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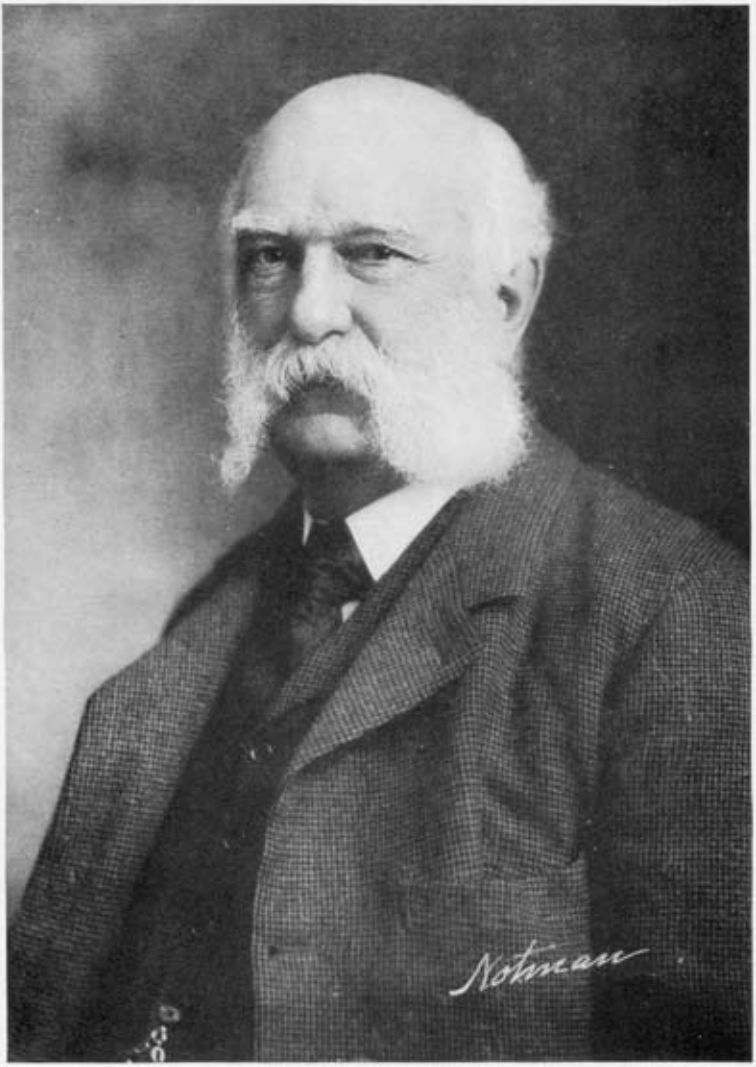

J. W. Crafts

JAMES MASON CRAFTS

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James Mason Crafts was born at Boston, March 8, 1839. His father, Royal Altemont Crafts, was a well-known merchant and manufacturer of woolens of that city. His mother, Marian Mason Crafts, was a daughter of the noted lawyer and statesman, Jeremiah Mason, of Portsmouth, New Hampshire, and later of Boston. He married Miss Clémence Haggerty, of New York, June 13, 1868, who died in 1912, several years before her husband. His death, after some years of impaired health, occurred at his summer home at Ridgefield, Connecticut, on June 20, 1917. He is survived by four daughters, Mrs. Russell S. Codman of Boston, Mrs. Gordon K. Bell of New York, and Misses Elizabeth S. and Clémence Crafts, of Boston. The two last-named have more recently devoted themselves most earnestly to the cause of the French War Charities.

As a boy, young Crafts had an unusual fondness for scientific subjects and carried on much systematic experimentation in a laboratory of his own. His liking for science was fostered by the prominence given to it in the Lowell Institute lectures and by the interest shown in his own studies by his elders of scientific training, especially by Professor William B. Rogers, later to become the founder of the Massachusetts Institute of Technology. He entered the Lawrence Scientific School and pursued there the course in chemistry, graduating with the degree of S. B. in 1858, but continued his studies under Professor Horsford during a portion of the following year. He spent the next few years in study abroad at Freiburg, Heidelberg, and Paris. The University of Heidelberg was then at the height of its scientific reputation, since Helmholtz, Kirchhoff, and Bunsen filled the three leading scientific professorships. Mr. Crafts came into intimate relations with

Bunsen and had the good fortune to work under him, acting as his assistant while the new art of spectrum analysis was in process of application to the discovery of what were then called the "new metals." At Paris he studied under Wurtz and published a number of scientific papers, both under his own name and also jointly with Charles Friedel. Friedel and Crafts became close personal friends and co-workers in many scientific researches in later years.

In 1866-7, having returned to this country, Mr. Crafts spent a short time in professional work in the inspection of mines. Upon the opening of Cornell University he became, in 1868, Professor of Chemistry, in charge of the department, remaining there until 1871.

In 1869 the resignation of Mr. Charles W. Eliot, Professor of Analytical Chemistry and Metallurgy in the Massachusetts Institute of Technology, upon his election to the presidency of Harvard University, followed by that of Mr. Francis H. Storer, Professor of General and Industrial Chemistry, who had in 1870 accepted the position of Professor of Agricultural Chemistry in the newly organized Bussey Institute, practically vacated the department of its professors.

The corporation desired that the new incumbents of the positions should be especially interested in the teaching and development of Industrial Chemistry and Analytical and Organic Chemistry respectively. To fill the first of these vacancies Professor John M. Ordway was chosen and Professor Crafts for the second. His ability and reputation were such that his accession to the staff of the institute was warmly welcomed both by teachers and students.

There was no graduate instruction given in the institute at that time and there were few students who made a specialty of chemistry. Those who did, however, found themselves fortunate in receiving a training which aimed to make scientific men as well as skillful analysts. Professor Crafts encouraged them to undertake "the investigation of unsolved problems," and a number of very creditable published papers resulted. His scientific standing at this time was recognized in his election to membership in the National Academy of Sciences in 1872.

He continued his teaching and the development of the laboratory until 1874, when impaired health made it advisable for him to relinquish this taxing work. Personal reasons and the scientific resources open to him in Paris, whose value he had already learned by experience, led him to take up a temporary residence there. It was expected that this would be only for a year or two and he remained a member of the institute faculty until 1880, when it had become apparent that his stay abroad would be indefinitely prolonged. He therefore resigned his position, much to the regret of his colleagues.

While on active duty Professor Crafts was an earnest worker in the faculty, especially in the furtherance of a rigid and broad scientific training. With several others he was particularly interested in the establishment of advanced courses of study and research in chemistry, physics, and other branches which should lead to a higher degree. That of Doctor of Science was then established, although it has never been given. The time was not ripe for such work. Indeed, it was not until 1907 that the institute conferred any degree of Doctor, which was Ph.D.

Professor Crafts remained in France until 1891, during which time he was almost constantly engaged in research, chiefly at the École des Mines, and very largely in conjunction with Friedel. These labors bore important fruit, as is manifested in the long list of valuable papers published by them, chiefly in the *Comptes Rendus* and the Bulletin of the Chemical Society of Paris. Among these researches that relating to the use of aluminium chloride as a method of synthesis, the "Friedel and Crafts Reaction," has proved to be of exceedingly great value. The Friedel Memorial Lecture given before the Chemical Society of London in 1900 by Professor Crafts contains a very complete résumé of Friedel's work, with a charmingly written brief sketch of his life history, which considers incidentally conditions relating to scientific preferment in France and moreover throws an interesting light on some phases of the religious views prevalent in that country at that time and especially of those which existed in certain provinces a generation earlier. It is an astonishing revelation of intolerance to learn that the wife of Friedel, when a child, lived

"near Nismes in a house where the coffins of her relations occupied one of the drawing rooms because as Protestants they were refused Christian burial." The sanitary results of such a custom may be imagined.

The studies referred to were recognized by the award to Professor Crafts in 1880 of a Jecker Prize of 2,000 francs by the Paris Academy of Sciences, "for his researches relative to organic chemistry." In 1885 he was further made a Chevalier of the Legion of Honor.

During these years he also began an important series of researches relating to high-temperature thermometry, to which fuller reference will be made later.

Upon his return to this country he was made a member of the corporation of the Massachusetts Institute of Technology and was also invited by President Walker again to join the instructing staff. He became Professor of Organic Chemistry in 1892. Regarding the appointment President Walker said: "The accession of a chemist of Professor Crafts' reputation, a teacher of his experience and exceptional powers of inspiring interest and enthusiasm on the part of the students, marks an era in the history of the Institute." He continued to occupy this position for five years, carrying on his researches meanwhile, when he was called on to take up new and heavy duties.

The sudden death of General Walker, in January, 1897, made a vacancy in the office of president of the institute, which it was evident would be extremely difficult to fill. The number of available men proved to be very small, and after much search the committee charged with the business of selection found itself unable to come to a decision. Professor Crafts, who had been the spontaneous choice of the faculty as its chairman, had already been urged to accept the presidency, but had absolutely refused even to consider this, being entirely unwilling to break off his scientific researches and engage in executive work. A few months later, however, conditions had arisen which led him to see that it was very necessary for the best good of the institute that he should reconsider his determination. He was therefore made president in 1898, which office he held for two years.

Soon after his accession to the presidency he received the degree of LL. D. from Harvard University.

As an executive officer, President Crafts showed the same characteristics which had been evident in his earlier career. His long experience as a scientific man and acquaintance with scientific education in this country and abroad, together with his wide knowledge of the industries, gave him a very clear and true perception of the needs of a school of technology which should train men capable of meeting the professional calls of the future as they should arise, whatever these might be. In his annual reports to the corporation there is much regarding the general considerations which apply to technological education that is valuable at the present day. The occasional addresses delivered by him were of great interest and gave evidence of a remarkable breadth of literary and historical knowledge entirely apart from science. It is to be regretted that they were not published. While he was greatly hampered by lack of means, nevertheless important extensions were made in the facilities for instruction and research in many directions. A timely bequest enabled the institute to erect the Henry L. Pierce Building under his direction, which was not only excellently adapted for the purposes for which it was planned, but also, while of simple architectural design, was very satisfactory in its external appearance.

In his relations with his faculty he was invariably fair, just, consistent, and considerate of all interests. Measures which he presented to them he urged wholly on their merit and never through the authority of his position.

During the administration of President Crafts, two educational questions arose which are especially worthy of mention here.

At the wish of the Secretary of the Navy, there was laid out a three-year course in Naval Construction, particularly of war-ships, to be pursued by selected graduates of the United States Naval Academy. Various hindrances delayed further action in this direction for the time being, but the outcome was the establishment, a few years later, of such a course along the lines originally laid down, which has continued up to the present time.

President Crafts, like many others at that time and since, was strongly impressed with the belief that it would be greatly to the advantage of scientific and technical instruction in this country if in some way an arrangement of affiliation could be brought about between the Lawrence Scientific School of Harvard University and the Institute of Technology, so that the two institutions should work in harmony and join their forces for a common end as far as might be practicable, while retaining the independence of each.

Informal consideration of the matter led to the appointment of a committee composed of members of the corporations of the two institutions. The various possibilities of co-working were considered and a detailed plan was drawn up which was acceptable to the members of the joint committee. President Crafts felt very earnestly that the course of action proposed would be for the best good of both institutions at that time and in the future. But as this came to be considered more widely by those with whom the final decision rested, difficulties arose which ultimately led to its abandonment, though with the expressed hope "that as friends and earnest promoters of instruction we can so direct the course of our respective institutions that they shall mutually help one another and avoid duplication of work."

This termination of the endeavors of the committee was a great disappointment to Professor Crafts, not because a plan which he favored had failed, but rather because in his judgment a promising opportunity for the advancement of scientific education had been lost.

The labors of the presidential office, although he carried them with complete success, were not really attractive to him, especially as he found that they necessarily precluded a continuance of his scientific work, and, unwilling to set this aside permanently, he resigned the presidency in 1900.

It was felt by all his colleagues that to lose him entirely would be most unfortunate. A private laboratory was therefore provided for him, and this he fitted up according to his wishes as was necessary for the continuance of his researches.

As a result of his work at this time there appeared several

papers on Catalysis. He devoted himself particularly, however, to another line of research.

A few years after the beginning of his long term of labor in Paris, he had entered upon a series of physical researches. Measurements of the density of iodine vapor and like investigations in which he engaged naturally led him to begin a precise and methodical study of the peculiarities of the mercury thermometer of precision and the sources of error which are liable to occur in high-temperature measurements, and likewise to the accurate determination of the boiling points of various substances—a matter of great importance in view of the desirability of securing fixed points of reference. The value of the results of these early studies has been strikingly confirmed by their agreement with more recent measurements. In recognition of this important work the American Academy of Arts and Sciences, in 1911, awarded to Professor Crafts the Rumford Medal, the terms of the award being "for his investigations in high-temperature thermometry and the exact determination of new fixed reference points in the thermometric scale."

To the continuance and extension of his researches on thermometry he now applied himself in his new laboratory. He devoted several years to designing and perfecting the elaborate apparatus needed for his purpose, and when this was finally completed to his satisfaction he entered upon the actual work of experimentation about 1904.

In the summer of 1911, while abroad, he suffered from a severe attack of neuritis, from the effects of which he never wholly recovered and which precluded further extended work in the laboratory. Though no longer able to continue this, however, he devoted himself to putting his experimental results into form for publication, and in 1913 there appeared in the *Journal de Chimie Physique,* Part 1 of an extended paper entitled "Points fixes de thermométrie entre 100° et 400°. Tensions de vapeur de la naphtaline, de l'eau et de la benzophénone."

This contains an exhaustive description of the form of apparatus used by him in these studies, embodying many new devices of his own. A constant volume nitrogen gas ther-

mometer, a special type of open manometer, and also a new form of ebullioscope were employed. Of available substances tested for constancy of vapor pressure, only water, naphthaline, and benzophénone proved to be sufficiently stable. Water was found to be absolutely so between 70° and 170°.

It is the result of his studies upon naphthaline, however, to which this paper especially relates. His measurements, given in extended tables of pressure boiling-point values, run from temperatures 171° to 270° and pressures 231 mm. to 2,149 mm., the relationship of temperature to vapor pressure being capable of representation throughout by a formula. He found, moreover, that naphthaline, when properly prepared and used, retained a constant boiling point during continued boiling for twelve months. He concludes that this material has "a value almost equal to that of water for establishing temperatures," a result which, as he remarks, completely confirms his early conclusion, published in January, 1883.

A second part of the paper entitled "Tensions de vapeur de l'eau entre 40° et 100°" appeared in the same journal in 1915, whose object, as stated, relates to a much-needed revision of Regnault's tables concerning the vapor pressure of water. These tables are still used, even in their original form, although from various circumstances of Regnault's measurements, probably unavoidable in the state of scientific knowledge at the date at which they were made, there are in some parts errors which are by no means negligible. In others of Regnault's results, as, for example, the tables for the expansion of mercury, errors of as much as one-tenth of a degree are present. Regnault's tables as corrected by later scientists, of which those of Broch and Wiebe are considered the best, are probably exact between 80° and 100°, but at temperatures between 0° and 60° are open to question because of considerations which they have overlooked but which are fully considered in this memoir. These relate both to the degree of exactness of mercury thermometers, which have always been chiefly used, and to the accuracy of the determination of the freezing and boiling points of water employed in their calibration.

Regnault, while taking the utmost precautions known to him as necessary, worked at a date when various important facts as to the construction and use of thermometers of pre-

cision were still to be ascertained. The early researches of Professor Crafts in 1880 first showed how certain errors in these matters could be reduced to a minimum. Furthermore, an entirely erroneous assumption has been made as to the character of Regnault's mercurial thermometers, which have been assumed to be made of "cristal de Choisy-le-Roi," while in fact they were of ordinary French glass. Were these still in existence a comparison with the hydrogen thermometer would give new importance to the work of Regnault. But, to quote Professor Crafts, "Malheureusement, par un acte de vandalisme extraordinaire, tous les appareils précieux de Regnault ont été détruits méthodiquement pendent l'occupation de Sèvres par les Allemands."

It was the original intention of Professor Crafts to undertake a series of measurements of the vapor pressure of water between 45° and 140°, making use of the nitrogen-gas thermometer devised by himself and described in part 1 of his paper under consideration. But, unfortunately, the condition of his health rendered this impossible. He was able, however, by the use of an indirect but accurate method to determine values from 135° to 230°.

Two vessels of proper construction were placed side by side, one containing naphthaline and the other water. By suitable adjustment of pressure these were brought to the same boiling point within a few tenths of a degree, the pressure being measured by the manometers. The slight temperature differences existing between them could be measured accurately by a carefully calibrated and tempered mercury thermometer with a probable error of the result of about two one-hundredths of a degree. The method proved to be a very satisfactory one.

The results thus gained agree closely with those of Holborn and Henning, published subsequently to the actual completion of the measurements of Professor Crafts, in which the temperatures were measured by a resistance thermometer.

The latter part of the paper is devoted to a consideration of the applicability of various empirical formulæ which have been proposed to give the relation between vapor pressure and temperature. A brief article relating to this subject was published by Professor Crafts in *Comptes Rendus,* December 22, 1913. In the present paper he discusses at length three particular

formulæ and considers their relations to many substances, with results shown in extended tables. He finds that these, each for a particular class of substances, may be of great service. The substance naphthaline, with which he had made an additional series of 250 experimental determinations with a new form of hydrogen gas thermometer at pressures from 80 mm. to 2,200 mm., shows so close an agreement with the formula proposed that experimental results which it fails to represent are probably due to errors in measurement.

It was the intention of Professor Crafts to complete the paper on vapor pressures by one containing the results of his measurements upon the substance benzophénone, which, however, he was not able to prepare for publication.

These papers form a fitting close to his labors, but at the same time show how great a gain to science might have been wrought had his physical strength been equal to his intellectual and experimental abilities.

Professor Crafts was a member of a number of learned societies besides the National Academy, among which were the American Academy of Arts and Sciences, the American Association for the Advancement of Science, the American Chemical Society, the Washington Academy of Sciences. He was a Corresponding Member of the British Association and an Honorary Member of the Royal Institution of Great Britain. His club membership included in Boston the Somerset and Country Clubs and in New York the University and Technology Clubs, of which last he was an honorary member. His religious affiliations were with the Episcopal Church, and for a number of years he was a vestryman of Trinity Church, in the city of Boston.

The personality of Professor Crafts was such as to impress itself upon the memory of every one who came in contact with him. He was not only a scientist of the first order, but also a gentleman of the highest culture. It was a great pleasure to his younger colleagues, who frequently sought his laboratory for advice, to enter into conversation with him regarding collateral subjects and so to draw upon his long experience and seemingly inexhaustible knowledge.

His studies involved the greatest nicety of construction of

the apparatus used, which was largely done with his own hands. While his genius was by no means merely a capacity for taking infinite pains, this element of success was possessed by him in a surpassing degree.

His manner was quiet and gentle. His opinions were definite and positive, but he invariably showed great respect for the views of those who differed from him. The only thing which he seemed to hold in contempt was bad work in pupil or professor. He did not care in the least for display of any kind, and while valuing approbation at its proper worth, no desire for it ever influenced his actions. No man could have been more absolutely free from self-seeking. He had the affection of his colleagues and pupils and of the whole staff of mechanicians and janitors as well. A certain reticence of manner, wholly superficial in its character, served to protect him from triviality in those who had no claim on his attention. But when occasion called for it he showed the keenest sympathy for such as were in trouble of any kind. Speaking for those who knew him well, our remembrance of him is more and more strongly cherished with the lapse of time.

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