

nation had been chosen to differentiate the four year course from three-year courses leading to the B.S. degree in science, offered at some institutions to stimulate enrollment in the sciences, and to compete with the traditional A.B. four year degrees (mainly in the classics). There were no graduate courses at M.I.T. when I entered in 1900, though they were instituted soon after I graduated in 1902.

M.I.T. was then located in "Back-Bay" Boston in the block between Berkeley and Charleston Streets on Boylston Avenue and was popularly known as "Boston Tech." Naturally it lost this title, to the dismay of former graduates, when it moved to its present stately site in Cambridge on the Charles River at Massachusetts Avenue where the very fine main building was made possible by the donations of the late George Eastman of the Eastman Kodak Company.

The four year course in chemistry at M.I.T. was then regarded as the best undergraduate chemical curriculum in the country. Its excellence was maintained by such professors as A. A. Noyes in physical chemistry, James Norris and Samuel Mulliken in organic chemistry, Henry P. Talbot and Henry Fay in analytical chemistry and Helen Richards in the chemistry of foods. Besides my regular courses in physical and organic chemistry, neither of which had been offered at Washington and Lee, there were so many required ones including mechanical and free-hand drawing in the freshman year, that it took every hour of the 5½-day week during my entire two years for me to catch up. I never became a "regular" student without back requirements until I passed the last examination a few days before my graduation. But I managed it somehow and was appointed to an assistantship under Professors Talbot and Fay for the following year at a salary of \$500. My duties as assistant in the course of advanced analytical chemistry consisted in supervision of the laboratory work of the students required to take it—Chemists in their Junior year and Chemical Engineers in their Senior year. Analytical chemistry then was much more emphasized than now in chemical curricula, and the analytical methods have changed greatly. Operations were mostly by hand, both gravimetric and titrational. The modern application of physical principles had not arrived and some of the long and tedious procedures would not be tolerated today; for instance hand grinding of a hard silicate to less than 200 mesh before fusion to determine sodium or potassium in the resulting extraction. At the end of that academic year in 1903 I was granted a two-year Dalton fellowship for graduate study—also at \$500 per year—which I decided to take at the University of Leipzig.

In the early nineteen-hundreds M.I.T. sought to differentiate itself as much as possible from the looked-down-upon academic colleges. The traditional cap and gown for graduation day was rejected in favor of high silk hat and frock coat. I believe M.I.T. has now adopted the usual academic costume. But I remember one incident of my graduation day in June, 1902. We were all lined up on the stone steps of the Museum around the corner in Charleston Street waiting to march, when a lone pedestrian came by. Having nothing better

to do, we began to mark time by tapping our canes in unison with his steps. I shall never forget his nonchalant. He stopped, raising and adjusting his monocle, he deliberately and calmly surveyed this assembly of freaks as if they were inmates of the Museum, who presumed to mar the decorum of staid old Boston by invading the privacy of a passing individual. I take off my hat to him. He literally stared us down with scorn. When our tapping had subsided he resumed his hurried walk until lost to sight. Surely he must have been an English actor to outface and quell 200 M.I.T. men on their own ground. Or perhaps we came to feel our conduct unworthy of high hats and canes, especially on our graduation day.

Many students of M.I.T. lived at home in Boston or in its suburbs and either walked or commuted before the days of autos. Those from out of town roomed in the Back Bay section or across the railway lines, along Columbus Avenue and its side streets. Columbus Avenue was then on the edge of respectability. The color line coming up from the south side had not yet reached that far, though it later swept across the railway, across Huntington Avenue and Boylston Street on toward Arlington Street and the Charles River. I express here no prejudice against race or color. I am simply noting that even in Boston when the race of color moves in, the other moves out, and that if M.I.T. had not moved to Cambridge its more numerous students might now find housing impossible within walking distance because today commerce is also replacing much habitation in that district.

I found a room on the third floor of a red brick rooming house off Columbus Avenue and roomed for two years with a congenial student of electrical engineering from Alabama named Lawson. Both of us were entering the third year where specialization begins to separate underclassmen previously associated in common courses and in first year military training. Consequently we did not have the broad range of acquaintance so readily formed in the first two years. But I did get to know the fifteen or twenty specializing in chemistry and made good friends with my classmates, Bobby Edwards, of Portland, Maine and with the late Herbert Walker from Washington, D.C. At the instance of Professor Howe I was invited to join a fraternity but declined, as I had at Washington and Lee.

I really had no time for such little student life as there was then at M.I.T. I never entered the so-called "Chapel," the Brunswick Hotel bar across Boylston Street, seldom heard the Boston Symphony Orchestra or attended theatre. In my third year as Assistant, I had more leisure and lived in an apartment on Boylston Street with my youngest uncle, Warner Colville, with whom I spent much of my free time. He made annual trips to Europe and on one of them had met the Tolman Family of West Newton, parents of the distinguished chemist Richard C. Tolman whom I knew at M.I.T. and who graduated in the class one year behind me. Tolman Sr. was a member of the Board of Trustees of M.I.T.

On one occasion my uncle and I were invited out to the Tolman's in West Newton for dinner. When I got

home from work my uncle was already dressing and began to worry for fear I would be late. I urged him to relax—there was plenty of time. But he became more worried as, with time passing, he found I had not even begun to dress. Finally he became so exasperated he put on his coat and hat saying he would go on and leave me to come in my own sweet time, but he would be embarrassed, as well as I, when I arrived after delaying dinner for half an hour. He departed in haste. There were plenty of suburban trains then before the days of autos, so I did not hurry. The result was, as he later recounted in merry self depreciation, that he arrived half an hour before dinner time. Mr. Tolman had just come from town. No one had dressed or come downstairs, and no one except a servant was ready to receive him. And to top it all I arrived later just on time.

In my third year at M.I.T. while I was assistant, I published my first piece of research, a small paper entitled, "The Constitution of K_2RuCl_5NO in Water" [J. Am. Chem. Soc., 25, 928 (1903)]. It was a minor piece of research and the conclusion today for the structure of such a salt in aqueous solution would be taken as a matter of course. But then it was of interest to find that the NO radical acted like Cl in being attached to ruthenium in the anion. The freezing point lowering and electrical conductivity were found to be those to be expected from a salt of its character.

During my year as Assistant in Chemistry I was very fortunate in being awarded a Dalton fellowship for graduate study in chemistry. It seemed at M.I.T. at that

time that there was but one place worth considering, the Laboratory of Physical Chemistry under the direction of Geheimrat Wilhelm Ostwald at the University of Leipzig, where Noyes, Whitney, Bigelow, Cottrell and many other distinguished physical chemists from America had recently taken their doctorates.

At the turn of the century when I went to Boston, it was as it always had been—one of the most important American cities. It was especially distinguished for its cultivation of the fine arts. Its handsome Public Library and its famous Symphony Orchestra had at that time no equal in the United States. The paintings by John Singer Sargent decorating the walls in the corridor and stairway of the Library were greatly admired and gave the building an air of cheerfulness and welcome. Although they may not be so much in vogue now as then, I can never enter the library without remembering the thrill they gave me the first time I saw them and without stopping again to renew my enjoyment.

Unfortunately my studies did not leave me much time to enjoy the cultural influences of Boston. Although the subway was already there I seldom got over to Cambridge to visit Harvard University and I believe there was not so much contact between the two institutions as now since M.I.T. has moved to the Cambridge side of the Charles, and some joint courses have been instituted.

I doubt if much of the Boston culture rubbed off on me. But I am still fond of the city and like to visit it and wander along Boylston Street and recall my student days.

CHAPTER 4

THE UNIVERSITY OF LEIPZIG, GERMANY

In the previous chapter the Massachusetts Institute of Technology award to me of a Dalton Fellowship for graduate study was mentioned as well as my choice of the Ostwald Laboratory of the University of Leipzig and my reason therefor. In order to acquire some facility in speaking German before entering the University in October, I conceived the idea of spending the three summer months in a small town or village where I could meet people and have opportunities of talking with them. I had imagined there would be towns like the small county seats in the United States. I soon learned, however, that in Germany there seemed to be no such towns—nothing between a city and a small country village or dorf populated by peasants who work in the surrounding fields. Rather discouraged, I decided to go to the city of Kassel, where the purest German was supposed to be spoken, and try to find lodging and board in a family. On my first Sunday there, I went out to one of the country inns nearby where I could ramble about and have dinner. Perhaps I looked very lonely eating alone or maybe it was her instinct for business that inclined Frau König to invite me to join her party, consisting of her husband, two young Russian officers and a young German Fräulein. Frau König explained that she had a small "pension" in the city where she

took a few guests, including the two Russians, for room, meals, and to learn German. She would have a place for me where I could have daily German lessons with her. I accepted at once and moved into the Pension. The lessons were mainly reading and pronunciation. She insisted that I avoid all contact with English speaking people and claimed she could detect deterioration in my German whenever I strayed into association with American or English people living in Kassel.

The chief summer amusement in Kassel was in the city park to attend evening concerts by the city orchestra. I found them so enjoyable I decided to buy a season ticket. On my offering a hundred mark note in payment, the official, after inspecting my note carefully, said it would be subject to a discount of 3% since it was issued by one of the German provinces that did not have full credit. Being rather suspicious of his claim, I found I had a note from one of the other German states which I then offered instead. The official looked rather embarrassed, agreed that my second note had full value and so accepted it. I had no trouble elsewhere in having the first note accepted fully. Incidentally, I heard later that the official said that the Americans seemed to have 100 mark notes in abundance like playing cards. I only wished it might have been so in my

case. Those were the only two I had. At that time gold in ten or twenty mark coins instead of notes was in more common use in Germany, and many merchants had standard weights ready for balancing proffered coins to insure against counterfeiting or adulteration.

Kassel, the capital of the province Hesse-Nassau, I found a very pleasant place to spend the summer. I made acquaintance among the small colony of English people living or visiting there. Bicycling on the well kept highways was enjoyable, though on one occasion it resulted badly. Riding with one of the English ladies, I unfortunately turned too sharply in trying to pass to her left. My front wheel touched her rear wheel, but it was just enough to send her into a spin that grounded her and her bicycle. She complained of her ankle, but I think it was more the ruined silk stocking, which I of course replaced, though they were not easily come by in Germany at that time.

In September, after a pleasant and profitable summer in Kassel, when I was ready to leave for Leipzig, my host, Herr König, invited me into his tobacco shop on the ground floor below the Pension. In saying farewell he explained to me that all the house mail, including mine, was first left with him for distribution. He had taken the opportunity to use my name for his dealing with a pool in Berlin through which he placed wagers on horse racing. In order to insure that his wife would not discover him, he requested me to continue to have my mail come to Kassel and he would forward it to me after extracting his betting lists. Much to his disappointment, I explained I thought this would be an awkward arrangement that would delay my mail, might embarrass me otherwise, and I regretted I could not consent.

After a pleasant and rewarding summer's stay in the fine old city of Kassel I left it to take up my work in Leipzig that will be described below. I have never returned to Kassel but was much concerned that it was badly damaged during the bombardments by the Allies in World War I. The Spirit of Kassel was far from Prussian and it seemed unjust it should suffer so severely for the wrongs perpetrated by the Kaiser and his regime with which it had little sympathy.

In 1903 the University of Leipzig was one of the four or five best known universities of the twenty-nine then existing in the German Reich—some of the other best known ones being Berlin, Heidelberg, Göttingen and München. Leipzig was financed by the state of Saxony, one of the larger provinces of the German Empire, and was governed by the Ministerium of Saxony. Like most of the other German universities, Leipzig did not have a centralized location similar to an American campus. The various institutes occupied buildings scattered about the city. Wilhelm Ostwald's laboratory, situated some distance from the Augusteum on Augustus Platz in the center of the city, enjoyed the same independence of management as did Organic Chemistry under Professor Des Coudres in its quarters a half-mile distant or Applied Chemistry under Professor Beckmann in yet another location.

Ostwald and his family of several sons and daughters lived in a house belonging to the University, adjoining his laboratory. He had many interests beside chemistry,

painting, violin playing, philosophy, etc. His family also had tastes and talent for music and art. Ostwald also invented a method of pastel painting. Through these talents he brought together those with similar tastes and frequently invited the older students and assistants for concerts or entertainment in his home. But in the Laboratory he no longer had much direct contact with the students and their work. He left their instruction and the supervision of their research almost entirely to two very able Privatdozenten, Drs. Robert Luther and Max Bodenstein, while he had a private assistant who carried on work for him on subjects in which he was personally interested. He invented a method for the catalytic oxidation of ammonia to nitric acid from which he was said to derive quite an income.

Ostwald by 1903 had developed a great interest in what he called "Naturphilosophie." He gave a course in that subject, not for chemists but for a general audience attracted to his lectures in the Augusteum downtown. I think few chemists attended. He was a prolific writer and published many books not only on chemistry but on "Naturphilosophie," art and anything that interested him.

In his latter days in Leipzig he confined his chemistry lectures to one semester only, each year a two-hour course per week in Thermodynamics. In 1904 he had the great honor of being invited to Harvard as the first of the American-German exchange professors. This must have renewed his interest in chemistry—or there may have been a contractual requirement. In any case, at Harvard, instead of giving one lecture course he gave three. But that turned out to be unfortunate. On returning to Leipzig, Ostwald petitioned the Ministerium to relieve him of the one course he had been giving. The Ministerium however declined—on the ground that if he could give three lectures at Harvard he should continue to give at least one for a half-year at home. Ostwald was not a man to take "No." He forthwith resigned and retired to an estate at Grimma, fifty miles from Leipzig, where his chemical activities ceased entirely except for writing—principally renewal of older texts and editorial work.

On the whole, Ostwald was one of the four great figures in Central Europe who created Physical Chemistry and gave it to the world as a lusty youngster. It is still growing 70 years later. The others were Van't Hoff, Arrhenius and Nernst. Ostwald by his teaching, writing and research gave Physical Chemistry the interest that launched it on a great future. Yet it has been said *sub rosa* that when the Committee decided to give him the Nobel Prize which he received in 1909, it had difficulty in finding an outstanding experimental achievement that would justify the choice. And one can today pick out a few flaws in Ostwald's teaching which contrast with an otherwise brilliant background. He taught the indivisibility of all matter—that even gases on expanding are being only stretched like 3-dimensional rubber—and this some time after Rutherford had proved the individual existence of helium atoms by the study of alpha particles. This reminds me to note that radioactivity made at first so little impact on the Ostwald laboratory that during my two years there,

seven years after the discovery of radium and polonium by the Curies, I never once heard the subject mentioned.

One of Ostwald's most valuable contributions was the founding of the *Zeitschrift für physikalische Chemie* in 1887 of which he was editor until 1922, when Bodenstein succeeded him. It remained an outstanding organ of physical chemistry until disrupted by the Second World War. It now appears using the same title under two different managements, the one in West, the other in East Germany. Both sadly reflected the influence of the war on German chemistry and chemists, but both have begun to regain their former prestige.

One may conclude from the foregoing that I reached the Ostwald Laboratory when it had passed its zenith. That might well be true so far as Ostwald's influence was concerned. But fortunately he had put the guidance of the doctorants into two extraordinarily able hands. Robert Luther was the senior of the two—Max Bodenstein a relatively newcomer from Heidelberg. Most of the candidates went to Luther first for guidance. He advised me to seek Professor Bodenstein, which I did at once. But in making acquaintance I made a most embarrassing mistake. By introduction I said: "Herr Dr. Luther hat mich befohlen (has commanded me) Sie zu besuchen" instead of: "hat mir empfohlen (advised me) to visit you." Bodenstein smiled understandingly and soon we had arranged for me to do my thesis under his direction.

But first let me explain how I had got that far. At that time in the United States the leading universities interested in graduate work had organized the American Association of Postgraduate Universities. It then had fifteen, now has some forty members. In studying the means of promoting graduate work in the United States it had eyed suspiciously the strong lure of German universities which took so many Americans abroad. The Association had decided that attaining the doctorate in Germany was too easy, that students not well prepared were being allowed to attain the Ph.D. in two years instead of the three-year minimum at home. Therefore the Association petitioned the German universities to stiffen their requirements, to grant no Ph.D.'s with less than 3 years beyond the bachelor's degree, and of course, to accept no graduate time from the United States except from one of the fifteen members of their Association.

Four of the German universities, Berlin, Leipzig, Göttingen and Heidelberg granted the petition at once and raised their requirements, one of which was an entire semester of pre-doctoral studies before undertaking a thesis. In chemistry this included laboratory tests and a preliminary examination. Upon arrival at Leipzig I learned this from two fellow students from America, William C. Bray and Victor Sammet, both of whom had already run afoul of the new rules.

Believe it or not, Bray, who later became a world authority in analytical chemistry, had failed his "unknown" mixture, either by reporting an element not there or by failing to find one. Sammet had failed his "preliminary" from lack of knowledge of the "phase rule," a rather new subject at that time. Both of them later recouped and went on to Ph.D.'s *summa cum*

laude. Warned by their experiences I put in a very full fall semester of preparation both by study and experiment. For the "unknown" in qualitative analysis I did several practice ones until I felt I had mastered the system of Professor Bötger, who was in charge. He gave me a mixture with about six bases and two acid components—with a two-day time limit. When I reported he shook his head and said I had correctly found everything present, but was mistaken in reporting nickel, which was not supposed to be there. I asked for a new sample, and again found nickel. When he became convinced of it, he blandly admitted it was probably an impurity in the cobalt component and looked almost aggrieved that I had found it.

In the quantitative test he usually gave a mixture of two metal salts and asked for their separation and determination. He gave me iron and manganese and I happened to have taught their separation by the basic acetate method at M.I.T. So they caused me no trouble. I also passed my oral preliminary examination by Luther and was ready for my thesis. It was then that I introduced myself to Bodenstein as I have already recounted.

During my vacation in the summer of 1904, midway in my work at Leipzig, I took a trip to Sweden to visit the land of my father's birth and to meet some of my kin. Being rather tired, I decided on a leisurely trip north through Denmark to cross to Sweden from Helsingör to Hälsingborg.

Among the notable sights of Copenhagen, including its majestic cathedral, is its fine Botanical Gardens. There a simple thing has left a lasting impression on me, as apparently violating the laws of nature, but at the same time illustrating vividly their application. A beautiful fountain more than head high played sparkingly a few feet before my admiring eyes, and yet I could hear not a sound. This would not surprise me today, but at that time my hearing was still excellent, making the apparent miracle all the more unbelievable. Of course, the explanation is that the fountain was enclosed in a glass case with double wall, providing a vacuum so soundproof that the beautiful water nymph seemed to be making the effort to speak but had been struck dumb, though her face was still smiling naturally and showed no abhorrence of the vacuum.

Leaving Copenhagen after a few days during which I had visited her famous beach resort, I took the train toward Helsingör. I had planned to visit one of the two provincial cathedral towns en route. By stopping off between trains at the second one I could see the cathedral and still reach Helsingör in time for the afternoon boat to Sweden. But I must have dozed en route. Nothing is more tiring than sight-seeing. When the train stopped I awoke to see a cathedral on a hill and crowds of tourists walking in that direction. I followed to the cathedral and dutifully inspected it. Whether two cathedrals could be so much alike or whether I paid too little attention to the details of my Baedeker I do not know. But I do recall that the lack of correspondence sometimes puzzled me. When I went back to the railway station to continue my journey I wondered at the failure of the train to arrive. Trains in Europe were surprisingly

dependable. After waiting some time and noticing that no other passengers were waiting, I looked up the Station Master. He could not speak a word of English nor a word of Danish, which made communication difficult. Finally by showing him my time table and the train I intended to take he made it clear to me I had got off at the first station instead of the second, and that my train had already gone. There would be other trains but I could no longer make my boat and would have to spend the night in Denmark. So I took the next train, stopped off to see the second cathedral and then on to Helsingör where I spent the night before crossing to Hälsingborg the next day.

In order to see as much of provincial Sweden as possible on the way to Stockholm I had decided to take the Göta canal boat via Jonköping. Passing through the many locks gave me time to stroll about and see the small towns and the interesting sights and quaint country people.

After two days of this kind I arrived in Stockholm and put up at the Grand Hotel. I was resolved first of all to visit my aunt, my father's older and only living sister, who lived some 25 miles from the city on one of the many lakes that surround Stockholm. I knew very little of the family. My father had kept contact with his sister through occasional letters. But in forty years he had so completely forgotten his native language that he had to have her Swedish letters translated to English. So I knew nothing of her except that she was a widow living alone. I had written her I would come on a certain day to visit her. For the past several weeks I had spent some spare time in trying to learn a little of the Swedish language so that I could make an effort to converse with my kinsfolk. What little I acquired proved quite helpful during my visit. But like my father I have forgotten it completely.

One morning I took a steamer which made its tortuous way through many lakes and canals, stopping frequently to disembark passengers and freight. At first we passed islands or promontories with fine estates and noble architecture. I wondered if my aunt would be living in one of these grand houses and what she would be like. Gradually as we got farther from the city the houses became less ornate and smaller, the scenery more country-like. And finally we drew up to a small dock where my aunt was waiting to meet me. She picked me out at once and made herself known. I don't think I have ever had a warmer, more heart-felt welcome, nor myself had more immediate affection for anyone. She seemed at once to transfer to me all the love she had borne my father, and soon told me he had been her favorite brother, and I sensed at once I might become her favorite nephew.

We walked up the hill to her simple little cottage which she had surrounded with flowers and a small garden. After the evening meal she brought out all my father's letters which she had treasured through the years, even his first to his mother when he went to sea at sixteen, telling how he had saved his money to buy a heavy sweater. She told me how my father, after finishing the country schools, had lived in Stockholm

with relatives and thus received his further education, quite beyond that of his home schools.

After spending the night I went with my aunt back to Stockholm to the home of her son Carl, my cousin. But my aunt was not content for me to stay there and got me quartered across the street. I think she feared I might be corrupted. My cousin had the reputation, I learned, of occasionally or frequently imbibing too much. But he behaved well while I was there. His wife and cousin who lived with them were both likable and cordial. After a few days my aunt bade me farewell and returned home. I never saw her again. But we exchanged letters until her death a few years after my visit.

After the usual tourist sights of Stockholm I went to visit one of my uncles, who had a substantial farm at some distance in the country. I spent one night there and was glad to become acquainted with him, his wife, and two daughters. The younger one (twenty-one) was particularly charming and made it rather plain she would have no objection to living in the United States. But I cautiously made no overtures. She married soon after and I recently had a letter from her son which I will refer to below. I did not visit my other uncle, who also had a farm—but at quite a distance from Stockholm.

After returning to the United States I kept up correspondence with my aunt until her death. I then lost contact with all my Swedish relatives until a few years ago I received a letter from the son of one of my cousins who said his mother had spoken of my visit to Sweden after seeing some account of me which gave my address. She had asked him to write me. It was a friendly letter giving me news of the family and requesting a reply. Promptly I wrote at some length telling of my wife, son and grandchildren and of my various activities since I was in Sweden. Having had no reply I suspect they had not known of my marriage and lost interest in me.

During my visit to Sweden I took advantage of the opportunity to make a side trip to Oslo (Christiania it was then called) and at least have a glimpse of Norway. Even in early September it was getting too cool for a farther northern trip to be pleasant. In the late afternoon in a public garden overlooking Oslo, a light blanket was supplied the guest so that he could wrap up and be comfortable while having tea.

The sight of the city from this height was very impressive, especially the extent of the large docks and the number of Norwegian and foreign vessels indicating the international character of their shipping.

The Norwegian architecture in its sturdy outlines without too much ornamentation gave one the impression of the strong and rugged background of its people. Visits to its library and public buildings, including its cathedral, showed a high degree of cultural development reaching back over many centuries.

I also took boat trips into some of the deep fjords surrounded by steep, towering mountains from which poured the streams that have since been harnessed to give Norway its stupendous supply of water power.

It was with regret that after a week I returned to Stockholm on my way back to Germany where I landed

in the great port of Danzig and continued on through Berlin to Leipzig, back to finish my work in the University.

Bodenstein's specialty was gas kinetics. He had formerly done a brilliant piece of work under Professor Victor Meyer at Heidelberg on the thermal combination of hydrogen and iodine which was accepted for his doctor's thesis and has become an all-time classic. In the meantime it had been suggested that if one knew the rate of combination of hydrogen with each of the three halogens, iodine, bromine, and chlorine, and if each reaction proceeded by the same kinetic law, a relation similar to Ohm's law might exist between rate, chemical affinity, and "chemical resistance," later disproved as will be shown below. Bodenstein wished to complete the series and had already had a candidate work on hydrogen-bromine. He therefore assigned me the hydrogen-chlorine reaction to be attacked by his technique of introducing mixtures of the two gases into a series of hard glass tubes connected by narrow capillaries. After filling, the tubes were separated by sealing the capillaries. Each tube was then heated at a desired temperature for a given time and later opened under water to measure the amount of hydrogen chloride produced.

At once I found that it was impossible to duplicate results by this method. Two tubes, when filled and handled identically, might show rates of combination differing by as much as 12-fold. After a month's experiments we became convinced of their futility and Bodenstein asked me to repeat the hydrogen-bromine thermal synthesis of HBr. He did this because he was doubtful of the results of one of his former students, which had never been published except as a Ph.D. dissertation. The former data seemed to agree with Bodenstein's bimolecular formula within a given series but when the experiment was made at the same temperature with a different initial proportion of H_2 to Br_2 , again a rate constant was attained, but not the same one as before. This did not make sense, so I was given the task of trying to straighten it out.

My first approach was to make a large supply of pure bromine by the Stas method consisting of preparing $KBrO_3$ by recrystallization, converting five-sixths of it to KBr by heating, adding the KBr to the remaining $KBrO_3$ and treating with 50% H_2SO_4 by dropping gradually onto the mixture and distilling to collect pure bromine. It is a slow process, and one day as Bodenstein stopped beside me to watch the liquid fall slowly in beautiful red drops, I grew impatient and facetiously exclaimed: "Well, if making beer were as slow as this, there would be great thirst in Germany!" Then, remembering that his father had made a fortune in brewing beer, I feared he might be offended. But instead, he patiently explained to me that brewing is a slow operation which takes at least six months to make a good product.

This reminds me of another time when Bodenstein came into the room where his private assistant, Dr. Kuhl, and I worked. And this visit did not turn out so well. Dr. Bodenstein had on a new spring suit, worn for the first time—very elegant, evidently quite expen-

sive and one which he was wearing with some pride. He was not talking with me at all but with Kuhl, while standing near a gas burner above which I was heating a large beaker full of hot chromic acid, cleaning some of my hard-glass reaction bulbs for re-use. The hard-glass roughened tips had evidently scratched the bottom of the beaker and weakened it. Suddenly it collapsed and most of the hot, highly corrosive liquid landed on Bodenstein's new suit. This time he did not smile. He was not even patient—but railed at me as cause of the disaster until he realized I was not responsible and could not have known it would happen. After quickly dousing himself with water so he would not be burned, he went home in a taxi and showed up later for his morning lecture in a fine white suit. Mrs. Bodenstein told me later the acidified suit was collected in shreds from the bathtub—a complete loss. I did not feel my responsibility extended to the offer of more than sympathy—certainly not of a new suit, which I knew he could afford much better than I.

This incident recalls one in which I was more personally involved. One of our friends from the United States who owned one of the first autos even in Germany had invited Bray and me to drive with him down to Grimma to visit a friend. I was hurrying to finish a piece of work before getting off. I stood on top of the table to do some glass blowing and inadvertently placed the blast lamp so that it played on a thick glass cylinder containing 30% caustic soda. It immediately broke and spilled the caustic solution. This in itself was not serious, but in my haste I sprang to the floor into the pool of caustic, than which nothing is slicker. I came down on my seat in the caustic. Like Bodenstein I had to don a laboratory coat and ride home to change clothes for the trip to Grimma.

The trip itself was full of incidents. I think it was my first in an auto—certainly of that length, 100 miles round trip. I do not remember the make of the car. There can have been few like it—one cylinder—no fender nor mud-guards, as they were then most suitably called,—solid rubber tires, etc. We wore head gear but the dust was awful on the cobble roads. Fortunately the one cylinder continued to function and we made the fifty miles to Grimma in about two and a half hours. We repaired at once to the city swimming pool and were badly in need of a dip. I remember a diving tower with three stages. I confidently climbed to the topmost, thinking I could, as in my teens, dive from any height. But when I looked down at the pool so far below, my knees seemed to buckle. I tried in vain to get up courage to renew my youth, but finally settled for the lowest board, about 8 feet above the water. And today I shamelessly climb down the ladder and slip into the water without even wetting my head.

The trip back from Grimma began about midnight and took at least five hours. The chaussee had filled up with ox-drawn carts, plodding their slow way into Leipzig with the morning milk supply. The stolid oxen, although they had probably never seen an auto, were not the least frightened, and their drivers walking beside them were equally unconcerned. We had to thread our uncertain way among them in the dust which they and