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125 Years of Chemistry at Rensselaer Polytechnic Institute

BY

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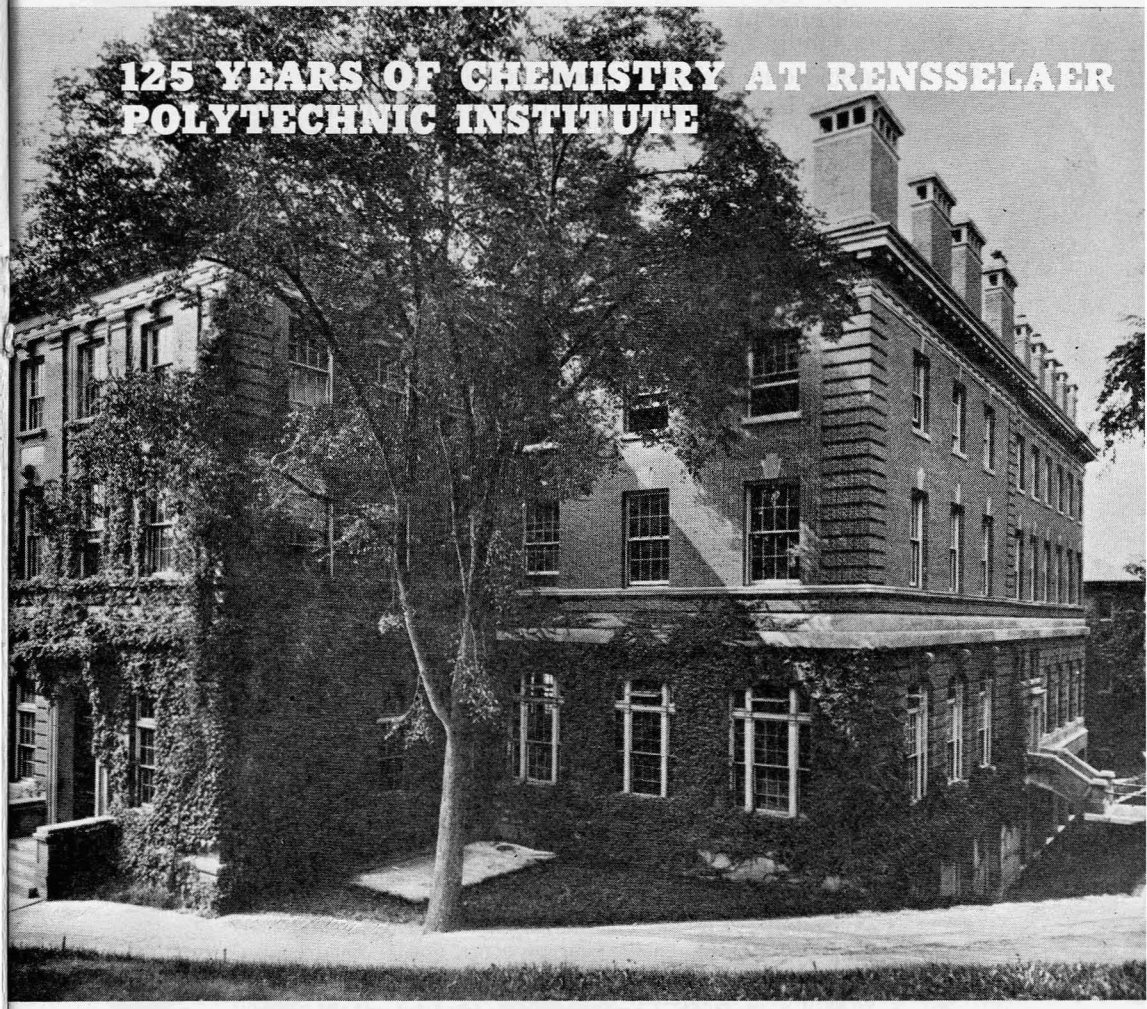
125 YEARS OF CHEMISTRY AT RENSSELAER POLYTECHNIC INSTITUTE



Walker Laboratory of Chemistry

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PARAPHRASING the poet laureate of ancient Greece, a resident of twentieth century Troy might well state that the generations of students at R.P.I. replace each other as the leaves on the trees. For one who has seen one generation go and another take its place, it is interesting

to note the changes brought about at the oldest engineering school of the country in the short space of 25 years. To Amos Eaton, its founder, were he alive today, the metamorphosis in 125 years from a school with one full-time professor and less than 30 pupils into a "poly"-technic institute with over 4000 students would seem nothing short of miraculous.

The late President Ricketts, shortly before his death in 1934, published the third and last edition of his history of the Institute and little of interest could be added here in the way of general information. This article, therefore, deals with the Institute's history only in so far as it concerns the teaching of chemistry. This branch of the so-called "natural sciences" played an important part in the early years, then suffered a gradual decline. It regained its former status, first slowly around 1885 and more rapidly since 1910, so that, at present, chemistry and chemical engineering occupy a prominent place among the 12 courses of study now pursued at the Institute.

It is only a few years ago that Miss E. M. McAllister, Eaton's latest biographer, came across a letter written by Eaton to Stephen Van Rensselaer, which indicates that it was the need for equipment and apparatus used in teaching "practical chemistry," which induced the "patroon" to act as patron of science. This letter, written on the back of a circular issued by Eaton and dated Aug. 24, 1824, contains the following passages:

> After my last interview with you, I concluded to make a trial as before stated in this circular, with a few young men at my own risque. Since this was printed, about 30 young gentlemen have proposed spending the winter with me. This number will require considerable apparatus. As usual, I again turned my mind to the almost only patron of science in our country. If you could make up your mind in favor of furnishing apparatus to the value of about three hundred dollars (let me select it economically) I could go on and pay myself with student's fees. The apparatus to remain your property, and I would engage to keep it in good repair, and to supply all articles which happen to be broken or injured.
>
> In addition to the benefit of the loan of apparatus (which I feel unable to purchase) I could then have the great additional benefit of announcing the School as under your sanction and patronage. This will be the first attempt in the world. And I am very desirous that the plan be fostered by the same patronage which originated the most extensive geological survey in the world.

Eaton had fixed up six rooms in his place of residence for a classroom, a library, three laboratories, and a museum of specimens. This unpretentious "Rensselaer School" (Figure 1), a two-story brick colonial building with a one-story addition on the side, located in North Troy, was formerly used as a bank and hence

was known as the Old Bank Place. It was occupied from 1824 to 1834 and again from 1841 to 1844. Here "Amos Eaton, Esq., of Troy, Professor of chemistry and natural philosophy and lecturer on geology, land surveying, etc." taught his first classes according to an entirely novel scheme, outlined in the first school catalog of 1826 in the following manner:

> The most distinctive character in the plan of the school consists in giving the pupil the place of teacher. From schools and colleges where the highest branches are taught to the common schools, the teacher always improves himself more than he does his pupils....
>
> Taking advantage of this principle, students of Rensselaer School learn by giving experimental and demonstrative lectures. In every branch of learning the pupil begins with its practical application and is introduced to a knowledge of elementary principles from time to time as his progress requires. After visiting a bleaching factory, he returns to the laboratory and produces the chlorine gas and experiments on it until he is familiar with all the elementary principles appertaining to that curious substance....

The same catalog stated further:

> For admission each student must pay $25.00 to the treasurer. Board in the commons amounts to about $1.50 a week. Expenses for chemical substances and damages to apparatus ought not to exceed 2 or 3 dollars for each term.

Each student was required to give in the winter term 15 lectures on chemical powers and substances not metallic and 15 lectures on metalloids, metals, soils, manures, mineral waters and animal and vegetable matter. In the spring term these lectures were 10 and 10, respectively. As a text Eaton's "Chemical Instructor" was used.

Degrees of Bachelor of Arts in Rensselaer School were given after one year of residence on the satisfactory passing of a final oral examination. Eaton, a prolific writer on all branches of natural science, made important contributions to geology and several of his pupils became noted geologists. His chemistry texts were reviewed by the writer some years ago.[1] Although highly successful as a teacher, Eaton was hopelessly inefficient as an administrator and his financial backer Van Rensselaer had to supply over $20,000 in 8 years to support the school. His total contributions from 1824 to 1839, the year of his death, amounted to well over $30,000. Of Eaton's pupils there are only a few that made a name for themselves in chemistry, *viz.*, Robert Peter, James Booth, and Eben N. Horsford. Quite a number of entering students were college graduates and several of them became physicians in later life.

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[1] Van Klooster, H. S., This Journal, **15**, 453 (1935).

Eaton's original idea was to train young people to become teachers of science. This is clearly stated in a letter which Eaton wrote to the first president of the school, the Rev. Dr. Blatchford in which he said:

> My principal object is to qualify teachers for instructing the sons and daughters of farmers and mechanics by lectures or otherwise with the application of experimental chemistry, philosophy and natural history, agriculture, domestic economy, arts and manufactures.

To this end he induced his patron to offer *free* tuition to prospective candidates who agreed to teach at least for one year in country schools after graduating from Rensselaer School. This scheme, however, fell through. The times were not yet ripe for the establishment of teacher's colleges. There was, evidently, at that time, greater need for engineers. This demand was met by the greater emphasis laid on engineering subjects in Eaton's later years. From 1835 on, degrees of Civil Engineer (C.E.) were conferred and the old A.B. degree was replaced by that of B.N.S. (Bachelor of Natural Science). At the same time (around 1833) the school was designated as Rensselaer Institute. Eaton's interest in chemistry having subsided meanwhile, he devoted the remaining years of his life (1835–42) to civil engineering and geology. The teaching of chemistry was turned over to his pupil James Hall (1811–97), for 62 years (1835–97) State Geologist of New York. Besides chemistry, Hall also taught "physiology, including the elements of organic chemistry." In Hall's time the tuition had gone up to $45 a year, board and lodging to $3 a week, while extra expenses in chemistry amounted to $8. Hall was succeeded in 1841 by another of Eaton's pupils, George H. Cook (1818–89), a C.E. and B.N.S. of the class of 1839, described in the catalog of 1841 as "an experienced chemist, who has been a successful teacher at this Institute for 3 terms." On

RENSSELAER SCHOOL 1824.
No.703 River St.
Farmer's Bank.Troy.1802

Figure 1

Cook's shoulders fell the task of carrying on as senior professor and professor of civil engineering, geology, etc., when Eaton died in 1842. This was a heavy load to carry with only one part-time coworker: Dr. John Wright, M.D. (later F. B. Leonard, M.D.), teaching botany and zoölogy. Cook resigned in 1846 and became later connected with Rutgers College, winding up his brilliant career as State Geologist of New Jersey.

In 1847, Cook's place was taken by Eaton's pupil, Benjamin Franklin Greene, C.E., A.M., of the class of 1842, who became the first director, and professor of mathematics and physics, being at the same time placed "provisionally in charge of mineralogy, chemistry, and geology." Greene fully justified the hopes of his parents who had named their offspring after America's foremost scientist. He was a man of initiative and foresight who felt that the time had come for a radical change. His coming to Troy coincided with the founding of the Lawrence Scientific School at Harvard by Eaton's pupil, Horsford, of a similar school at Yale (later the Sheffield Scientific School), and the establishment of a course in civil engineering at the University of Michigan in 1847. In less than 4 years Greene transformed the institute into a polytechnic institute with courses spread over a period of 3 years, later extended to 4 years by the inclusion of a "preparatory class."

Greene at once increased his teaching staff by the addition of 2 "repeaters" and 1 instructor. The repeaters were the American equivalent of the répétiteurs of the École Polytechnique and the École Centrale des Arts et Manufactures, the two models which the Institute most closely resembled. The roles which chemistry and physics were to play in the new setup were outlined in the catalog of 1854 as follows:

> In chemistry and physics, the student is expected to avail himself of the resources of experiment and observation. The study of chemistry with its facts and philosophy is made a school of mental and mechanical training of fundamental importance, not for the acquirement of chemical knowledge only, but as presenting a most favorable introduction to the general study of experimental science and as constituting an element of preparation essential to the business of research.

It was Greene's intention to acquire at once a resident full professor in general and analytical chemistry and also, as soon as the necessary funds could be secured, a professor of chemical technology. Meanwhile, these professorships were temporarily filled by Greene, first alone and later in part also by his colleague, E. A. H. Allen, of the class of 1850 who held the chair of geology from 1850 to 1854 and that of natural history from 1854 to 1855.

With the appointment of William Elderhorst (1828–61) as professor of theoretical and practical chemistry and mineralogy, in 1855, the Institute entered upon its "Woehlerian" period of analytical chemistry. Elderhorst and his immediate successors, Goessmann and Nason, were all pupils of the renowned German master, Friedrich Woehler.[2] Elderhorst, a native of Celle in Hanover, introduced blowpipe analysis into the curriculum and published a "Manual of Blowpipe Analysis" in 1856. A second edition appeared shortly before he died of yellow fever on a trip to Venezuela in the summer of 1861. Though he was connected with the Institute for only 6 years, he was highly esteemed as a competent teacher and 13 years later (in 1874) a memorial window was dedicated to his memory.

Elderhorst's successor was Charles A. Goessmann (1827–1910), a former assistant of Woehler who had emigrated to America in 1856 and came to Troy in 1861 as professor of physics and chemistry. This position was on a part-time basis since Goessmann retained his job as chemist to the Salt Company of Onondaga in Syracuse, New York, which he filled from 1860 to 1866. The teaching of chemistry occupied Goessmann during the winter months when there was little activity in the salt works. Goessmann resigned in 1864 whereupon his place was taken by his former pupil, Henry Bradford Nason (1831–95), who had obtained his doctor's degree under Woehler in 1857 with a thesis on the formation of ether. Nason was a versatile man of many accomplishments who was already connected with the Institute since 1858 as professor of natural history, while at the same time holding a similar professorship at Beloit, Wisconsin. With Goessmann's departure Nason became a full-time professor at the Institute, teaching chemistry and mineralogy for 30 years (1864–94) and geology from 1878 on. During this time he reëdited Elderhorst's "Manual of Blowpipe Analysis" (1873) and brought out a completely revised fourth edition in his own name in 1880. Besides this popular text he published in 1865 and in 1870 "Tables of Reactions for Qualitative Analysis" and in 1868 a translation of Woehler's "Handbook of Mineral Chemistry." Although not an alumnus of the Institute, Nason became secretary of the Alumni Association and in that capacity published in 1887 his "Biographical Record, 1824–86." A general favorite with students, famous as Winslow Laboratory Quizmaster and original narrator of the "Antimony Pill" story, Nason was equally popular among his fellow chemists who elected him president

[2] Van Klooster, H. S., This Journal, 21, 158 (1944).

of the American Chemical Society in 1890, in those "good old days" when there were only 238 members instead of some 60,000 in 1949.

A great many changes occurred in Nason's time. The great fire of May 10, 1862, caused by the sparks of a passing locomotive setting fire to the shingled roof of the covered bridge over the Hudson River, destroyed a considerable part of the city of Troy, including the two Institute buildings. A new Main Building was erected on Eighth Street in 1864. This was followed the next year by the construction of the first chemical laboratory, the "Winslow Laboratory," named after a former president and benefactor of the Institute (Figure 2).

This three-story brick building, embodying Nason's plans for an up-to-date course in chemistry and metallurgy, contained on the ground floor the metallurgical laboratory, on the second the chemical laboratory, and on the third the library and the lecture, recitation, and apparatus rooms, "fitted up in the most approved manner for complete courses in general and analytical chemistry."

The original Eatonian method of teaching was still

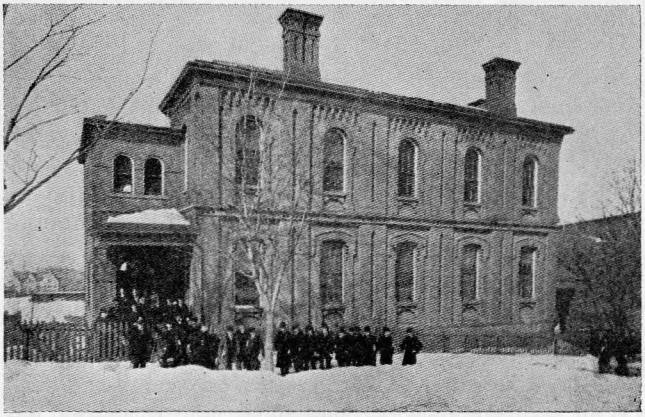

Figure 2. Winslow Chemical Laboratory North of Old Main Building

used under Director Greene. In a privately published biography of the noted educator, Nathaniel T. Allen (1823–1903), the following statement occurs:

> . . . having listened to a lecture, we were called upon the following day to repeat the lecture. This was done in squads of eight with a gentleman "repeater" as critic, an admirable discipline. The whole experience at the Institute I have always considered extremely valuable. . . .

With the larger classes in the sixties, it was no longer possible to require daily lectures from each student and daily interrogations and blackboard demonstrations

were substituted. The one-year course leading to the degree of Bachelor of Natural Science had been transformed by Director Greene into a two-year course in 1850 and on his departure in 1859 it was made into a three-year course (or including the preparatory year, a four-year course) designed largely for future chemists. This course did not flourish and was discontinued after 1871. A total of only 14 B.S. degrees were conferred from 1850 to 1871. The B.S. course was revived in 1885, again as a four-year course of which the first two were identical with the C.E. course while in the last two years less higher mathematics and engineering was included but more natural history, chemistry, and geology. This revival coincided with the appointment of William Pitt Mason, Nason's assistant, as professor of analytical chemistry.

Mason, a C.E. of the class of 1874, had been connected with the Institute since his graduation and enjoyed a great reputation as a teacher. He was, judging from the student yearbooks of the eighties, not only "the most popular and admired instructor" but also "our only original searcher in the tangled paths of science." For his numerous publications extending over a period of 40 years (1882–1922) reference is made to the list published in 1947.[3] In 1885 4 B.S. degrees in the newly revised course were conferred and the B.S. graduation theses from then on dealt mainly with topics suggested by Dr. Mason whose specialty, then and later, was water analysis and water supply. On the death of Nason in 1895 Mason became his successor and was put in charge of all the courses taught in the Winslow Laboratory.

Thanks to the student yearbook of 1897 (p. 137) one can readily get some idea of the kind of instruction imparted to engineering students of 50 years ago (Figure 3):

> From October, when the long aprons are donned for the first time, until March, the wash bottle and evaporating dish, sulphuric acid, and H_2S are faithfully used for 3 hours and "boil, filter, wash" is the motto of the day. Then the juniors leave the laboratory for a season while Dr. Mason tells delightful stories to Division A, at the same time giving lectures on metallurgy. The first time a class sees the "lab" is in sophomore year when it is admitted to the third story and takes the course in general chemistry.
>
> Then the main floor is turned over to its members. Lastly, it finds in the lower regions of the basement a most appropriate place for the course in assaying. Here the juniors come together and in the same long aprons, unrecognizable by long contact with acids and water, they toil before the long row of pot ovens or swelter in the glow of the muffle ovens as they watch the "silver buttons" or lift the covers from the clay crucibles, buried in the fierce glow of the white-hot furnaces.

One word of parting must be said to "Bummer,' Lab. George, who makes every fellow feel as if he were doing George a kindness by asking him a question and who is always ready to do anything for anybody.

The year 1904 proved to be another eventful milestone in the history of R.P.I. The Winslow Laboratory, having been partially destroyed by fire on two previous occasions (August, 1884, and October, 1902), in May, 1904, suffered, for the third time, from a case of

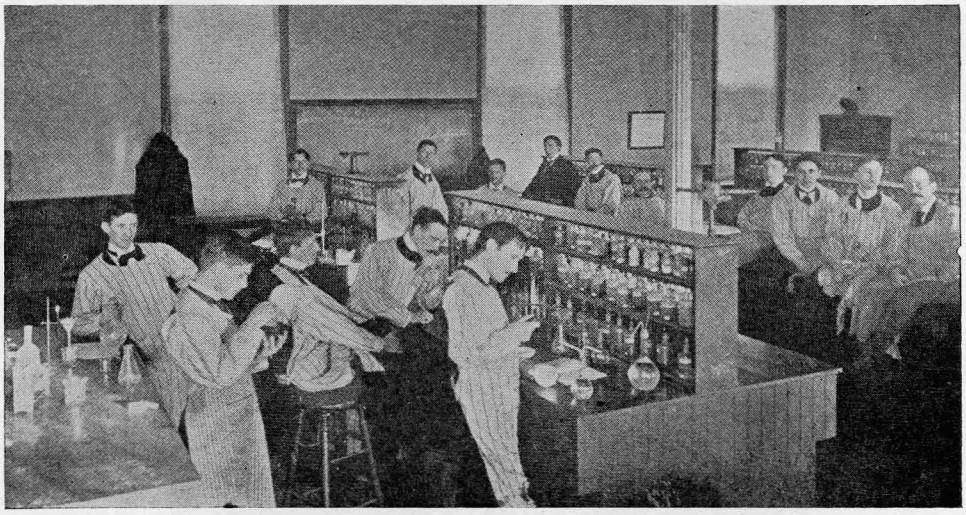

Figure 3

internal combustion. In the same year (June, 1904) the Main Building of the Institute was also destroyed by fire. This last disastrous fire, which gave Trojans a chance to speak facetiously of their "pyrotechnic" Institute, proved to be a blessing in disguise. Wealthy friends came to the rescue of the Institute. As a result the present Walker Laboratory, named after a graduate of the class of 1886, was erected in 1906.

This building, built according to plans drawn up by Mason, took care of 130 men in qualitative analysis and 74 in assaying. It was remodeled in 1913 and more than doubled in size by an addition completed in 1920. Ample space and additional equipment opened up new opportunities for the training of chemists and special two-year courses were given in the new building. These courses, in which water analysis and sanitation chemistry were particularly stressed, continued until 1925 and

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[3] Van Klooster, H. S., and J. B. Cloke, This Journal **24**, 210 (1947).

Figure 4

trained a number of analytical chemists some of whom, later on, occupied important positions in water works and filter plants.

At the same time (around 1908) new lecture and laboratory courses were organized in physical and in organic chemistry. Physical chemistry, which dates back to 1887 when the *Zeitschrift jür physikalische Chemie* was started, first was taught in America in 1895 at Cornell University by Wilder D. Bancroft, a former student of van't Hoff. It was Bancroft's pupil and coworker, Azariah T. Lincoln (1868–), the first Ph.D. in chemistry at the University of Wisconsin, who introduced this subject at the Institute, where he taught from 1907 to 1921 (Figure 4). American texts in this field of en-

deavor were scarce in those days, English and translated German texts being mainly used. Dr. Lincoln, therefore, prepared a text of his own published by Heath & Co. in 1918. This text, one of the earliest in the field, was reprinted in 1920 and was used for a number of years at the Institute. Other courses introduced by Lincoln were industrial chemistry and food analysis.

Organic chemistry which had been part of the general course in chemistry for a great many years was not taught as a separate, theoretical as well as practical course until the Walker Laboratory was opened. It was Frederick W. Schwartz (B.S. 1905, Ph.D. Columbia University 1911), Mason's long-time assistant and his successor as professor of analytical chemistry, who, from 1908 until 1925, was in charge of this course. When these new courses were introduced they took the place of other courses which were eliminated or else given in some other department. The course in assaying for engineering students was dropped in 1915 and a few years later also for B.S. and special students. Metallurgy was turned over by Mason to a former student of his, Enrique Touceda (C.E. 1887), who had become a practicing metallurgical engineer of wide repute. Blowpipe analysis gradually became a minor part of qualitative analysis and in the early twenties it was dropped altogether.

This revamping of the chemical curriculum proved to be of great value to the new department of chemical engineering. Under the vigorous leadership of Director Palmer C. Ricketts, from 1901 to 1935 also president of the Institute, two new departments, *viz.*, those of mechanical and electrical engineering had already been established a few years earlier (in 1908). In 1913 it was decided to start a fourth department, *viz.*, chemical engineering. In doing so, the Institute followed the lead of Columbia, Illinois, Lehigh, Massachusetts Institute of Technology, Missouri, Pennsylvania, Purdue, and Wisconsin, where chemical engineering departments had already been functioning for some time.

With the resignation of Dr. Mason in 1925, after 50 years of service, the directorship of the Walker Laboratory was taken over by Albert W. Davison (Figure 5). Born in 1888, he was educated at Denison University (B.S. 1910), at Ohio State University (M.A. 1911), and Cornell University (Ph.D. 1914). After three years of teaching at the University of Cincinnati, he entered the United States Army as captain in the Chemical Warfare Service. From 1919 to 1921 he was general manager of the Virginia Haloid Corporation. In the fall of 1921 he came to Troy as professor of physical chemistry on

the place of the course in qualitative analysis which was discontinued for C.E. and M.E. students. With the establishment of a course in metallurgical engineering in 1936, the teaching of metallography was transferred from the chemistry to the metallurgy department.

On the completion of the Ricketts Laboratory the existing chemical engineering equipment was moved from the Walker Laboratory to the east wing of the Ricketts Laboratory where additional new types of equipment were installed. The evacuated space in the Walker Laboratory became available for more courses in physical and colloid chemistry and plastics.

The accompanying graph (Figure 6) indicates the number of degrees given in chemistry and in chemical engineering (since 1937 the Ch.E. degree was replaced by that of B.S. in chemical engineering) from 1915 to 1949. During these years the number of graduates in chemical engineering averaged around 40 annually, while the number of graduating chemists has never exceeded 14 and dropped to one in 1944. This was due to the fact that from July, 1943, to July, 1946, the Institute operated on the Navy V-12 program, in which there was no place for chemists.

Dr. Davison resigned in the fall of 1942 to accept the position of Director of Research of the Owens-Corning Fibre Glass Corporation in Newark (Ohio). In recognition of his long and fruitful services to the Institute, the honorary degree of Doctor of Engineering was conferred upon him in December, 1942. It was decided at that time to divide the department of chemical engineering and chemistry into two separate departments. This plan has just been carried out. Dr. John B. Cloke has been appointed head of the chemistry department. Dr. Lewis S. Coonley is head of the department of chemical engineering.

Just previous to and during the recent war a number of changes occurred to which brief reference should be made. In the first place, the old "intensive" system of teaching, *viz.*, two classes of two hours each (lecture followed by recitation) and a two-and-a-half hour laboratory period for two successive seven-week periods, five days a week, followed by a four-week review and examination period without laboratory work, was abandoned in July, 1943, when the Navy curriculum went into effect. As a result, all courses are now given on a semester basis and are run on essentially the same plan as that in use at other engineering schools.

Another innovation occurred in 1942, 100 years after Amos Eaton's death when the Institute opened its doors to women, thus becoming a coeducational institu-

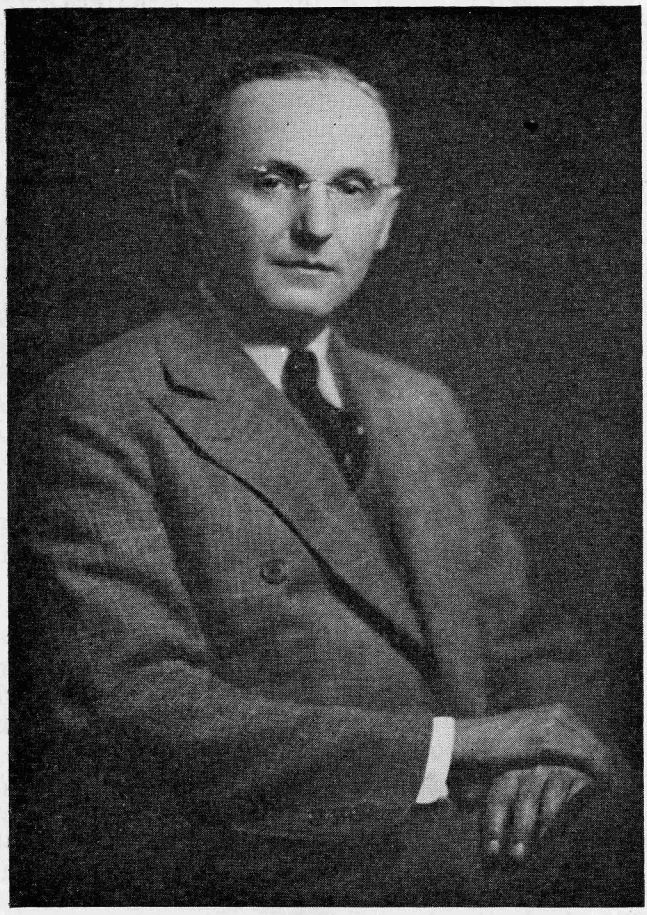

Figure 5

The greatly augmented staff and the new laboratory equipment installed in the twenties under the Davison regime was necessitated, in part, by the establishment of new courses in chemistry, physics, and biology. The old B.S. degree in general science, which, in practice, was given to those who intended to become chemists, was replaced by the B.S. in chemistry degree. In addition to this degree three other B.S. degrees (in physics, biology, and business administration) were established. In the chemistry curriculum a new course, colloid chemistry, an offspring of physical chemistry, was given for the first time in 1928. Another new course, metallography, likewise a branch of physical chemistry, was taught to chemists and chemical engineers beginning in 1924 and to students in civil and mechanical engineering for the first time in 1923. This latter course took

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tion. Eaton, as is well known, was no misogynist (he was married four times!) and thoroughly believed in teaching science to women. Due to the opposition of Van Rensselaer, Eaton was forced to instruct girl students privately in a separate room of his residence, ingloriously called the "sheep pen" by the regular male students.[4] Now, at long last, full equality of opportunity exists and the Institute, at present, has already a few graduate alumnae in chemistry.

In the past ten years the Institute has also abandoned the system of rigidly prescribed courses, to the extent that students in their senior year and in some cases already in their junior year, are permitted to drop one or two scheduled courses and substitute other courses from a list of "technical" and "nontechnical" courses with the same number of "credit" hours. While this system, obviously, is of some benefit to a number of students, the fact remains that unavoidable schedule difficulties make the new system, if not impossible, at least frequently difficult to execute.

Since the war has demonstrated the extreme importance of new developments in science and engineering, new courses have been introduced in various departments and it is not surprising to find in the Walker Laboratory, since 1947, a small well-equipped laboratory for the teaching of nuclear chemistry.

Realizing that the future of the Institute would be better assured by active research on the part of faculty and student body, Director Ricketts inaugurated in 1913 a graduate program of studies, leading to advanced degrees in engineering and science. In order to encourage graduates to take up advanced work, Mrs. Russell Sage, in 1913, established 2 fellowships of $600 each with free tuition. Since 1923 10 more fellowships, likewise of $600 each and free tuition, are awarded annually by the Board of Trustees.

Starting with 2 graduate students in September, 1913, the number increased very slowly at first (6 in 1917, 9 in 1924, 15 in 1930), then more rapidly, and reached a maximum in 1931 when the number of graduate students in engineering and science was 74 (including 37 instructors). Since that time the number has averaged around 60 annually. On the outbreak of the war the number dropped sharply (only 7 in 1943). When the war ended, the number increased rapidly (67 in 1946) and reached a peak of 277 (of which number 34 were enrolled in chemistry and 8 in chemical engineering) in the fall of 1948. The first Ph.D. degree in chemistry

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[4] Clarke, J. M., "James Hall of Albany, Geologist and Paleontologist," E. E. Rankin, Albany, New York, 1921.

was conferred in 1926. Of the total number of Ph.D. degrees conferred in the period 1913–49 (54) no fewer than 32 were given in the chemistry department (15 in organic chemistry, 9 in physical chemistry, and 8 in analytical chemistry). Ten of these Ph.D.'s in chemistry are professors at various universities and colleges, 2 entered the services of the federal government, while the others are connected with oil companies and various industrial concerns.

The results of the experimental and theoretical studies pursued at the Institute have been published in a number of scientific journals and also, to a considerable extent, in a series of Institute publications numbered consecutively from 1 to 58, which appeared from 1913 to 1943. Of these, a total of 8 dealt with work carried out in the Walker Laboratory.

While a considerable number of chemistry students took up advanced work after graduation (from 1921 to 1949 80 M.S. and 32 Ph.D. degrees were conferred), the corresponding figures for chemical engineering are, notwithstanding the much larger number of graduates, comparatively small (from 1921 to 1949: 54 M.S. and 4 D.Ch.E.).

In concluding this brief review of the development of chemistry at R.P.I. in the past 125 years, the writer wishes to thank those of his colleagues who have kindly supplied pertinent data, and, last but not least, the faithful stockroom custodian, "Billy" Bolger, who was present at the opening of the Walker Laboratory and is still going strong after 40 years of service.