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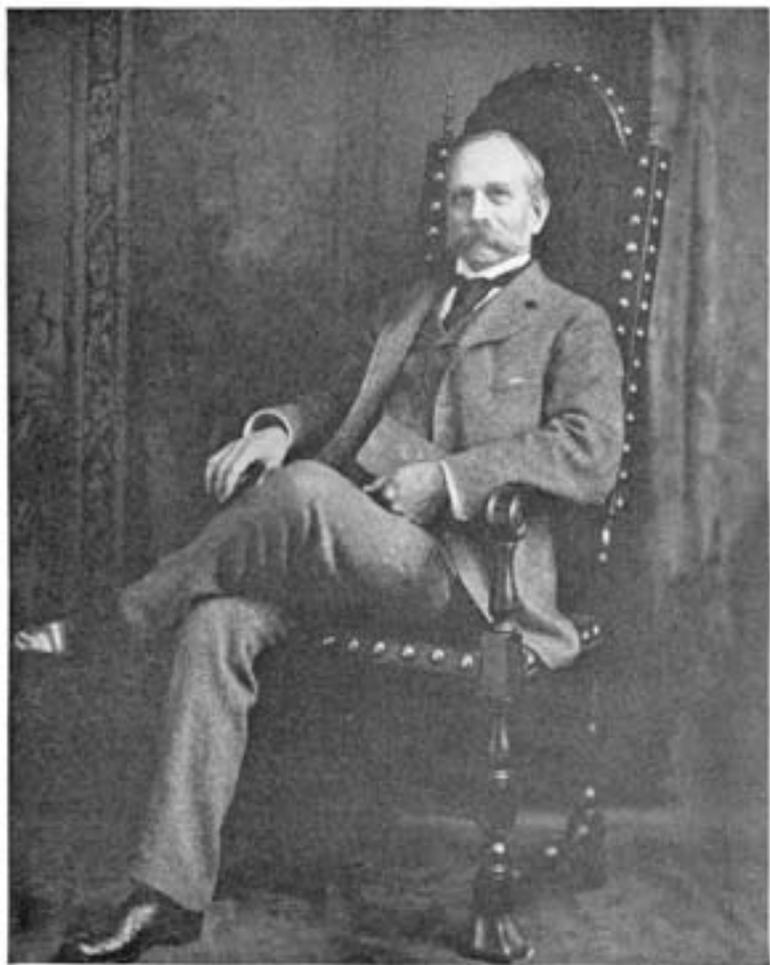
CHARLES FREDERICK CHANDLER
1836-1925

BY

MARSTON TAYLOR BOGERT

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C. F. Chandler

CHARLES FREDERICK CHANDLER

BY MARSTON TAYLOR BOGERT

I. ANCESTRY

The first Chandlers to arrive in this country were William Chandler and Annis, his wife, who came to Roxbury, Massachusetts, from England, in 1637.

On the paternal side, the Chandler ancestors were prominent in Massachusetts life, three successive John Chandlers having been Judges of Probate in Worcester County and Colonels in the Provincial Army. The Revolution broke out during the life of the last of these three, who begged to be permitted to remain neutral, as he certainly could not bear arms against his fellow-countrymen nor could he bring himself to fight against the flag under which he and his forebears had fought. But feeling ran so high that he and eight other royalists were expelled from the country and their property confiscated. This John Chandler settled in London where he lived until 1800, and where he was generally known as "the honest refugee," because he never uttered any complaint nor made any demand for reimbursement for the financial losses suffered. At his own urgent request, his wife and children had remained in America, and one of these children, Nathaniel, who graduated from Harvard College in 1792, was the grandfather of Charles Frederick. It was in this grandfather's home, in Lancaster, Massachusetts, on December 6, 1836, that Charles Frederick was born.

His maternal grandfather was John Whitney, an old Boston merchant, and his grandmother was a daughter of John Slack.

II. BOYHOOD

His father, Charles Chandler, owned a dry-goods store in New Bedford, Massachusetts, which provided a modest living for the family. Their home was located at the corner of Third and Bush Streets, and there Charles passed his early life, in company with his sisters, Catherine and Mary, and his brother, William H., later Professor of Chemistry and President of Lehigh University.

As a boy he attended the New Bedford High School, where he received his first lessons in chemistry. The teacher in this subject, fortunately for the cause of that science, was a young and gifted instructor, Hemingway by name, whose fascinating and inspiring manner of presenting the subject made a wonderfully deep and abiding impression upon the eager plastic mind of the boy. It was the genius of this teacher which planted the seeds that quickly sprouted and grew until chemistry became the over-spreading interest of young Chandler's life.

At about this time, his father was having some difficulty in finding a boy to help in the store, so Charlie volunteered for the job. To his father's objection that it would interfere with his school work, the lad replied that he could get up earlier in the mornings and work after hours in the afternoons. Former store boys had received a dollar a week. Charlie agreed to take the job for fifty cents per week and one cent per package delivered. He arose in the mornings at six o'clock, swept the store, attended to the fires, trimmed and filled the lamps, and looked after the other chores until it was time to go to school. In this way, he earned enough money to build and equip a little chemical laboratory in the attic at home, and there he made olefiant gas from alcohol and carried out other simple chemical experiments, much to his own delight and to the admiration of his schoolmates. One of these experiments, carried out when he was but fourteen years old, was recalled by him a lifetime later when he appeared on the witness stand as chemical expert for John Wesley Hyatt in defense of the celluloid patents. An uncle of young Chandler, having failed in his attempts to make gun-cotton for his rifle, turned over the materials to his nephew, and the boy succeeded where the man had failed. In fact, he both startled and entertained his family and friends with demonstrations of the excellence of his product, for he would place a little of the material with a few grains of black powder on the palm of his hand, or on the parlor table, and then touch off the gun-cotton with a match. The cotton would flash and disappear, leaving the black powder unburned, and flesh or table uninjured. Another source of modest income was the

money received for taking care of the family vegetable garden, at so much per week, payable annually on July 4th.

On Sunday afternoons in the spring and early summer, when the weather was fine, his father often took the children out for a ramble in the woods, where they collected wild flowers and other natural history specimens; or they would go down to the seashore, at what was then known as Clark's Point, and, with a cloth bag tied to the end of a long pole, gather algæ which were brought home, there to be carefully floated in a basin of water, a sheet of paper slipped underneath and the specimen removed and mounted. In this way, an algal herbarium was gradually accumulated.

The summer vacations were spent at his grandfather's place in Lancaster, a locality noted for the variety of fine minerals to be found in the vicinity, such as chialstolites, petalite, spodumene and many others. The librarian of the Public Library there, himself an ardent mineralogist, aroused the boy's interest in this field of natural science and stimulated him to search for these and other rare minerals. The Lancaster Academy offered certain summer courses, and here, when only ten years old, the youngster took his first course in botany, under Miss Emily Shaw, the head teacher, using as textbook Miss Lincoln's "Botany."

The New Bedford whaling vessels often returned in ballast, and not infrequently this ballast contained minerals not found in the neighborhood of their home port, such as flints, geodes and others, and from this source also the boy gleaned for his collection.

At that time, the elder Agassiz used to journey down from Harvard to New Bedford occasionally, to lecture before the Lyceum there on corals, fishes and other zoological topics, and when he had arrived at the advanced age of fourteen, young Chandler was allowed to attend these lectures. The eminence of the lecturer, and the absorbingly interesting way in which the subject was presented, charmed and enthralled the budding scientist in the audience and further fired his imagination with the wonderful opportunities for science in the service of mankind.

After graduating from the New Bedford High School, he continued his studies privately with a friend of the family for nearly a year, to make up the Latin and Greek required for admission to college and which had been neglected in his eagerness for science, and then set out in the autumn of 1853 to secure an education in chemistry.

III. STUDENT DAYS AT COLLEGE AND UNIVERSITY

In those early days, there were but few places in the United States where even an elementary training in this science was obtainable. Chemical laboratories had been established at Yale College and at Amherst. There was a private laboratory in Philadelphia, and one had just been equipped and opened in the Lawrence Scientific School of Harvard College. Chandler decided upon the last as being nearest to his home, and in September, 1853, began the study of his chosen profession under the genial Professor Horsford, who was there only on part time. Quite naturally, he attended also the lectures in geology by Agassiz, whose addresses at New Bedford he remembered with such keen delight.

There were about a dozen students in the chemical laboratory, half of whom were beginners. The textbook used was Will's "Qualitative Analysis," and all the students were set to work on the analysis of the "100 bottles." When this task was completed, Quantitative Analysis was undertaken. The chief difficulty encountered, however, and one which was then quite general throughout the United States, was that there had never been worked out any carefully planned and well balanced curriculum, of a definite number of years, for the training of those who wished to be professional chemists. In fact, at that period there were no lectures on chemistry at all for the students of the Scientific School at Harvard, and such students were not generally permitted to attend the lectures in this subject given by Professor Josiah Cooke to the College students, although young Chandler succeeded in hearing a few of these. They were expected to provide themselves with suitable textbooks and study these at home, while at the Scientific School they were

simply turned loose in the laboratory and supposed to look after themselves.

The inevitable result of this condition of affairs was the exodus to Europe of increasing numbers of the abler and more ambitious American students, the majority of them going to Germany.

While Chandler was at work in the laboratory one day, Charles A. Joy, Professor of Chemistry at Union College, who happened to be visiting Harvard, came in and recounted to the boys some of his experiences as a student at Göttingen and Berlin. With characteristic promptness, Chandler sat down that evening and penned an epistle to Professor Joy telling him that there were a number of the young fellows at the Lawrence Scientific School who were eager to become chemists and would like his advice as to the best way of achieving their ambition. Within a few days he received a lengthy response from Professor Joy, advising him to go to Germany if possible and giving all necessary information as to details.

After a conference with his uncle, Professor Theophilus Parsons of the Harvard Law School, with Professor Cooke and others, as well as with his parents, the latter agreed to send him over, for they wished their boy to have the best education the world could give, although it meant a heavy struggle on their part and the sacrifice of many personal comforts to raise the money required. Fortunately, a friendly neighbor who owned some whaling vessels heard of the contemplated trip and told young Chandler that he had a vessel which would be sailing in a few days for Antwerp with a cargo of whale oil and other freight and that if he wished to go over on her, it would not cost him a penny; and in this way he took his passage across the Atlantic in 1854, without expense and the only passenger on board.

Arrived in Europe, he directed his steps first towards the University of Göttingen. In response to the young man's request, Professor Joy had given him a letter of introduction to Professor Friedrich Wöhler, and Chandler had inquired, with characteristic thoughtfulness and Yankee shrewdness whether he might not supplement this by some gift or offering in recog-

nition of the courtesy he was asking. Joy, knowing Wöhler's love of rare minerals, suggested that he take over with him a few of the less common ones available here and, with the help of his good friend the Lancaster librarian, he gathered a collection of specimens which in those days were very difficultly obtainable in Germany. Wöhler was so delighted, not only with these rare minerals, but with the personal attractiveness and evident earnestness of their bearer, that he took him immediately into his private laboratory where he labored, in the words of this master, "mit meisterhaftem Fleisse," and where he found conditions much more favorable for the study of chemistry as a profession. There were thirty students in Wöhler's laboratory then, thirteen of whom were Americans, and they had the opportunity of attending also lectures in physics by Weber, in botany by von Griesbach, and in mineralogy by von Waltershausen.

In the fall of 1855, he moved to the University of Berlin where, through the influence of Wöhler and his friend, Professor Joy, of Union College, he was fortunate enough to secure the position of private assistant to Professor Heinrich Rose, in whose laboratory his only companion, besides Rose's lecture assistant, Oesten, was Nils Erich Nordenskjöld, later famous as an arctic explorer. He attended the lectures of Heinrich's brother, Gustav Rose, on mineralogy, of Magnus on industrial chemistry, and of Dove on physics.

It was while he was a student at Berlin that Alexander von Humboldt invited him to the Royal Palace at Charlottenburg, where he himself was a guest, and became so interested in the young man that he spent an hour and a half talking to him.

In 1856, he received the degrees of A. M. and Ph. D. from the University of Göttingen. His dissertation was entitled "Miscellaneous Chemical Researches," and was reprinted (in English) at Albany, New York, in 1857, by C. Van Benthuyssen. It was dedicated to his father, Charles Chandler, "As a slight tribute of grateful affection," and consisted of analyses of the following rare minerals: I. Zircon from Buncombe County (North Carolina), II. Saussurite from Zobten, III. Stassfurthite from Stassfurth, IV. Analysis of a rock resem-

bling talcose slate, from Zipser, V. Columbite from Middletown (Connecticut), VI. Columbite from Bodenmais, VII. Tantalite from Chanteloube, VIII. Yttrotantalite from Ytterby, and IX. Samarskite from the Urals. All of these analyses were carried out in the laboratory of Professor Heinrich Rose at the University of Berlin. In addition to these analyses, the dissertation contained also X. Experiments on the cerium metals, and XI. Artificial heavy spar, the work on which was conducted in the laboratory of the University of Göttingen under the supervision of Professor Friedrich Wöhler. Bearing in mind this early training, it is not surprising to find that Chandler maintained throughout his life a keen appreciation of the importance of analytical chemistry and a strong predilection for it, as well as a very lively interest in minerals and mineralogy.

Thus having equipped himself with the best training which the world could provide at that time for those who wished to make chemistry their life's work, he turned his face once more towards the homeland, reaching our shores in the autumn of 1856, where he soon discovered that interest in the subject of chemical education was already increasing and that additional colleges and universities were opening chemical laboratories for practical instruction.

He sought to establish himself in New Bedford as an expert in oil chemistry, but soon discovered that while the whale oil industry occasionally required his services for the analysis of their products, there was not enough business to provide a living and no great promise for the future in that line.

IV. AS TEACHER

1. At Union College, Schenectady, New York

Having heard that his old friend, Professor Joy, of Union College, needed an assistant, Chandler proceeded at once to Schenectady, only to find that there was no budget appropriation for an Assistant in Chemistry, but that there was an item of \$400 for janitorial assistance. Characteristically undaunted, Chandler accepted the job of assistant, with the official rank

of "janitor," and for this munificent salary the new incumbent, in addition to his teaching duties, actually swept and cleaned the laboratory, made the fires, carried the fuel and ashes, and did all the other chores.

It was in January, 1857, that he accepted this job of Janitor-Assistant in Analytical Chemistry on the staff of Professor Joy, and in the spring of that year they opened the new chemical laboratory, with an enrollment of six students in the first class. At that time, Union was one of the largest colleges in the United States, ranking even Harvard in the number of its students.

In April of the same year, Professor Joy was called to the Chair of Chemistry at Columbia College, and Chandler succeeded him at Union, lecturing to 150 seniors, most of whom were older than their lecturer. The late U. S. Senator Warner Miller, of Herkimer, New York, was a member of that class.

Little attention had been paid at Union to instruction in the sciences, so that permission was secured without difficulty for the introduction of new courses from time to time, with the result that he was soon lecturing in general, inorganic, organic, analytical, and agricultural chemistry, blowpipe analysis, mineralogy and geology.

For more than seven years he remained at Union in charge of the lecture and laboratory work in chemistry and other subjects, first as Adjunct, then as full Professor of Chemistry, rapidly building up a strong and influential scientific branch of the college's work.

It was during this period that he collaborated with Dr. D. K. Tuttle of the University of Virginia in the preparation and publication of "A Manual of Qualitative Analysis," which appeared in 1860, and was reprinted by John Wiley & Son, of New York, in 1873. It bore the following dedication: "To Friedrich Wöhler, Professor of Chemistry in the University of Göttingen, this little work is respectfully inscribed by his pupils, the Authors." It employed the old dualistic chemical formulas (e. g. PbO , NO_5 for nitrate of lead, HO for water, et cetera) and was quite innocent of chemical equations of any kind or of theoretical discussions. It was a clear and compact

presentation of the more important analytical tests for the detection and separation of the principal bases and acids, arranged in the analytical groups common to that day, and was doubtless very helpful to the students as a laboratory *Vade Mecum*.

His skill and power as lecturer and teacher were manifest even in those early years and his personal popularity was attested by his election to the Kappa Alpha Fraternity.

Union College possessed an unusually fine collection of minerals which had been brought together by Mr. Charles M. Wheatley of the Wheatley and Perkiomen Mines of Pennsylvania, and had been purchased for the college by Mr. Delavan, owner of the Delavan House, at Albany, N. Y., for \$10,000.

This splendid collection was the lodestone which attracted to Schenectady scientists from all parts of the country, among them Professors Benjamin Silliman the elder and Brush, of Yale, as well as Dr. Thomas Egleston, a mining engineer, of New York, who had received his early training under Professor Silliman and then had studied at the *Ecole des Mines* of Paris.

It was in 1864 that Egleston's visit occurred and that he made the acquaintance of Chandler and began a friendship which lasted until his death. He was somewhat startled to see Chandler conducting commercial assays of ores for silver and gold, and to learn that he gave lectures on the subject also, for he had been under the impression that only the graduates of foreign schools of mines were competent to give instruction in that field. This was one of the considerations which led Dr. Egleston to the decision that Chandler was the man needed to join with General Vinton and himself in the project of establishing a School of Mines in New York City, as a part of Columbia College, and a formal invitation arrived soon afterward.

Chandler was disposed to accept, but many of his friends attempted to dissuade him, arguing that he would be leaving a good position with a promising future and a friendly Board of Trustees, for what was at best an uncertainty, both as to its present success and its future prospects, and as concerned the

attitude of the Columbia Trustees toward him and the undertaking. But, as already mentioned, his old friend, Professor Joy, was now a member of the Faculty of the School of Arts, or academic department of Columbia, and naturally he was one of the first with whom Chandler discussed the matter, to learn how Joy would regard his coming to Columbia and to prevent the birth of future misunderstandings and possible friction. Joy readily admitted the possibility of developing at Columbia the kind of school which Chandler and his associates had in mind, but was quite frank in acknowledging the fear that the presence of two professors of chemistry at Columbia might lead to some conflict of authority, overlapping of work, or disturbance of the existing courses in chemistry, "unless," he added to Chandler, "that other professor were you, in which case I would have no fear of such interference."

Thus reassured, Chandler accepted the appointment, and he and Joy worked together in friendship and harmony until the death of the latter resulted in the transfer of his courses also to Chandler.

To the credit of Chandler's deep sense of patriotic duty be it said that he delayed his departure from Schenectady until after Election Day, 1864, so that he might cast his vote for Abraham Lincoln.

In these days of prohibition agitation, it is worth noting that one of his earliest contributions was "An investigation on the formation of alcohol during fermentation," which was published in "Biblical Temperance," by E. C. Delavan, Esq.

The influence of his training in Germany for his Ph. D. degree was manifested in the immediately succeeding years by his continued attraction to the field of analytical chemistry while he remained at Union, during which period he published the following papers:

Analysis of Dolomite. In the Report of the Geological Survey of Iowa, by James Hall and J. D. Whitney; Albany, 1858.

Examination of interesting urinary calculi, included in a report of Dr. Alden March. Printed in the Annual Report of the New York State Medical Society for 1858.

"Analysis of Datolith." *Am. Jour. Sci.*, 28, 13 (1859).

“A Manual of Qualitative Analysis,” by D. K. Tuttle, Ph. D., and C. F. Chandler, Ph. D., 1860; reprinted in 1873 by John Wiley & Son, New York.

A new metal in the native platinum of Rogue River, Oregon; *Am. Jour. Sci.*, 1862, 351.

Analyses of one blende, two smithsonites, one cerusite, and with J. P. Kimball, analyses of nine shales, five galenas and one dolomite; in the Report of the Geological Survey of the Upper Mississippi Lead Region, by Professor J. D. Whitney, Albany, 1862.

2. At Columbia University, New York, New York

School of Mines.—Fortunately for the School of Mines project, Columbia had just installed, in 1864, Dr. Frederick Augustus P. Barnard as its president. Himself a distinguished scientist and one of the founders of the National Academy of Sciences, President Barnard immediately welcomed the idea of such a scientific school for Columbia and followed with sympathy and understanding the growth and development of the venture.

At the time of Dr. Chandler's move from Union to Columbia College, there were but few technical schools in the country and no mining schools, and many regarded this project of founding a School of Mines in New York City as decidedly visionary and unpromising. Nevertheless, the three professors immediately concerned were so enthusiastic on the subject and had such unbounded faith in its ultimate success, that they agreed to undertake the work without any definite or guaranteed salary whatever, other than the fees received from such students as might register for the course. The timid and those without vision regarded this as very foolish on Chandler's part, for he was now married, and there seemed little likelihood that his share of the students' fees would be sufficient in amount to support a family in New York.

George T. Strong, William E. Dodge, Jr., and several other good friends provided a total of about \$5000 to equip the laboratories. A fine cabinet of minerals was donated by Gouverneur Kemble, and President Barnard, Dr. Torrey and other

Columbia trustees encouraged the enterprise in every way possible.

Some vacant rooms in the basement of the old college building on Madison Avenue and 49th Street were fitted up as laboratories and accommodations there provided for twelve students. The new school opened its doors on November 15, 1864, and twenty-four students presented themselves for admission on that date. Chandler often told, in his own inimitable way, how he used to open the laboratory at seven A. M., start the fire to warm it up, sweep and clean the room, and do all in his power to make the place as attractive as possible and the lot of the students a pleasant one. It was inevitable that there was passed on to these students at the same time some of his own overflowing energy and enthusiasm.

The school was a phenomenal success practically from the beginning. During the entire winter, carpenters and plumbers were kept busy installing new desks for new students and the number of students for the first year finally rose to forty-seven. During the following vacation a large four-story factory building on the campus, formerly used for the manufacture of sash and blinds, was placed at the disposal of the school, and sufficient funds provided to equip it with suitable laboratories, lecture rooms, et cetera. Accommodations were arranged for seventy-two students. Eighty-nine registered for the second year and the school was thronged. The success of the venture being so great and so obvious, the trustees finally arranged to place it on a substantial basis as an integral part of the college work. Professor J. S. Newberry was called to the chair of geology, relieving Chandler of this subject, and a complete faculty of professors and junior officers was established. A new building was erected especially for the school, the plans for which were drawn up by Dr. Chandler himself. It was designed to accommodate one hundred and fifty students and was soon overflowing.

The school continued to prosper and its field to unfold and expand until what began as the School of Mines in a few basement rooms with twenty-four students, had become at the time of Chandler's death a whole group of great technical

schools (Mines, Engineering, Chemistry, Architecture and Pure Science) with many thousands of students and six splendid buildings and with a reputation not merely national, but international.

Although at first appointed Professor of Geology, Analytical and Applied Chemistry and Assaying, Dr. Chandler soon was made Dean of the school and became its leading figure, all-pervading genius and chief driving force. The school had its own Bursar (Mr. Fisher) and its own Registrar, both of whom served under the immediate personal supervision of Dean Chandler and formed part of his office staff. For thirty-three years he served as Dean, and of the many able and devoted men who built their lives into this splendid institution, none contributed so much as he. In 1897, when the University moved to its new site upon Morningside Heights, Professor Chandler resigned his post as Dean, but continued in charge of the Department of Chemistry as the "Mitchill Professor of Chemistry" until his retirement from active service, July 1, 1911. In the early days, he lectured upon all branches of chemistry, both theoretical and applied, but as the staff grew in numbers he transferred to his younger associates most of this so that during the later years of his professorate his lectures were mainly upon general and industrial chemistry.

It was largely through Dr. Chandler's personal solicitation and influence that the Havemeyer family generously provided the funds for the erection of the splendid chemical building which bears their name. Before drawing up the plans for this building, Dr. Chandler made a special trip to Europe for the purpose of examining the construction of the leading chemical laboratories there, with the result that Havemeyer Hall, when finally completed, embodied the best that was then known concerning laboratory construction, and was universally regarded as the finest chemical laboratory in the United States.

Under date of January 3, 1910, Professor Chandler addressed the following communication to the President of Columbia University:

“MY DEAR DR. BUTLER:

“After mature deliberation I have decided that it is much better to withdraw from active service while one is in the full enjoyment of health and strength, rather than to wait until the infirmities of age make it evident to all that one has outlived his usefulness.

“This is my forty-sixth year of service at Columbia, and my fifty-fourth year of college teaching, and I feel that I have had my fair share of this most agreeable life.

“I wish to take this opportunity to express my gratitude to you and the other members of the Board of Trustees and their predecessors for the confidence with which they charged me from the outset with the various duties of instructor, dean, bursar and registrar, and the generous support which I have always received from them.

“I would respectfully request that I may be relieved from the active duties of my professorship at the end of the present academic year.

“Very respectfully yours,

“CHARLES F. CHANDLER.”

The minute adopted by the Trustees in accepting this resignation, after reciting briefly his career, concludes with the following: “Professor Chandler will carry with him into his retirement the affectionate regard and esteem of two generations of students as well as a host of colleagues on the teaching staff of the University. The Trustees record their grateful appreciation of this long and generous career of devoted service.”

He was granted a year's leave of absence on full pay, and appointed Emeritus Professor of Chemistry to take effect upon the date of his retirement, July 1, 1911.

The Columbia Alumni established a Chandler Lectureship and Chandler Medal at Columbia, and gave a huge banquet in his honor. On that occasion, President Butler spoke with deep feeling of Dr. Chandler's approaching retirement and paid a glowing tribute to the man and his work. “In the University,” said he, “as in the nation, we mark most of all, and we cherish beyond all else, the coming and the passing of personalities.

No substitute has been found in specialized scholarship or in technical skill or in acquired art for those precious qualities of mind and heart that make a man a great teacher to generations of students. . . . It is by the coming and the passing of the services of these personalities that we mark the real history of Columbia, and we shall be poor indeed, no matter how magnificent our site, how splendid and how numerous our buildings, how large our endowments and how great our enrollment, we shall be poor and wretched indeed when personalities—great human personalities—are no longer found in Columbia's life. . . . The world is full of chemists, but there are not very many Chandlers. . . . I know that we cannot get on without personality, and I mark with sadness and sorrow the retirement from active service of a personality which has been familiar to me for thirty-two years and which has always been full of charm, abounding in loyalty, generous in doing for Columbia and the public, and anxious to find new ways in which to serve. I call that a great academic and a great human service and am glad to have had this personality on the proud rolls of Columbia."

President Butler's Annual Report of November 7, 1910, contains the following additional reference to Dr. Chandler: "To his teaching power as well as to his effective and conscientious service as administrator, the Department of Chemistry and the School of Mines, to which it primarily belonged, owed almost everything for many years. Professor Chandler has long been a point of contact between the University and the public, between science and industry and the public health. His career is unique of its kind, and we shall not soon look upon his like again."

In commenting upon the same subject, the Columbia Jester, a student publication, in its issue of January 20, 1910, has this to say as indicative of the students' attitude: "Year after year he has taken the entering classes by the hand and has led them through a course of Chemistry, Ethics and Humor, so cleverly combined that it has made men of them. It is a striking tribute to his popularity that the class never fails to stamp their ap-

plause when he enters the room. It is a striking tribute to his splendid, practical ideas of health and to his wholesome, hearty, jovial nature that he is still only a boy, and with a mind and body sound enough to do all that a boy can do. . . . We who have had the last chance to see him and hear him in the midst of the labors which were truly play to him, should be both proud and happy that this opportunity has not been missed. Truly do we fear for the future Freshmen who will not have him as a guiding spirit. And though we lament that so intimate and cherished a connection is finally to be severed, we rejoice that our last picture of him is one of a man hale and hearty, in the full possession of all his faculties and talents, working up to the last moment at his life's profession, and yielding finally to younger hands so that he may spend his remaining years as overseer of the work he carried to so high a development."

I first became acquainted with Professor Chandler in 1888 when, as a student in the Columbia College School of Arts, I attended his lectures in general chemistry.

The College then occupied the block bounded on the west by Madison Avenue, on the north by Fiftieth Street, on the east by the tracks of the New York Central and New York, New Haven and Hartford Railroads, and on the south by Forty-ninth Street. Across the railroad tracks were the buildings and grounds of the Woman's Hospital. Across Forty-ninth Street was "Fritz's" bar and lunchroom. At Forty-ninth Street and Fifth Avenue was the Hotel Buckingham, familiarly known as the "Buck," a favorite hang-out for the students.

The Forty-ninth Street front of the College block was occupied by Hamilton Hall, containing the offices and classrooms of the academic department, or School of Arts, as it was called, with the office of President Barnard on the second floor, and the students' locker-room in the basement, presided over by that ubiquitous and kindly old proctor, Stephen Weeks. Columbia students of more than one generation will recall "Stevie," with his dark suit and plug hat, his spare figure stooping somewhat in the later years of his long service, as he moved

from place to place to see that proper order and discipline were maintained among the students.

On the Forty-ninth Street side was the new library building, where Melville Dewey, of "Dewey-decimal" fame, held sway, until he withdrew and was succeeded by Librarian Baker.

The old asylum building, popularly known as the "Maison de Punk," occupied part of the Fiftieth Street front just north of the library. Adjoining the Maison de Punk on the east was another old building, the upper floor of which was used for the Chapel; Rev. Mr. Duffy was Chaplain at the time. This old building was so close to the library that at one place the passage between the two was so narrow students could go through only in single file. It was therefore dubbed the "Pass of Thermopylæ" and many were the scrimmages staged there.

The School of Mines building filled the northeast corner of the block. It was L-shaped, one leg running along Fiftieth Street and the other along the railroad tracks on the east side of the block. Inside of this angle formed by the two wings of the School of Mines building the Power House was situated, and south of it, on the Forty-ninth Street front, between the east end of the library and the south end of the east wing of the School of Mines building, was the Administration Building, where were the offices of the Superintendent of Buildings and Grounds and others. A footpath ran from Forty-ninth Street straight up to the main door of the School of Mines building, and morning and evening Dr. Chandler could be seen going in or coming out, with his ever-present market basket on his arm.

Dr. Chandler was then Dean of the School of Mines, as well as its Professor of Chemistry. His office was on the ground floor just to the left of the entrance. Here his faithful aid, George Fisher, performed for many years the duties of Registrar and Bursar.

Most of Chandler's lectures were given in the large lecture room on the ground floor at the south end of the east wing of the building. In these lectures he was assisted by Dr. Louis H. Laudy, his "fidus Achates." Dr. Laudy was associated with him in the work for so many years that he became a sort

of tradition. Few knew just when he first entered upon these duties, so that it was generally said that Chandler must have graduated "summa cum Laudy."

Like most great teachers, Dr. Chandler had a keen sense of humor and his lectures were always enlivened by witty stories, timely jests, waggishness, puns and amusing anecdotes.

When discussing photographic and photo-mechanical processes, on one occasion, he produced a picture of a very attractive young lady, which he said was Titian's daughter, Polly, claimed to be the first politician.

Dr. Edward Gudeman of Chicago, who was his assistant for a time, recalls the following. Dr. Chandler, during his lectures upon specific gravity, was endeavoring to bring home to his class the fact that substances lighter than water not only would float but also possessed a buoying capacity equal to the difference between their weight and that of an equal volume of water. To illustrate, he recalled the case of the Baptist minister who was considerably embarrassed by his lack of success in trying to immerse completely an elderly and somewhat corpulent sister, until he learned from one of his elders, who was the physician of the lady in question, that she was buoyed up by gas in the stomach and a wooden leg.

Once when called upon unexpectedly by the chairman of a meeting, he was enjoined to speak with telegraphic brevity. To which he replied that while the body of the telegram was usually ten words, the address was always unlimited.

On another occasion he was being crossexamined in a lawsuit by a self-confident and very obese lawyer who, wishing to impress his man at the outset, said to him that whenever he was expected to examine a so-called chemical expert he always took the precaution of eating one before breakfast. "Which explains," said Dr. Chandler, "why you appear to have more brains in your stomach than in your head." After which encounter, the legal luminary handled the chemist somewhat more gingerly.

The late Senator Roscoe Conklin, who frequently stood with his hands in his pockets, introduced Dr. Chandler at a certain meeting as that "*rara avis*—a doctor who takes his own medi-

cine." Dr. Chandler retorted that he was proud to be introduced "by that eighth wonder of the world—a lawyer with his hands in his own pockets."

To illustrate the difference between politeness and tact, he used to enjoy telling the story of the week-end guest who, finding the bathroom door unlocked, started to enter, when he suddenly saw his hostess about to step into her bath. Backing out hurriedly, he said, "Excuse me, sir," The "Excuse me," said Chandler, was politeness, but the "sir" was tact.

Dr. Ellwood Hendrick tells the following amusing anecdote: "Dr. Chandler was an intimate of the late Henry H. Rogers, the guiding spirit of the Standard Oil Company. Wishing to play a joke on the doctor, Mr. Rogers once sent him a common towel which had been stained with greased ink, requesting him to remove that 'damned spot.' The request was accompanied by a long letter, which rehearsed the doctor's attainments, crediting him with every scientific achievement of the century, not only eulogizing his supremacy as textile, oil and color expert, but citing him as the only living authority in this field. It was requested that the work be completed and reported on within twenty-four hours. Dr. Chandler turned the matter over to his assistant with the suggestion that a pair of scissors might do the work.

"In twenty-four hours Mr. Rogers received the towel, the spot having been cut out and enclosed with it, and a detailed report which called attention to the marvelous rapidity with which the work had been executed, the monumental dexterity that had not only rid the towel of the blemish but had also preserved the spot intact. In view of this, it was stated, the bill enclosed was most reasonable, including only the cost of chemicals and apparatus employed, time and service not being charged for. The assistant signed the letter with the doctor's name, adding his own initials. In a few days the assistant was summoned to the professor's office to receive a cheque for a respectable sum of money from Mr. Rogers, with a letter which said that the assistant and not the spot should be damned. Later on he remarked that Professor Chandler trained his assistants well."

As an educator, Dr. Chandler possessed all the finer attributes of the great teacher. Imbued with a deep sense of his responsibilities to his day and generation, a keen appreciation and penetrating vision of the services which the scientist can contribute to the progress of civilization; self-forgetful and generous to a fault; with an abiding love for his fellow-man, an ability to see and understand the other's point of view, and a spirit of justice and fair dealing to which no one ever appealed in vain; he had a remarkable gift of transmitting across the lecture table to his students unconsciously, without preachment or pedantry, his own high ideals of the rôle of the scientist and the citizen. No one ever attended his lectures without recognizing the beneficent influence that radiated from this unusual personality. The student received not only an enticing introduction to the fascinating field of chemistry, but had before him constantly the potent example of a life really worth while and what that signified.

Like all great teachers, Dr. Chandler was an enthusiast for his subject. To him nothing was more wonderful, more beautiful, or offered greater opportunities for useful service than his beloved science of chemistry, and until his death he never wearied of talking about it or of listening to others who were discussing it. Time and again, in the later years of his life, I have heard him say to various gatherings of chemical students that what he envied them more than anything else was the many years they had ahead of them to devote to chemistry, and he would then proceed to picture to them, with so much fire and conviction, the delights of such a career, that they all went home with a new and heightened estimate of the dignity and importance of the work of the chemist.

His generosity to his students, particularly to those who found it difficult to meet the cost of tuition, was often remarked, but only those in his closest confidence actually knew how frequently these loans and advances were made. One instance will suffice for illustration.

I was standing by his side in his office one day some thirty years ago, and while he was opening his mail we were discussing matters of mutual interest. His correspondence was always

very heavy and as he opened the letters and spread them out on top of a pile which was already many inches high from the accumulations of previous days, he remarked that his letter pile was much like that of Robert Louis Stevenson, who referred to it as "a veritable quicksand, for anything placed on top of it slowly sinks down and disappears, never to come up again." As our conversation continued, he opened another letter and a slip of paper fluttered to the floor. I picked it up and handed it to him, whereupon he passed it back to me with the request that I examine it. It proved to be a check to his order for \$500 from someone I did not happen to know. In reply to my look of inquiry, he said, "That check is from one of my old boys. When he came here as a student many years ago, he had great difficulty in raising enough money to pay his fees, so I loaned him \$500. I heard from him occasionally after his graduation, but he was still having a struggle to make both ends meet and I came to the conclusion that there was little chance of the repayment of the loan. It is now several years since his last letter and I had about forgotten the incident, but if you will read this communication you will find that the writer says he is at last beginning to make his way and that the \$500 forwarded is the first that he has been able to save." How many other students were helped financially by Dr. Chandler probably will never be known, for he never kept any careful record of these accommodations and was the most lenient of creditors.

His generosity even went so far as to assist his university in the purchase of certain of the equipment for the new Havemeyer Hall laboratories. Part of this equipment consisted of many hundreds of sets of laboratory reagent bottles, with beautifully etched and painted labels which were imported from Germany. When these arrived, Dr. Chandler was much distressed to learn that the cost of Havemeyer Hall was exceeding the estimates and that there might be no funds available for the purchase of these laboratory reagent bottles. He was telling me about this trouble a day or two afterwards and said that he had decided to offer to pay for these bottles himself. "I have," he said, "five thousand dollars in bonds which I put

away for my old age, but I am offering them to the university in order that our laboratories may have this beautiful equipment." Whether Columbia accepted this sacrifice or not, I never learned, but it is to be hoped that it did not.

His services as chemical expert were in such demand that his contacts with chemical industry were numerous and often exceedingly important.

Largely as the result of this work, he accumulated a collection of chemical products of all kinds which grew so rapidly that it soon became necessary to house it in a separate room, and thus began Columbia's great Chemical Museum, which now bears the name of its founder. By purchase, as well as by gift, this collection was augmented until it was universally recognized as the largest and finest museum of the kind in the world, and a most valuable adjunct to the lecture courses. For many years it was unique, and it still remains one of the world's great collections. There the visitor will get a very vivid impression of the extent to which our modern civilization is dependent upon the science of chemistry.

With the death of its originator and patron saint, its growth ceased, partly because his successor as executive officer of the Department of Chemistry, Alexander Smith, was never greatly interested in it, partly because space and funds were not available for its development, and partly because changes in the organization of the work and in the methods of instruction rendered such a museum less necessary. Further, it has been found in several instances that small and highly specialized collections are often more useful when kept in association with the particular laboratories where such material is of immediate interest, than when maintained as part of one all-inclusive museum.

3. At the New York College of Pharmacy

Professor Chandler's educational activities were by no means limited to the Columbia School of Mines. Another New York institution which owes largely to him its present proud position is the New York College of Pharmacy.

This was organized March 18, 1829, at a meeting of leading pharmacists and wholesale druggists, but did not secure a charter until April 25, 1831. During its early years, it led a rather precarious existence and in 1866, Professor Peter W. Bedford of its faculty sought Dr. Chandler's assistance in the development of its work. At the time, the College occupied a single corner room in the second story of the old building of the University of the City of New York on Washington Square, and had an enrollment of thirty-two students. It is typical of the man that, in determining upon his answer, the only question he asked himself was whether or not it was to the interest of the community that he undertake it. It did not occur to him to inquire "What is there in it for me?" He said to himself, to quote his own words, "We must have apothecaries; we can't live without them, and they must be educated, for our lives are in their hands." He therefore accepted the invitation and lectured three evenings a week throughout the winter year after year, until some of these lectures could be transferred to new members of the staff. At first he received \$400, and provided apparatus and lecture material himself. The faculty then was composed of Professors Mayer, Bedford and Chandler.

In 1878, the College had outgrown its one room in New York University, so it purchased the old Morton Memorial Church at 209-211 East Twenty-third Street, and remodeled it to adapt it to the new needs. In these more commodious quarters the College grew so rapidly that in 1892 it purchased the plot at 115-119 West Sixty-eighth Street, and erected thereon the fine modern fire-proof structure which still stands as an enduring monument to the untiring zealous efforts of Dr. Chandler and his associates, Trustees and Faculty, and to the loyal support of the druggists of New York City. For many years, Dr. Chandler served not only as a member of the Faculty, but also as Vice President and finally as President, which latter position he was occupying when he received a letter from President Butler, in 1905, inviting the College of Pharmacy to become affiliated with Columbia University. This invitation was accepted by the College, and it has since been the College of Pharmacy of Colum-

bia University. Thus was justified the faith of those who in the days of small things labored so faithfully and self-sacrificingly.

That work of this kind is not without rewards which far transcend any financial remuneration is strikingly illustrated by the remarks of Dr. Chandler at a banquet tendered him by the officers, trustees, faculty and alumni of the College upon his retirement from active duty in 1910: "Wherever I see the green and red lights of the apothecary in New York, there I know I have a friend. I never go into a drug store but that some one comes up and tells me he was of the class of such and such a date, or is possibly a student still. Sometimes they are boys but newly matriculated at college. Sometimes they are old gray-haired men whose stooping shoulders and faltering footsteps make them seem older than I myself; always they are friends. This has been my highest reward, this has been my most cherished compensation. The feeling that I may have helped in the upbuilding of the institution, have aided in the formation of the characters of the rising generation of pharmacists and that this help has brought me the friendship of my students, is a source of pride and will remain a source of pleasure so long as I live."

4. At the College of Physicians and Surgeons

Another New York educational institution in whose development Dr. Chandler was enlisted not many years after his arrival in New York, and where he served with his customary distinction and success, was the New York College of Physicians and Surgeons, which later became the School of Medicine, or College of Physicians and Surgeons of Columbia University.

In 1872, he was appointed Adjunct Professor of Chemistry and Medical Jurisprudence under Professor St. John, and on the death of the latter in 1876 succeeded to his chair, lecturing on physics and chemistry every afternoon from 5 to 6 o'clock. This chair he held for over twenty years, retiring in 1897.

His voice was always raised there in favor of a more thorough scientific training for medical men and he was largely instrumental in having adopted the present four-years required course.

His work there, as was the case always, was progressive and constructive, and this great school owes no small part of its present international reputation and prestige to what Dr. Chandler built into it.

Eleven of the twenty-five years during which Professor Chandler taught at the College of Physicians and Surgeons were coincident with his presidency of the New York City Board of Health, and his students had the unusual opportunity of listening to lectures upon modern sanitation and hygiene by the man who was himself making the history of these subjects for their city.

V. AS AUTHOR AND EDITOR

As an author, Professor Chandler has a long list of publications to his credit, embodying the results of research and invention, official reports, public addresses, sanitary regulations, analyses of waters, minerals, milk, et cetera, a survey of which shows at once the wide range of his interests and the versatility of his genius. These will be found in the bibliography with which this biography concludes.

As an editor, he supplied for several years an American Supplement to the monthly edition of the *Chemical News* (of England); and, in July, 1870, in association with his brother, Professor William H. Chandler, of Lehigh University, founded the *American Chemist*, and continued its publication until April, 1877, when it was given up, to make way for the *Journal of the American Chemical Society*. Another editorial task, and one which proved most laborious, was that of chemical editor for "Johnson's Encyclopedia."

VI. AS BUILDER OF AMERICAN CHEMICAL ORGANIZATIONS

I. The American Chemical Society

The founding of our great national organization of chemists, the American Chemical Society, came about in the following way. (*American Chemist*, 5, 35-114 (Aug.-Sept.) 195-209

(Dec.) (1874); 6, 401-406 (May) (1876); "Proc. Am. Chem. Soc.," 1, 3-18 (1876); and "The Organization of the American Chemical Society," by William H. Nichols, in "A Half-century of Chemistry in America, 1876-1926. An historical review commemorating the fiftieth anniversary of the American Chemical Society," edited by Charles H. Browne, Philadelphia, Sept. 6-11, 1926, Chapter II, pages 11-16).

At a meeting of the Chemical Section of the New York Lyceum of Natural History, May 11, 1874, President J. S. Newberry in the chair, the subject of a Chemical Centennial was discussed and, on motion of Dr. Henry Carrington Bolton, the following resolutions were adopted:

"Whereas the discovery of oxygen by Joseph Priestley on August 1, 1774, was a momentous and significant event in the history of chemistry, being the immediate forerunner of Lavoisier's generalizations on which are based the principles of modern chemical science; and

"Whereas a public recognition of the one hundredth anniversary of this brilliant discovery is both proper and eminently desirable; and

"Whereas a social reunion of American chemists for mutual exchange of ideas and observations would promote good fellowship in the brotherhood of chemists: therefore

"Resolved that a committee of five be appointed by the chair, whose duty it shall be to correspond with the chemists of the country with a view to securing the observance of a centennial anniversary of chemistry during the year 1874."

President Newberry subsequently appointed the following committee: Dr. H. C. Bolton, chairman; Professor C. F. Chandler, Professor Henry Wurtz, Professor A. R. Leeds and Professor C. A. Seeley, by whom the Centennial was organized and the call issued. Acting upon the suggestion of Professor Rachel L. Bodley, of the Woman's Medical College of Pennsylvania, the meeting place selected was at the grave of Priestley, Northumberland, Pennsylvania, and there, on July 31 and August 1, 1874, the chemists of the country assembled and organized by the election of Professor C. F. Chandler as President of the Centennial.

This is not the place to describe in detail this memorable gathering, which marked the transition from the earlier epoch of American chemistry to the present one which is characterized by the cooperation of American chemists in great national societies in place of the former local or regional organizations.

After this Centennial Meeting of 1874, the project of establishing a chemical society was often broached by many of the New York chemists, and it was finally determined to call a meeting for the purpose. As was to be expected, Chandler immediately became the recognized leader of the movement and, under date of January 22, 1876, a self-constituted committee, of which he was the guiding genius and spokesman, sent out a circular letter to all chemists in New York and vicinity inviting cooperation in the formation of a local chemical society, and submitting a tentative draft of a constitution and by-laws for an American Chemical Society. Replies were received from forty or more assuring the Committee of their interest and support. Encouraged by this result, the Committee decided to attempt the organization of a national, instead of a purely local society, and to this end sent out a second circular letter to a much larger and more widely distributed list of chemists.

The response to this circular was so gratifying that the Committee issued a call on March 27, 1876, for an organization meeting, which was held on Thursday evening, April 6, 1876, in the lecture room of the University Building, New York College of Pharmacy, at the corner of Waverly Place and University Place, New York, with thirty-five chemists in attendance and with Professor Chandler in the chair, and the American Chemical Society was born.

Naturally, there was some opposition to the launching of this new undertaking. It came partly from those interested in the Chemistry Section of the New York Academy of Sciences, formerly the New York Lyceum of Natural History, and partly from those chemists who were ardent supporters of the Chemistry Section (Section C) of the American Association for the Advancement of Science. Then, too, there was the usual quota of timid and conservative souls who feared for the success of the venture and dreaded to take the plunge. These

various opponents questioned the need of such a society, either locally or nationally, because of the existence of the chemistry sections mentioned, doubted the ability of its organizers to enroll many members, to secure a sufficient number of meritorious papers for the meetings or funds for publication and general expenses, and were inclined to view the entire movement as inopportune and unnecessary.

Fortunately these conservatives were decidedly in the minority. The progressives rallied overwhelmingly to Chandler's support, and when the motion to proceed with the organization was put there were but three dissenting votes. A Constitution and By-laws were adopted and the organization completed by the election of officers and various committees. Dr. John W. Draper was elected President, and Chandler one of the vice presidents.

Among those most active in the support of this venture was another of the great builders of American chemical industry, William H. Nichols, who at that time uttered the following prophecy: "We do not come here expecting to find a society ready formed, with a library and a fine building; those will come in time. There is enough enthusiasm among the chemists to give us them by and by." Two of the men largely responsible for the fulfillment of that prophecy were Chandler and Nichols, the former of whom was President of the Society in 1881 and 1889, and the latter in 1918 and 1919.

Chandler was thus the father of the American Chemical Society. The handful of members enrolled in its first year has grown to over seventeen thousand, and this vast membership, far exceeding that of any other chemical organization in the world, is drawn not only from our own land, but from all quarters of the globe. The income of \$1780 of 1876 has swelled to an annual budget of approximately \$500,000. There are now more than twice as many Local Sections as there were chemists at the organization meeting. To take the place of the *American Chemist*, the Society publishes three great journals, *Chemical Abstracts*, *Industrial and Engineering Chemistry* and the *Journal of the American Chemical Society*, which circulate among all the civilized nations of the world.

2. The Chemists' Club of New York

Although Professor Chandler was not the originator of the movement which led finally to the establishment of the Chemists' Club of New York, he had always spoken in favor of such an affiliation of our New York chemists and was the unanimous choice of the membership for the Club's first president. Without his wise and experienced guidance, his unquenchable optimism and his financial assistance, the Club would have had a hard struggle for existence. Through fair weather and foul, he was its outspoken and undismayed champion.

VII. AS INDUSTRIAL CHEMIST

Chandler was one of America's first great industrial chemists, and aided and enriched almost every chemical industry which this country supported during the two decades following 1866.

His services were always in demand by those great corporations whose manufacturing processes were based upon chemistry, for he had not only a thorough knowledge of that science, but also an alert mind stored with original and valuable ideas. He was generally recognized as the highest authority in his day in this country in the field of industrial chemistry. While other able and eminent chemists had their single specialties, Chandler was called a specialist in all branches, and was particularly expert in sugar refining, petroleum refining, the manufacture of illuminating gas, photo-mechanical processes, and calico printing. He served as chemist for the New York Gas Company, and for the New York Steam Sugar Refining Company, as consultant for the Standard Oil Company and for various other great business interests.

He had no rival to the title of dean of the industrial chemists of the United States. Even at the ripe age of 83, he labored daily in the offices of the Chemical Foundation, Inc., helping to prepare our country for the international chemical competition he felt certain that we would have to face.

One of his first and far-reaching contributions to the progress of chemical industry was the invention of the system of Assay Weights, as outlined in his article entitled "A new system of

assay weights," which appeared in the American Supplement to Chemical News of August, 1869. Although this system has been for years the one used by all assayers and metallurgists throughout the civilized world, it is safe to say that but few of them are aware of the fact that it was Chandler who introduced it, with the aid of Becker & Son who manufactured the weights according to his specifications.

His observations and belief in the possibilities of the Castner Process for the production of caustic soda by electrolyzing sodium chloride in a "tipping cell" with a flowing mercury cathode, were communicated to the Mathieson interests and they later, acting upon his advice, purchased the American patent rights and established in this country a great electrochemical industry at Niagara Falls, New York.

Water was one of the subjects to which he early turned his attention, and complete analyses were made of nearly all the famous Saratoga Springs waters. His first important commission was the investigation of boiler incrustations and feed waters for the New York Central Railroad Company, which investigation was begun in 1863 and completed in 1864 at the School of Mines.

His first publication after coming to New York was "Report on water for locomotives and boiler incrustations, made to the President and Directors of the New York Central Railroad Company, including analyses of waters between Albany and Niagara Falls, and analyses of incrustations." It was an octavo pamphlet of thirty-five pages, and appeared in 1865. It proved his interest in the practical problems of the community, and was his first contribution to the important field of water supply, in which he soon became one of the country's recognized leaders.

Other papers which indicate his activity in this same field were the following:

Sanitary qualities of the water supplies of New York and Brooklyn. Report to the Metropolitan Board of Health, 8 vo., 9 pp., New York, 1868.

Analysis of the Ballston Artesian Spring (with E. Root); *American Supplement to the Chemical News*, 1869, 54 (July).

Analyses of six new mineral springs at Saratoga; *American Supplement to Chemical News*, 1869, 194 (Sept.).

Analysis of the Saratoga Seltzer Spring (with Paul Schweitzer); *American Supplement to Chemical News*, 1869, 395 (Dec.).

Report on the water supply of New York and Brooklyn, made to the Metropolitan Board of Health; 8 vo., 9 pp., New York, 1870.

Analyses of the Chittenango Sulphur Springs, Madison County, New York; *American Supplement to the Chemical News*, 1870, 221 (April).

Saltiness of the waters around the island of New York; *American Supplement to the Chemical News*, 1870, 225 (April).

Analysis of the Geysers of Saratoga (with F. A. Cairns); *American Supplement to the Chemical News*, 1870, 373 (June).

Lecture on water; delivered before the American Institute; 8 vo., 49 pp., Albany, 1871.

Lecture on water (revised and elaborated); *American Chemist*: 1. General, 1871, 161 (Nov.); 2. Mineral Waters, 1871, 201 (Dec.); 3. Water for manufacturing and domestic purposes, 1872, 259 (Jan.), 281 (Feb.); 4. The Croton, 1872, 321 (Mar.).

Analysis of the Florida Sulphur Spring; *American Chemist*, 1871, 300 (Feb.).

Analyses of Staten Island waters (with F. A. Cairns); *American Chemist*, 1871, 347 (Mar.).

Report on the water of the Hudson River; made to the Water Commissioners of the City of Albany. A special discussion of the destruction of the sewage contamination of large rivers, caused by the dissolved oxygen; 8 vo., 25 pp., Albany, 1872.

Analysis of the Empire Spring at Saratoga (with F. A. Cairns); *American Chemist*, 1872, 93 (Sept.).

Analysis of the Glacier Spouting Spring at Saratoga (with F. A. Cairns); *American Chemist*, 1872, 165 (Nov.).

It may be of interest also to note in passing, a fact which is probably unfamiliar to many, namely that it was due to Chandler's advice and urging that the firm of Eimer and Amend started their laboratory supply business in 1874. The founders of this firm were German apothecaries who were dissatisfied with the standards of purity of the American pharmaceutical products of that day and therefore began the importation of alkaloids, etc. Chandler, who was personally acquainted with them through his connection with the College of Pharmacy, called at their office and urged them to extend this branch of their business and to include also the importation and manufacture of chemical apparatus. How great an assistance it has been to the cause of American chemistry to have had at hand the stores of fine chemicals and apparatus provided by this firm, it is difficult to overestimate.

So much of his time was occupied in great patent suits that but little was left for investigation. I well recall his advice, when I asked him to give me some guiding principles in serving as chemical expert in such litigation. His answer was brief and to the point: "Know your lesson. Tell the truth. Don't be afraid to say 'I don't know.'"

The most famous suit in which he participated was that brought in the interest of the widow and assignees of the Rev. Hannibal Goodwin, an Episcopalian minister of Newark, N. J., and an amateur photographer, who was the first successful inventor of a flexible nitrocellulose film for the kodak camera and for moving picture negatives and positives. Goodwin's opponents kept him in the Patent Office ten years before he could get his patent, when he died. Thirteen years of most strenuous litigation were required to win against the infringer. Rather than have a Court investigator examine the books to determine the proper award, the defendant settled with the plaintiffs by the payment of \$5,000,000, which is believed to be the largest amount ever secured in a patent suit up to that time.

Other noteworthy suits were the first synthetic coal tar color cases, of which there were five concerned with Artificial Alizarin, and others later which had to do with the Roussin patents, owned by Poirier & Company, of Paris, for the Azo

Dyes obtained by diazotizing sulfanilic or naphthionic acid and coupling with suitable amines or phenols; but to review even briefly the many notable suits in which he has been engaged would require more space than is available for this biographical notice, for they included subjects in almost every branch of chemical industry.

Sugar

Dr. Chandler's connection with the sugar industry began in an interesting way.

The Kappa Alpha Fraternity, of which he was a member, held a banquet in New York which he felt that he really should attend, although the tickets cost \$6.00, and his annual income was very meager. Mrs. Chandler also urged him to go, for she knew that the recreation and change would rest him. So, to the banquet he went, and enjoyed himself so thoroughly that he spent \$18.00 in treating his comrades to proper liquid refreshment. The cost of supplying this pre-Volstead enjoyment, plus the cost of the ticket, made the expense of the evening \$24.00, as he explained with rueful countenance to his wife upon his return home. She cheered him, however, by suggesting that after all his presence at so important a gathering might later prove to have been worth while.

And so it proved. For one of the guests at the dinner was Mr. Peters of the Booth & Edgar sugar refinery, at King and West Streets, who was so much pleased with his acquaintance with Chandler on that occasion that he later approached him with an invitation to do their chemical work for them. They recognized the need of proper scientific control of the operations of their plant, but had not succeeded in finding a satisfactory man for the job. Mr. Peters expressed the belief that Chandler could do all the work they required if he could give them about two hours a day, for which they would pay him \$1500 per annum.

As this would materially increase his income, Chandler accepted the offer, and on May 1, 1888, began work for them on this basis, his hours being from six to eight A. M., and

his work consisting of analyses of sugars, syrups, boneblack, et cetera, polarimetric determinations, and the study of various chemical problems, both in the laboratory and in the plant.

VIII. AS PUBLIC SERVANT

1. In the Service of New York City

Board of Health.—Unquestionably Dr. Chandler's greatest services in the utilization of science for the benefit of mankind were in safeguarding the public health and saving human lives through improved sanitary measures.

In 1866, he was invited by Dr. Harris of the Metropolitan Board of Health to make some scientific studies of various sanitary questions affecting the health of the community. Although there was to be no pay for the service, Dr. Chandler undertook it unhesitatingly, and the commissioners were so well satisfied and so convinced of the importance of the work that at the end of the year they created the position of Chemist of the Board of Health for him, a position which he held until 1873, when he was appointed President of the Board by Mayor Havemeyer, and in 1877 re-appointed by Mayor Ely, his second term expiring May 1, 1883.

Devoting himself assiduously to all branches of hygiene and sanitary science, he studied with the utmost care and thoroughness all factors bearing upon the health of a great city.

Among the many important matters included within the wide sweep of his investigations were the gas nuisance, dangerous kerosene, the city water and milk supplies, adulterated liquors, poisonous cosmetics, offensive trades, the removal of the stalls around Washington, Fulton and Centre Markets, the abatement of the sludge acid nuisance, the regulation of slaughter houses, cattle driving, the construction of tenement houses, the introduction of a proper system of plumbing and house drainage, the establishment of the summer corps of visiting physicians, the permanent system of gratuitous vaccination, and the proper care of contagious diseases in special hospitals. It is desirable to consider a few of these reforms in somewhat fuller detail, so that we may see more clearly just what they meant to the city.

The *water supply* was found to be entirely satisfactory, the adulteration of *liquors* less than was expected, but *cosmetics* were causing some trouble because of the frequent presence therein of poisonous lead compounds, the *gas* industry was creating and maintaining nuisances, and dangerous burning oil was taking its toll of human lives through numerous lamp explosions.

One of the first and most successful investigations was that of the cause of kerosene accidents.

The subject of artificial illumination had always attracted him. New Bedford, his home town, was the whaling headquarters of the United States. Whale oil, sperm oil and spermaceti were everywhere in evidence. When the boys burned any "midnight oil" in the study of their lessons, it was whale oil which supplied the illumination, and when they were punished by being taken upon a whaling expedition to the back shed, it was whalebone switches that extracted the blubber. On account of the high price of sperm oil, and the inferior quality of whale oil (from the "right" whale) and its property of gumming up the lamps, "camphene" (rectified spirits of turpentine) was introduced at comparatively low cost as a substitute. This camphene could not be burned in lamps without chimneys on account of its smoking. It was therefore mixed with alcohol, so that it could be used in open wick lamps without any chimney, and this mixture was sold under the name of "Burning Fluid." Both this and camphene were exceedingly dangerous, because of the inflammable vapors they gave off even at ordinary temperatures, and many fatal accidents resulted from their use.

This was the situation when he left New Bedford in 1854 for Germany. In the fall of 1855 he moved from Göttingen to Berlin and arranged to board with a private family there. The first evening when he lighted his lamp, he observed at once that it was filled with a kind of oil with which he was unfamiliar and which he was told was called "Photogen." The following day, when he went to the University, he learned from Professor Magnus, the lecturer on Industrial Chemistry, that it was made by the distillation of "Boghead Coal," or "Torbane Hill

mineral" from Scotland. He became very much interested in this new oil and gathered all the information he could about it. On returning to New Bedford in the fall of 1856, he told his friends all about this new oil, especially his uncle who owned a large refinery and candle works, but they all derided the idea of its being good for anything, or of its ever supplanting whale or sperm oils for either illuminating or lubricating purposes.

Unconvinced, Dr. Chandler then turned to the only scientific journal with which he was familiar in this country, the *Scientific American*, and wrote its editors, Munn & Company, about the new oil, offering to supply gratuitously an article on the subject. He received a reply that they "did not care for the article," as they "did not think this kind of oil would ever interest the American public." But within two years there were coal oil factories from Portland, Maine, to Wilmington, Delaware, including one at New Bedford, making oil from various shales (usually Boghead coal), and one of these plants called its product "kerosene," a name which has clung to burning oils ever since, whether obtained from coal or from petroleum.

The coal oil industry soon gave place to the distillation products obtained from petroleum. Accidents due to the explosion of kerosene were then of frequent occurrence, but inasmuch as similar accidents had occurred with the various burning fluids mentioned above, the layman supposed that such accidents were either unavoidable and due to the peculiar properties of such substances, or else were caused solely by carelessness.

Dr. Chandler suggested to the Board of Health that the cause of these accidents be examined into more thoroughly, and they requested him to undertake the work.

On January 11, 1869, he submitted his report, and it was subsequently published in the *American Gas Light Journal*, of February 2, 1869, under the caption, "Dangerous Kerosene." It pointed out the fact that kerosene was only dangerous when it contained the cheaper and more volatile naphtha fractions. There were profiteers in those days also, and the greed of certain grocers had led them to mix safe refined kerosene with the

much more dangerous but cheaper naphtha or benzine. The inevitable result of this criminal practice was an appalling loss of life wherever this highly inflammable mixture was used for illuminating purposes, and scarcely a day passed in New York City without one or more accidents from lamp explosions, some of which proved fatal.

Chandler examined seventy-eight samples of oil purchased from retail dealers in the city, and not a single one was safe, while many were mainly naphtha sold under the ironical title of "safety oil."

This report created tremendous excitement, not only in New York but also throughout the entire country and even in Europe. Boards of Health in various American cities had it reprinted and distributed it broadcast; and it was quoted in many foreign countries.

Its direct effect was the introduction of a safe burning oil for the world. In the three years following, this led to a reduction in the death rate from lamp explosions in New York City from fifty-two per million to fifteen per million, with further reduction later. To the petroleum industry, it brought rapid and profitable growth in the sale of kerosene, a substance whose use previous to this report had been looked upon with more or less disfavor by the general public. To Chandler, it brought instant recognition and widespread renown. In 1872, he was invited to appear before the British House of Lords in regard to his investigations in this field.

Some years afterward, he was sent to Europe by the Standard Oil Company, visiting Germany on one occasion and England on another, the object of the visits being to induce the government authorities in these countries not to enact laws which would have been inimical to the interests of American producers and would have reduced materially the volume of American oil exported. In these missions he was entirely successful.

Markets.—One of the first reforms undertaken by Dr. Chandler in 1873, shortly after his election as President of the Board, was the destruction of the two-story structures which covered half the roadway of the public streets adjacent to Washington

Market, surrounding the block and interfering with the traffic in these thoroughfares. They were in a filthy condition, and great quantities of refuse had accumulated beneath them, giving rise to offensive odors and tending to taint all the food exposed for sale in the market. Many attempts to remove them had been made, but without success. After exhausting peaceful methods, the Board decided to resort to force, and Dr. Chandler was given authority to put Washington Market in order. The Board of Encumbrances refused to obey his orders to remove the stalls. The police likewise refused. The marketmen inquired whether a purse of \$50,000 would "square the matter." Threats of personal violence were also not lacking. Dr. Chandler was haled into court to show cause why a preliminary injunction should not be issued restraining him from tearing down the structure. The judge declined to issue such a preliminary injunction, but stated that at 10 o'clock next day he would be required to show cause why a permanent injunction should not be issued. On leaving the court room his counsel said, "This means that what you do between now and 10 o'clock tomorrow morning will be legal. What you may do after that time depends upon what the court may say."

With his indomitable energy and resourcefulness, Chandler went to work at once. He found an old house-wrecker who agreed to demolish and remove the structure for \$2500. But, under the law, no contract for city work for \$1000 or over could be let without advertising for bids. So he offered the wrecker \$999 to demolish the buildings, and then offered his foreman \$999 on a separate contract to remove them. He went before the Board of Police Commissioners demanding police protection for the wreckers. The commissioners laughed in his face, although the President of the Board of Police was himself a member of the Health Board. Chandler thereupon told them that he would at once prepare and file an affidavit to the effect that he had made formal demand for police protection for his men and had been refused. This affidavit would be placed where it would settle definitely the responsibility for any rioting that might occur. He went then to his own office in the same building, and in a few minutes received word that

the police protection would be forthcoming. Sixty of his own sanitary police were sent to remove the contents of the stalls to the inner portion of the market and three hundred of the regular police force formed a cordon around the structure. The attack began at eight o'clock in the evening, and by ten o'clock the next morning all of the ramshackle structures had disappeared, the débris had been carted away, and the pavement, which had not seen the light of day for forty years, had been washed clean by the Street Cleaning Department. When the case was called in court a laugh went around, for there was nothing for the court to do, as the marketmen decided not to submit their petition. A suit was subsequently brought against the city for about \$60,000, but the city won it. Similar treatment was accorded the stalls surrounding the other city markets.

The whole undertaking was not at all an unjustifiable high-handed proceeding, but a wise protection of the health of the great metropolis, for there was at the time an epidemic of cholera in Memphis, whose northward spread was causing anxiety in many of our cities, and unsanitary markets were recognized as among the best possible breeding places for such scourges.

Smallpox.—During the winter of 1874-75, three thousand cases of smallpox were reported in New York City, with twelve hundred deaths. It had been endemic since 1800, but was then epidemic. In those days, the patients were sent to Blackwell's Island and were nursed by the "seven day drunks" from the workhouse north of the hospital. The principal medicine administered was whiskey, much of which was drunk by the nurses. The tales of the cruelty and indifference with which the sufferers were treated reached the poorer quarters of the city and the families of the patients refused to report the cases. As a consequence, the first intimation of the presence of smallpox often came only when an entire tenement had been infected. The patients then were under the control of the Department of Charities.

It was one afternoon at about four o'clock that Dr. Chandler received word of the passage of the bill giving the Board of Health entire control of contagious diseases. He had himself

vaccinated immediately, and visited the hospital for smallpox, so that he might see for himself the true state of affairs, viewing for the first time a case of the disease, of which there were three hundred there at the time.

The first thing the Board did was to change the name of the hospital to Riverside Hospital, in place of Smallpox Hospital. Then Drs. Chandler and Smith went to Archbishop McCloskey and explained the situation to him, with the result that he furnished fourteen Sisters of Charity to replace the "seven day drunks" as nurses, and to be under the direction of a competent resident physician. Instead of the ambulance, or Black Maria, a fine coupe, drawn by a span of handsome gray horses, was provided. There was no label on the door publishing to all the world the nature of its business. On the box sat a uniformed coachman, and at his side a groom, and the outfit might have passed down Fifth Avenue any sunny afternoon without causing anything but envious comment. When this equipage appeared in the lower East Side, it created a sensation, and there was little objection to being driven away in style to a hospital where the poor knew that they were to have devoted Sisters of Charity as nurses. The effect was immediate and far-reaching. Smallpox cases were no longer concealed, and the epidemic was soon stamped out, with the assistance of the corps of vaccinators employed and the systematic house-to-house vaccination adopted.

The question of universal vaccination was approached diplomatically, in order not to stir up too much controversy. Instead of seeking a compulsory general vaccination law, they addressed the Board of Education and induced them to pass a regulation refusing admission to the schools to all children who had not been vaccinated. As the law required all children within certain ages to go to school, the desired result was accomplished, and this reform has been in force ever since.

Hospitals for contagious diseases were erected on North Brother's Island to take the place of the one on Blackwell's Island, although this reform was not completed until after the termination of Dr. Chandler's service on the Board.

At first, the vaccine was prepared from human beings. There was considerable opposition to this, and an Anti-Vaccination Society was organized, but this difficulty was readily met by the Board's hiring a farm in New Jersey and preparing all virus needed by using calves.

Milk Supply.—Numerous analyses of the milk sold in the City of New York, clearly established the fact that this important food was so heavily adulterated that for every three quarts of milk supplied, one quart was water; in addition to which a considerable percentage of the cream had been removed. It was also found that most of the condensed milk companies skimmed the milk before concentrating it. The total frauds thus perpetrated by the milk-men were estimated as amounting to \$10,000 a day. The Board of Health had not attempted to grapple with this villainy until Dr. Chandler became its President. He then promptly inaugurated a vigorous warfare against the dishonest dealers on the grounds that as milk was the chief food of the 130,000 children under five years of age then living in New York, it was a most important article for sanitary supervision.

Impure or watered milk was dumped into the gutter by the thousands of gallons, and the offending milk-men were arraigned and fined or imprisoned. The milk dealers organized an association to resist this attack, engaging legal and chemical experts and fought both the law and the chemical methods employed, but the Board of Health won its suits and the best chemists in the country approved the methods employed. Fifty thousand dollars were paid into the city treasury as fines by guilty milk dealers, and a number of them enjoyed the hospitality of the city jail from ten to ninety days apiece.

Air Pollution.—Not content with having safe-guarded the food and water supply, the improvement of the conditions surrounding its great markets, and rigid inspection of its drinking water, Dr. Chandler next turned his attention to the purification of the air then being breathed by New Yorkers.

For many years most intolerable odors prevailed over great areas of the city, now on the east side, and now on the west side. These odors were at first attributed to the sewers, but it

was later ascertained that the gas companies were the guilty parties.

It is to their credit that when this matter was brought to their attention they, with one exception, modified their processes so as to suppress the odor, the immediate cause of which was found in the foul lime which was daily removed from the gas purifiers.

The one company which refused to pay any attention to the suggestion of the Board, claimed that it was not producing any disagreeable odor, that it was good for whooping-cough, that what odors were produced were inevitable, and that any change in their process would leave their gas so impure that it would not be safe to burn it in dwellings. A long trial before a referee ensued, in which the intransigent company was decisively beaten. The necessary changes were made and the gas nuisance ceased.

Other sources of pollution of the atmosphere were discovered in bone-boiling and in fat and refuse-rendering, and the stench from these plants often made the air of the city in certain sections well nigh intolerable.

The first attack by the Board of Health was made upon the New York Rendering Company, which had a contract with the city for the removal beyond the city limits of dead animals and offal. Instead of complying with the terms of their contract, the offensive material was rendered at the foot of West Thirty-eighth Street. The company was directed to stop rendering at once, and to live up to their contract by carrying the material away from the city.

At first they claimed it was impossible, but when policemen were placed on the dock, with orders to arrest the workmen if they attempted to continue the work, the company transferred the material to a vessel, carried it down the bay, and threw it overboard.

As most of it floated ashore it became the cause of equal offense in other localities. The company insisting that it must either "render or dump," the Board of Health declared the contract violated and made arrangements with other parties to transfer all the material to Barren Island, and these arrangements have been in force ever since, with entire satisfaction.

The Rendering Company, still retaining possession of their dock at the foot of West Thirty-eighth Street, placed every obstacle in the way of the new contractors and it became necessary to seize all their movable property, put it upon their two hulks, which had been tied up to the pier, and tow them over to the New Jersey shore. This resulted in a suit against the city for over \$100,000, which was defended by the Board with complete success. Some of the details of this long and bitter controversy will be found in the May 17, 1883 issue of "The Sanitary Engineer."

The next attack was upon the vessel *Algonquin*, which lay at the foot of Thirty-ninth Street, and on which offal from slaughtering houses was rendered. Orders issued directing the owners to discontinue the business were resisted and the industry was moved out into the stream, so as to carry on the work out of the reach of the inspectors.

The first encounter was a night attack upon the trucks engaged in carrying the offal to the end of the pier for delivery to the vessel. As this failed to put a stop to the business, a steam tug was hired and the *Algonquin* towed to Barren Island and tied up there. This put a final quietus on the business.

A gut cleaning establishment at the foot of West Thirty-ninth Street next received attention and the Board finally sent a gang of laborers which tore down the building and burned up the material, the owner being compelled to pay the cost which was \$125. Bone boiling, fat melting and lard rendering were sharply followed up, until every establishment engaged in the business was compelled to introduce improved processes which could be carried on without polluting the atmosphere.

Slaughter Houses.—Slaughter houses were scattered all over the city. On Manhattan Island alone there were fifty-two, and cattle were driven to them through the streets. The Board of Health, at the suggestion of President Chandler, encouraged the erection of a few large abattoirs near the East River, on First Avenue near Forty-second Street, where they remained for many years. The driving of cattle through the city streets was prohibited and it was required that they be transported by water instead.

The streets adjoining the slaughter houses actually ran with blood, which flowed from the gutters into the sewers and thence to the river. When the Board of Health forbade this, it was bitterly fought until Dr. Chandler showed the offenders how by the installation of proper equipment for drying this blood they could market it as a valuable fertilizer and make money out of it.

Night Soil.—Another source of air pollution was the removal of the night-soil from the twenty-five thousand privy vaults of the city's tenement houses. The contractors who undertook this work carried it out in such a slovenly manner as to constitute a serious nuisance. The Board of Health therefore declared the contract violated, and negotiated a new one with other parties at considerable saving financially and with the result that the nuisance was abated. The original contractors thereupon sued the city for \$300,000 and were defeated.

Petroleum Nuisances.—At Sixtieth Street and the Hudson River there was a petroleum refinery which spread offensive odors over all the neighborhood. Dr. Chandler sought in vain to get this company to alter its methods of refining so as to prevent this pollution of the air. As it continued stubbornly to refuse to do anything to reduce or stop this nuisance, the refinery was driven from the city.

Another source of contamination of the city's air was the fertilizer industry at Hunter's Point and Greenpoint, where the sludge acid from the petroleum refineries was used in the manufacture of superphosphates.

As the Legislature was averse to enacting laws for the suppression of nuisances in one place which had their origin in another place, the Board secured the necessary authority under a special act designed for another purpose, and proceeded to gather evidence fixing the exact times at which these various factories emitted foul odors. The officers of the Board of Health were then suddenly indicted on the ground that they had failed to suppress foul odors arising within the city limits, but this indictment was promptly quashed and Dr. Chandler and his fellow officers, with the new powers of their Board

acknowledged, turned on their late accusers and forced them to abate the nuisance.

The Summer Corps.—The vicissitudes of our climate are such in New York City that during part of the mid-summer months of July and August, we frequently suffer from very depressing and debilitating weather conditions with temperature and humidity excessively high. Such weather falls with particular severity upon the little children, and consequently results in adding several hundred to the ordinary death rate. It has happened for example, that in a single week the death rate has risen from five hundred to fifteen hundred, nearly a thousand children falling victims to the diarrhoeal diseases induced. To reduce as far as possible this excessive mortality, Dr. Chandler organized a Summer Corps of fifty physicians, one for each of the fifty districts into which the tenement house regions were then divided; it being the duty of each of these physicians to visit every room in this district, treating all sick children, furnishing the medicine required, giving advice to the mothers, placing in their hands instructions for the care of infants, printed in English and other languages, and distributing tickets for excursions on the barges of St. John's Guild.

As an illustration of the work accomplished, it is stated that the physicians of the Summer Corps in one month made 130,000 visits at a cost to the city of \$5000. The beneficent effects of such work enabled the Board to secure each year the appropriation necessary to continue it.

Tenement House Reforms.—Statistics having shown that two-thirds of the deaths in the city occur in that half of the population in tenement houses, efforts were made to improve the conditions of these structures by careful inspection and by suitable remodelling where possible. It was soon found, however, that this reconstruction was a difficult matter with the average tenement house building and that there should be radical changes made in the plans for such buildings, in order that they might provide adequate light and ventilation.

With the aid of the *Sanitary Engineer* and a number of public spirited citizens, the Sanitary Reform Association was organized which, working in conjunction with the health author-

ities, secured the enactment of such amendments to the Tenement House Act as gave the Board of Health complete control of all tenement houses thereafter to be erected. In the first three years after that law went into effect, accommodations were provided in new structures for approximately one hundred thousand persons, and in every case ample light and ventilation were supplied.

Plumbing and Drainage.—It was early recognized by the Board of Health that many serious defects existed in the plumbing and drainage of dwelling houses, by which exhalations from the sewers, often carrying germs of disease, found access to living and sleeping rooms. This was due not only to defective execution of the work, but also to the fact that in principle the system employed was unsafe.

Dr. Chandler therefore undertook experiments designed to provide a satisfactory system and one which would remedy these evils. It was soon found, however, as the result of these investigations, that no house was safe from sewer gas unless a soil pipe of undiminished calibre was carried through the roof, a trap placed between the house and the sewer, suitable traps placed under every fixture, every trap backaired to prevent syphoning, and all overflows, refrigerator and safes wastes disconnected from the sewer.

These improvements were so obvious and commended themselves so promptly to every intelligent citizen, that the Sanitary Reform Association secured the enactment of a law for the registration of all plumbers and for placing the control of plumbing and drainage for all new buildings in the hands of the Board of Health. This law went into effect June 4, 1881, and the rules adopted by the Board, after consultation with leading plumbers, architects and sanitary engineers, have proved so satisfactory that they have been adopted by many other large cities.

Effect upon the Public Health.—In 1866, out of every one hundred deaths in the city, fifty-three were of children under five years of age. The efforts at sanitary improvement so actively conducted under Dr. Chandler's leadership, together with the increased intelligence secured by the efforts of the sanitary

authorities, the sanitary organizations and the press succeeded in reducing this ratio year by year until at the conclusion of Dr. Chandler's services, the fifty-three deaths per one hundred had been brought down to forty-six.

This meant on the basis of the city's population at that time an annual saving of the lives of five thousand children, without considering the reduction in the death rate of persons over five years of age. If the latter were also included, it is fair to estimate that at least eight thousand lives were saved to the city every year as a result of these sanitary reforms. As for each death there are twenty-eight cases of severe sickness, the total amount of good accomplished becomes enormous.

Largely due to Dr. Chandler's activity, a State Board of Health was established of which he was made a member and chairman of its Sanitary Committee. He was always active in endeavoring to secure suitable legislation prohibiting the adulteration of foods and drugs throughout the state, and when such laws were finally placed upon the statute books, their enforcement as well as the regulation governing the sale of kerosene, were entrusted to him. Public analysts were appointed, samples of food, drugs and oils collected, and the necessary machinery set in motion to secure compliance with these laws throughout the state. For three years he served as chairman of this Sanitary Committee.

Upon completion of his second term as President of the New York City Board of Health, May 1, 1883, Dr. Chandler was nominated by the Mayor for a third six-year term, but the Board of Aldermen refused to confirm the nomination, and he held over for about a year. The reason for this action by the Aldermen in failing to continue in office one who had done so much for their city merits more than passing mention, for it is a striking illustration of the eternal fight between politics and probity, and in this particular case, to the disgrace of our city be it said, politics won.

It had been customary to accumulate the stable manure from the eighty thousand horses in the city and store it in huge piles in open lots in various parts of the city, as at the foot of West Thirty-eighth Street, of East Forty-fifth Street and West Nine-

tieth Street, where it was soaked with the rain and then, under the rays of the sun, fermented and decomposed. To prevent these piles from overheating and taking fire, it was necessary to fork them over frequently, and the odors from these rotting piles polluted the atmosphere of the entire neighborhood. As the farmers took such fertilizer only in the spring, as a rule, these localities were sources of evil odors for a large part of each year. When the Board of Health stationed policemen at these points and prevented the contractors from storing manure there, the latter refused to take it from the stables, and the nuisance was transferred to thousands of localities throughout the city. After three years of litigation, it was forbidden to store such material within the city limits, and arrangements were then made by the Board to have it stored outside of the city, but in the meantime, the interested contractors had succeeded in having slipped through both branches of the Legislature a bill which would prevent the Board of Health from interfering with this objectionable business in any way. The lawyer for the contractors immediately paid a visit to Chandler, and spent an entire morning endeavoring to induce him to withdraw his opposition, assuring him that if he did so the contractors' aldermanic friends would see that his nomination was immediately confirmed. Chandler finally told him that he would rather be carried off to the cemetery than betray the people in such a manner, and the lawyer left, after telling Chandler that he was a fool to continue his opposition. As this bill had been slipped through in the closing days of the session of the Legislature, there was only that day left within which the Governor could veto it, so Chandler immediately wired him pointing out that the lives of over a million people would be jeopardized if the bill became law. Governor Cleveland promptly vetoed the bill, the Board of Aldermen refused to confirm Chandler's nomination, and New York City lost as efficient a public servant as it has ever been her good fortune to possess.

In addition to his service on its Board of Health, Dr. Chandler aided New York City in other directions also.

As President of the Street Cleaning Improvement Society, he performed an effective part in bringing about the reorganization of the Street Cleaning Department.

At the time of the opening of the New York Subway, he was called upon to analyze the air in the tubes, since many people claimed that it was injurious to health. His analyses showed conclusively that the air in the subway was just as pure as that above ground and the anxiety of the public about this matter was thus relieved.

He served also as one of the scientific directors of the New York Botanical Garden, and was for many years Chemist for the Croton Aqueduct Commission.

2. In the Service of New York State

His State also made use of his scientific training and administrative abilities in many ways.

For several years he was president of the State Charities Aid Association and took an active part in securing proper state care for the indigent insane.

3. In the Service of the Federal Government

Not only the city and state, but the nation as well called upon Dr. Chandler for public service. Secretary of the Navy, William C. Whitney, selected Chandler as a member of a commission to investigate the preservation of timber, and soon thereafter the President of the National Academy of Sciences, at the request of the Secretary of the Treasury, placed him on commissions to investigate the manufacture of glucose, the denaturing of alcohol, and the waterproofing of fractional currency and bank notes.

When Chester A. Arthur was President of the United States, he named Chandler a special commissioner to study the subject of American hog products and report thereon, and in 1884 appointed him a United States delegate to the Health Exposition and the International Medical Congress at Copenhagen.

President Cleveland, soon after his inauguration, sent for Professor Chandler, told him that the previous Congress had

appropriated \$400,000 to keep cholera out of the country, and that he wanted his advice because both the National Board of Health and the Marine Hospital Service had each urged that the money be turned over to them. Chandler promptly responded, "Don't give it to either!" as it would have been only a drop in the bucket for either one, while if he created a Cholera Commission of the State Quarantine officers of the larger Atlantic ports, it would enable them to add to the equipment they already possessed, in stations, steamboats, hospitals and staffs of officers, such other conveniences as might be necessary. The President accepted the suggestion at once.

Three successive Presidents, Cleveland, McKinley and Roosevelt, appointed him a member of the Visiting Committee of the National Observatory at Washington.

At the request of the Postmaster General, he investigated the postage stamps and refuted the stories of the newspapers that they contained poisonous constituents which made it dangerous to touch them with the tongue.

Twice, in 1880 and again in 1903, he was called upon by the Secretary of the Interior to examine the original Declaration of Independence, not from the standpoint of its justice or morality, but to advise how the faded signatures might be made more legible. Some years previously, a publisher had been allowed to take a wet paper press copy of these signatures, which removed most of the ink from the parchment. All that could be suggested was to go over the signatures with india ink, but this seemed too hazardous and nothing was done.

IX. OTHER HONORS

In addition to the honors already recorded, the University of Göttingen, upon the fiftieth anniversary of his Ph. D. degree, officially renewed this degree and sent him a parchment to that effect.

He received the M. D. degree from the University of New York in 1873, and the LL. D. from Union College the same year. In 1900, Oxford University conferred upon him its D. Sc. This was indeed a signal distinction, as the only previous recipient of this honorary degree from Oxford had been the Prince of Wales. Chandler was thus the first scientist upon whom it was conferred. In 1911, Columbia also awarded its LL. D.

He was a member of the National Academy of Sciences, of practically all the leading chemical societies both here and in Europe, and of many other scientific, learned and philanthropic organizations.

On April 30, 1910, a huge banquet was given in his honor by the chemists of America, and a bronze bust of life size was presented to Columbia University. It is an excellent likeness, and now is housed in Havemeyer Hall where all may see it and where it shows to all students what the great builder of their Chemistry Department looked like.

When the Society of Chemical Industry decided to recognize its large and influential American Section, and to draw closer the bonds uniting the two nations, it made inquiry as to whether there was any one American chemist who, by the common consent of his colleagues and in virtue of his achievements, might properly be regarded as first among our industrial chemists. There was no question that Chandler was, and had been for many years, the leading figure in this field, and he therefore received the unprecedented compliment of election to the presidency of this great international society, being its first American president, and thus joined the group of distinguished men who had held that high office previously.

He died August 25, 1925, in his ninetieth year, after a brief illness, mourned deeply by all who knew him or were familiar with his remarkable contributions to the happiness of mankind.

X. BIBLIOGRAPHY

1. Inaugural Dissertation for the degree of Doctor of Philosophy; Göttingen, 1856. "Miscellaneous Chemical Researches: I. Zircon from Buncombe County, N. C., II. Saussurite from Zobten, III. Stassfurthite from Stassfurth, IV. Analysis of a rock resembling Talcose Slate from Zipser, V. Columbite from Middletown, Conn., VI. Columbite from Bodenmais, VII. Tantalite from Chanteloube, VIII. Yttrotantalite from Ytterby, IX. Samarskite from the Urals, X. Experiments on the Cerium Metals, XI. Artificial Heavy Spar."

2. An investigation on the formation of alcohol during fermentation. Published in "Biblical Temperance," by E. C. Delavan, Esq.

3. Analysis of dolomite. In the Report of the Geological Survey of Iowa, by James Hall and J. D. Whitney; Albany, 1858.

4. Examination of interesting urinary calculi, included in a report of Dr. Alden March. Printed in the Annual Report of the New York State Medical Society for 1858.

5. Analysis of Datolith; *Am. Jour. Sci.*, 28, 13 (1859).

6. "A Manual of Qualitative Analysis," by D. K. Tuttle, Ph.D., and C. F. Chandler, Ph.D., 1860; reprinted in 1873 by John Wiley & Son, New York.

7. A new metal in the native platinum of Rogue River, Oregon; *Am. Jour. Sci.* 1862, 351.

8. Analyses of one blende, two smithsonites, one cerusite, and with J. P. Kimball, analyses of nine shales, five galenas and one dolomite; in the Report of the Geological Survey of the Upper Mississippi Lead Region, by Professor J. D. Whitney, Albany, 1862.

9. Report on water for locomotives and boiler incrustations, made to the President and Directors of the New York Central Railroad Company, including analyses of waters between Albany and Niagara Falls, and analyses of incrustations; pamphlet, 8 vo., 35 pages, New York, 1865.

10. Report on the petroleum of the Taro, Italy; 8 vo., 8 pages, New York, 1868.

11. Sanitary qualities of the water supplies of New York and Brooklyn. Report to the Metropolitan Board of Health, 8 vo., 9 pages, New York, 1868.

12. Analysis of the Ballston Artesian Spring (with E. Root); *American Supplement to the Chemical News*, 1869, 54 (July).

13. A new system of assay weights; *American Supplement to Chemical News*, 1869, 113 (Aug.).

14. Analyses of six new mineral springs at Saratoga; *American Supplement to Chemical News*, 1869, 194 (Sept.).

15. Analysis of the Saratoga Seltzer Spring (with Paul Schweitzer); *American Supplement to Chemical News*, 1869, 395 (Dec.).
16. Report on the quality of the milk supply of the Metropolitan District, made to the Metropolitan Board of Health; *American Chemist*, 1870, 41, (Aug.); also as separate pamphlet, 8 vo., 13 pages, New York, 1870.
17. Report on the water supply of New York and Brooklyn, made to the Metropolitan Board of Health; 8 vo., 9 pages, New York, 1870.
18. Report on the quality of the kerosene oil sold in the Metropolitan District; made to the Metropolitan Board of Health; 8 vo., 23 pages, New York, 1870.
19. Report on the gas nuisance in New York; made to the Metropolitan Board of Health; and including a special discussion of the different methods of purification; 8 vo., 109 pages, New York, 1870.
20. Report on dangerous cosmetics; made to the Metropolitan Board of Health; 8 vo., 7 pages, New York, 1870. Also in *American Supplement to the Chemical News*, 1870, 293 (May).
21. The purification of coal gas, and the gas nuisance in New York; *American Supplement to the Chemical News*, 1870, 117 (Feb.), 177 (Mar.).
22. Analyses of the Chittenango Sulphur Springs, Madison County, N. Y.; *American Supplement to the Chemical News*, 1870, 221 (April).
23. Saltness of the waters around the island of New York; *American Supplement to the Chemical News*, 1870, 225 (April).
24. A simple lecture experiment to show the solubility of carbonate of lime in carbonic acid; *American Supplement to the Chemical News*, 1870, 228 (April).
25. Analysis of the Geyser Spring of Saratoga (with F. A. Cairns); *American Supplement to the Chemical News*, 1870, 373 (June).
26. Lecture on water; delivered before the American Institute; 8 vo., 49 pages, Albany, 1871.
27. Lecture on water (revised and elaborated); *American Chemist*:
 1. General, 1871, 161 (Nov.); 2. Mineral Waters, 1871, 201 (Dec.);
 3. Water for manufacturing and domestic purposes, 1872, 259 (Jan.), 281 (Feb.); 4. The Croton, 1872, 321 (Mar.).
28. Report on petroleum as an illuminator, and the advantages and perils which attend its use, with special reference to the prevention of the traffic in dangerous kerosene and naphtha; made to the Health Department of the City of New York; 8 vo., 110 pages, New York, 1871.
29. Analysis of the Florida Sulphur Spring; *American Chemist*, 1871, 300 (Feb.).
30. Reduction of the nitrate of silver by charcoal; *American Chemist*, 1871, 346 (Mar.).

31. Analyses of Staten Island waters (with F. A. Cairns); *American Chemist*, 1871, 347 (Mar.).
32. Composition of commercial zinc; *American Chemist*, 1871, 420 (May).
33. Condensed milk; its manufacture and composition; *American Chemist*, 1871, 25 (July).
34. Report on the water of the Hudson River; made to the Water Commissioners of the City of Albany. A special discussion of the destruction of the sewage contamination of large rivers, caused by the dissolved oxygen; 8 vo., 25 pages, Albany, 1872.
35. Report on petroleum oil, its advantages and disadvantages; made to the Department of Health (revised and elaborated); *American Chemist*, 1872, 409 (May), 446 (June), 20 (July), 41 (August).
36. Analysis of the Empire Spring at Saratoga (with F. A. Cairns); *American Chemist*, 1872, 93 (Sept.).
37. Analysis of the Glacier Spouting Spring at Saratoga (with F. A. Cairns); *American Chemist*, 1872, 165 (Nov.).
38. Elderhorst's Manual of Blowpipe Analysis; edited with H. B. Nason, 1873.