His next position took him to Newport, Rhode Island. The nature of this work, and the circumstances under which he undertook it, are best given in his own words.

"In the autumn of 1879, at the invitation of Professor Raphael Pumpelly, who was then organizing a division for the census work, under the U. S. Geological Survey, with headquarters at Newport, R. I., I accepted an appointment as Expert Special Agent of the U. S. 10th Census, to undertake the microscopic examination of representative iron ores. The slicing and grinding apparatus was put in operation and the sections were made by an expert, but the opportunity never came to me to examine them in more than a cursory way (I believe that they are now in the National Museum at Washington). My activities were diverted to assist Blair[4] in making the chemical analyses which ultimately engaged the service of half-a-dozen experts simultaneously, and finally, when he resigned, the charge of that work (recorded in Vol. XV, (Pumpelly) U. S. Tenth Census) devolved upon me.

"In October, 1881, came the appointment as chief chemist of the Northern Transcontinental Survey which Mr. Pumpelly was organizing at the request of Mr. Villard to deal broadly with questions affecting the utilization and development of the natural resources of the region tributary to the Northern Pacific Railway System. This splendidly organized survey, which included in its personnel half-a-dozen men whom the National Academy of Sciences has honored with membership, came to an end in 1884 when the system was beset with financial difficulties and Mr. Villard's retirement brought about a change of policy. Contributions to Pumpelly's volume of the Census reports, one giving analyses of the lignities of the Northwest and another relating to the conversion of lignites into fuel of high heating power, the records of analyses of iron ores (twenty-one complete and one hundred-and-forty 'partial'), a little paper describing

[4] Andrew A. Blair.

the device of a tubulated crucible useful in determining volatile products of ignition, constitute the records published in my own name in connection with the activities of this survey."

In August, 1880, Gooch married Sarah Elizabeth Wyman, daughter of John Palmer Wyman, of West Cambridge, Mass., and for the next four years the young couple made their home in Newport, in pleasant surroundings and with a very congenial circle of friends.

During the winter of 1883, Gooch accompanied Pumpelly on a trip to Mexico. Mr. Pumpelly had been engaged by the owners of a mine, of which great things had been expected and on which a very large sum had been spent without much result, to inspect the property and to make a report. Gooch was taken along "to act as assistant in seeing that there should be no 'salting' of samples and to make such assays as might be necessary on the spot." Since the mine was situated in a very thinly settled part of Mexico, many miles from a railroad, the trip carried with it possibilities of adventure. On the railroad journey across Southern Arizona they passed near a region where Mr. Pumpelly twenty-two years before had spent eight months full of dangers and excitement in a stronghold of hostile Apaches, as manager of the "Santa Rita" mine. From Gooch's account of the trip we quote the following incident, which took place at this point:

"We were making the run from Benson to Nogales on the Mexican border when Mr. Pumpelly turned to speak and I leaned forward over the back of his seat to catch the remark. 'This is my old stamping ground. I never expected to get out of it alive.'—referring to his hectic experience of nearly a quarter-century before.[5] Then came a smash of glass, a whirr past my head, a sprinkling of powdered glass in the face—all marking the flight of a rifle-bullet through a window on the opposite side of the car across the car and out at the window just behind us on our side of the car. It was the shot of some drunken

[5] Described in Raphael Pumpelly's "Reminiscences," Vol. I, pp. 194-224.

cowboy or other irresponsible individual from out of the darkness at our isolated figures in the bright light of the car.

" 'That,' said Mr. Pumpelly, 'is the first call.' "

Leaving the railroad at Magdalena, they proceeded on horseback, with a guide, over more than a hundred miles of trails through rough country. At points of danger a sharp watch was kept for Apaches but none was seen,—"nor did we see any while we were in Mexico; although the Apaches did raid and killed men within nine miles of us at the mines, and arms were issued to the miners, and a watch set." That the situation was perhaps worse than is here implied, we gather from Mr. Pumpelly's account,[6] which states that the entire force of whites at the mines, some fifteen in number, was under arms for two weeks while the surrounding country was being raided.

The mine was duly inspected and the assays made. Rich ore was present but only in small quantities—nothing to justify the enormous sum which had been spent for machinery for a stamp mill many times larger than was needed,—and on the strength of Mr. Pumpelly's subsequent report the mine was closed.

Leaving Newport in the spring of 1884, Gooch went to Washington as chemist on the U. S. Geological Survey in charge of the chemical work of Yellowstone Park Division, which at that time consisted chiefly in analyses of the waters of the Park. This position he held for two years, spending the first field season in the Park and the remainder of the time in Washington, where the analyses were carried out. The results of numerous analyses of the Park waters, and the description of special methods used in making them, have been published, under the joint authorship of F. A. Gooch and J. E. Whitfield, in Bulletin 47, of the Geological Survey.

In 1886, an appointment to be Professor of Chemistry in Yale College, received the year before, became effective, and Gooch removed to New Haven to take up what proved to be his chief and permanent life work.

The first and principal task before Professor Gooch in taking up this position was to establish, for the benefit of candidates

[6] Raphael Pumpelly's "Reminiscences," Vol. II, pp. 653-4.

for the B. A. degree, a suitable group of elective courses in the fundamental branches of chemistry, inorganic, organic, and analytical. At the start all of the classroom teaching was done by himself, but other instructors were soon added, as the work grew.

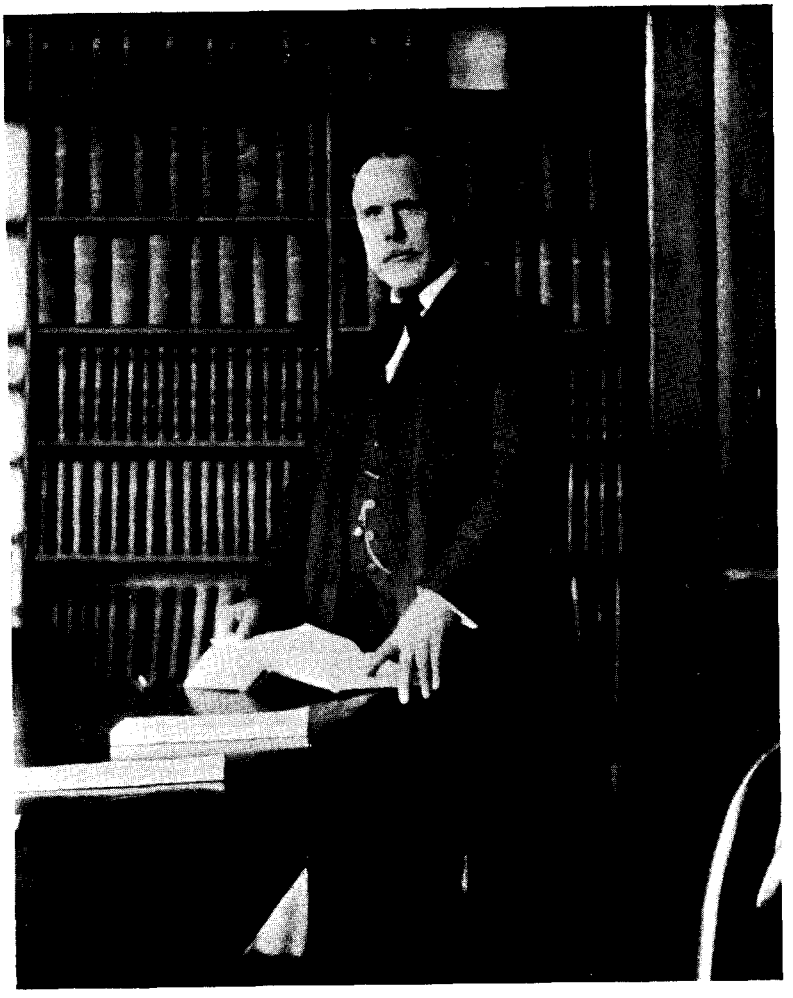
Since his appointment included service in the Yale Graduate School, a second task, following naturally upon the first, was to provide courses and opportunities for research for the students who, attracted by his unusual qualities as a teacher and investigator, soon began to come to him for postgraduate studies leading to the higher degrees.

The first year was taken up with the planning and supervision of the building of the Kent Chemical Laboratory. His first class at Yale began work in the autumn of 1887, although the laboratory was not completed and ready for occupancy until the following spring.

Under Professor Gooch's wise and able direction, and furthered by the trend toward the study of chemistry on the part of students not definitely committed to a scientific career, the work of the laboratory grew steadily, and to such an extent that two additions to the building were made (in 1902 and 1906, respectively), which together more than doubled its capacity. By 1915 the number of students under instruction in the laboratory was well over four hundred.

It was the good fortune of the writer of these pages to begin the study of chemistry in Professor Gooch's undergraduate courses, to carry out his postgraduate research under his direction, and to return, two years later, for fourteen years of service (1904-1918) as a member of the teaching staff headed by him.

As a teacher of undergraduate students Gooch aimed always to lay a secure foundation for further study of chemistry. His lectures covered a great deal of ground, too much perhaps for the average student, but they were followed with great interest and profit by the better ones. In later years his lectures on inorganic chemistry had to be given twice to accommodate the large classes. Always clear and well prepared, they included a large number of lecture table experiments, set up in advance with scrupulous care, and thanks to his skill in manipulation these



experiments seldom failed to give a clean-cut and satisfactory result.

It was, however, in the more advanced work, and particularly in research, that he was most conspicuously successful in arousing in his students a love of the science and a real enthusiasm to contribute to its advancement. To research students needing his help he gave freely and abundantly of his time, spending many hours with each student, observing the experiments and often participating in their execution. His keenness in observation, and quick intuition in finding the cause of unexpected and puzzling results, were truly remarkable. He read extensively, and aided by an excellent memory had an extremely broad and comprehensive knowledge of chemical facts, theories, and procedure.

The field which interested him most, and in which the greater part of his research was done, was that of analytical chemistry, but he was far from desiring this field to be unduly emphasized in the work of the laboratory as a whole. On the contrary, he gave all possible encouragement and support to those students and members of his staff who were carrying on investigations in other fields, and he took the greatest satisfaction in the results which they achieved.

Throughout his period of service at Yale he was active in conducting research. At the time of his retirement, in 1918, more than three hundred research papers from the Kent Laboratory had been published, of which over eighty bore his name either as sole or as joint author. His actual contribution to the total was in reality much greater, for he often, actuated by generous motives, declined to have his name appear on papers the successful outcome of which had been largely due to his ideas and supervision of the work.

Professor Gooch's published work, though chiefly in the field of analytical chemistry, covered a wide range. He devised or perfected a large number of analytical processes and methods, some of which are now recognized as the standard ones and so described in current books of reference; others are less well known but have their utility in special cases.

His most important contributions dating from the period before his coming to Yale, are probably the Gooch filtering crucible, the quantitative separation of lithium from the other alkali metals by the action of amyl alcohol on the chlorides, and the estimation of boric acid by distillation with methyl alcohol and fixation by calcium oxide.

Among his later researches, carried out with various collaborators and published in the Kent Laboratory series, the following deserve special mention: Useful methods for estimating the elements molybdenum, vanadium, selenium and tellurium; two novel applications of sodium paratungstate in analysis,[7] which take advantage of the fact that it is non-hygroscopic and can be fused without change in weight; important studies of the conditions necessary for precipitating phosphates of the composition required for weighing as magnesium or manganese pyrophosphate; and, finally, a long series of methods for estimating various elements and radicals, based on the volumetric determination of iodine, a reaction which he favored and put to many uses on account of its exceptional advantages from the standpoint of convenience and accuracy. Indeed, so far as is known to the present writer, his contributions in the field of iodometric methods are unequalled in number and value by those of any other investigator.

Another important contribution was a method for the rapid electrolytic estimation of metals, using very vigorous stirring, a principle which effects an enormous saving of time, and is now in common use. Although the question of priority in this idea is somewhat involved, Gooch seems to have been the first to publish it (with H. C. Medway in April, 1903), and it is certain that he conceived it in complete ignorance of the contemporary work of others. The apparatus used by Gooch and Medway in this work is also noteworthy in that it dispenses entirely with platinum dishes and electrodes of special types, the metal being deposited on the exterior surface of an ordinary small platinum crucible, mounted by a rubber stopper on a vertical axle rotated

[7] As a better substitute for calcium oxide in the method of the estimation of boric acid, just mentioned; and in determining certain volatile acidic oxides by loss in weight on ignition.

by a small motor at a speed of six hundred revolutions per minute, or above. Since no large or specially shaped platinum parts are needed, the method is within the reach of even a very modestly equipped laboratory. Later, impelled by the growing scarcity of platinum, he devised a process for the rapid electrolytic estimation of metals, which employed electrodes of such small size that the total weight of platinum required for both anode and cathode was not over one gram.

The analytical methods devised by Gooch reflect as a rule his own practical turn of mind. As seen in the work on electroanalysis just described, he sought whenever possible to avoid elaborate or costly apparatus and time-consuming procedure, and often obtained the desired results by devices of exceptional simplicity. He was a firm believer in the need for more intensive and intelligent study of the problems of analytical chemistry as an essential factor in the progress of chemical science. He scouted the idea expressed by certain distinguished critics that analytical chemistry was a nearly exhausted field, and held that advances of immense practical value were both possible and certain, a view which the notable development of analytical chemistry during the last twenty years, especially through the application of physical methods, has already done much to justify.

Professor Gooch was the author, or joint author, of a number of books and pamphlets (listed in the bibliography at the close of this article), including a text on Inorganic Chemistry (1905), one on Qualitative Analysis (1906), and one on Quantitative Analysis (1916). Of these the "Outlines of Qualitative Analysis," in which his colleague, Philip E. Browning, was associated with him as joint author, is probably the best known. It was widely used, and five revised editions were subsequently printed, the last in 1928. In addition to the text on quantitative analysis mentioned above, he compiled in 1912 a book entitled "Methods in Quantitative Analysis originated or developed in the Kent Chemical Laboratory," and in 1901 he edited for the Yale Bicentennial Series a reprint in two volumes of the Kent Laboratory Research Papers, one hundred and eight in number, which had appeared up to that time. His book on genealogy,

referred to on an earlier page, was not formally published, but was printed for the author in 1926.

From the outset Professor Gooch had been in fact the director of the Kent Laboratory, although the actual title was not added until 1905, and the necessary administrative duties made constantly increasing demands upon his time and energy as the work of the laboratory expanded. Yet his great industry and systematic habits of work enabled him, with little or no assistance, to discharge the manifold duties of this position, and at the same time to give most conscientious attention to his teaching and his research.

As an administrator he was keen, far-sighted, and efficient. All routine matters were given careful thought and conscientiously attended to, and when a written report was called for, it was always ready on time. He would never allow unfinished work to accumulate, but when the demands upon his time were especially heavy, kept his desk clear by long hours of night work. As a consequence, he seemed always able to devote as much time as needful to his research students, and was never too busy to give a cordial welcome to those who wished to consult him.

His relations with his staff and more advanced students were most informal and friendly, and his wise counsel in many difficulties, both scientific and personal, was freely sought and generously given. Tolerant to a fault, he saw the good qualities in everyone, and when he erred, it was on the side of leniency in his judgments. His interest in those closely associated with him was sincere, and the respect and affection for himself which he inspired in his research students and the members of his staff, from professor to janitor, were truly remarkable.

Dr. Gooch was a rather tall man, erect and well built, a dignified and distinguished figure. He possessed a rare charm of manner, and his unusual courtesy and consideration for others were as sincere as they were unfailing. A man of real culture, with broad interests and a keen appreciation of the finer things of life, he was ready and interesting in conversation, and a most delightful companion. He was gifted with an exceptionally keen sense of humor, loved to hear a good story or to tell one, and his fund of entertaining anecdotes was well-nigh inexhaustible.

That such unusual social gifts should have been combined with a rather retiring disposition and a comparative indifference toward social activities seems strange, but the fact remains that he was not often seen at the gatherings of the various scientific societies of which he was a member, nor indeed at any gatherings except those connected with his college duties, or within the circle of his intimate friends.

He was to an unusual degree a lover of home, and of family life, and generally preferred to spend his leisure hours in the company of his wife and his daughter, their only child. It is noteworthy that in spite of the heavy burden of college duties he devoted a large amount of time to the education of his daughter in her earlier years, and took the greatest pleasure in doing so. He was fond of chess, and of music, of which he enjoyed a great deal at home, for his wife and daughter were both talented musicians. The bond of affection with his wife was an unusually strong one, and her death, in 1904, was a blow which cast a heavy shadow on all his subsequent life. He was fortunate, however, in retaining to the last the companionship of his daughter, who, after her marriage, continued with her husband to make her home with her father.

In June, 1918, he retired from active service at Yale with the title of Professor Emeritus. Though his activity in research had continued unabated up to this time, he never thereafter resumed experimental work, nor did he make any further contributions to chemistry except for collaborating with Professor Browning in two revisions of the "Outlines of Qualitative Analysis," in 1925 and 1928, respectively.

Instead, he turned with great interest and enthusiasm to genealogical research. His uncle, Samuel Henfield Gooch, had left on his death voluminous data and manuscript notes on the Gooch Lineage in New England. Starting with these, Professor Gooch gave much time and study for a number of years to the task of confirming and amplifying these data, and especially to the study of the Gooch line in Europe in pre-colonial times. Finally, in 1926, the results of his labors were printed in a book entitled "The History of a Surname, with some account of the Line of John Gooch in New England." This work gives evidence of

a very intelligent and comprehensive study of the available sources of information, both medieval and modern, and of keen and thoughtful analysis on the part of its author.

From it we learn that the surname Gooch is one of the phonetically similar forms, spelled in various ways, of the family name Goz or Guz, which appeared in Normandy in the tenth century. It appears to have been at first a descriptive name or cognomen, indicative of personal appearance or place of origin, applied to one of the companions of the invader Hrolf (progenitor in the male line of William the Conqueror) who came over from Norway in 912, but to have been adopted as a family name by the descendants of Hrolf Turstain, half-nephew of the famous Hrolf.

Following back the ancestry of a certain John Gooch of Alvingham, Lincolnshire, a younger son, whose identity with the John Gooch referred to on page 105 of this article as resident in Maine as early as 1640 is made very probable by a good deal of circumstantial evidence, Professor Gooch succeeded in proving that John Gooch was a direct descendant in the male line of Hrolf Turstain, a step covering twenty generations. Except for the slight uncertainty involved in the identification of John Gooch of Maine with John Gooch of Alvingham, Professor Gooch had thus traced back his own ancestry, in the direct male line, through twenty-eight generations, covering more than nine centuries, a success which would have been gratifying to any lover of genealogical research, and was undoubtedly so to him. His book contains also a great deal of information about related lines, as well as many references to the original sources.

During this period he took much satisfaction in giving his two granddaughters their early education, as he had done for his daughter a quarter of a century earlier, and it was at this time that he wrote for their entertainment his "Trivial Reminiscences," from which so many extracts have been quoted. No one who reads this interesting autobiography, which in typewritten form covers some seventy pages, can fail to be impressed both by the charm of the author's style, and by his unusual powers of memory, as shown by his detailed and vivid descriptions of the scenes and experiences of more than half a century before.

His former students and associates were always sure of a warm welcome at his home, and the regularity with which they took advantage of visits to New Haven to call upon their former teacher showed clearly the great affection in which they held him. And this feeling was mutual, for a friend more loyal and sincere than Professor Gooch would be hard to find. He took the deepest interest in the welfare and scientific careers of his former students, and enjoyed most keenly these opportunities to hear of their interests and problems, and to renew old friendships.

After a severe attack of pneumonia in 1925 his bodily health was never fully restored. Other periods of illness followed, and on August 12, 1929, he died at his home in New Haven, in the seventy-eighth year of his age, after an illness of several months duration.

So ended a life of unselfish devotion to duty, rich in useful work accomplished, and in the love and respect of many who had felt its guiding influence and the inspiration of its example.

Professor Gooch was a member of a number of scientific societies and academies. He became a member of the National Academy of Sciences in 1897. He was also an associate fellow of the American Academy of Sciences, and a member, or former member, of the American Philosophical Society, the American Association for the Advancement of Science, the Philosophical Society of Washington, the American Chemical Society, the Connecticut Academy of Arts and Sciences, the New York Academy of Sciences (corresponding member), Sigma Xi (Yale Chapter), and of various other organizations of a scientific or social character, including a number of clubs.

Two brief biographical articles on Professor Gooch have already been published, both from the pen of Professor Philip E. Browning; one, in the series "American Contemporaries," in *Industrial and Engineering Chemistry*, 15, p. 1088, (1923); the other, an obituary, in the *American Journal of Science*, 5th ser., *18*, pp. 539-540, (1929).

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