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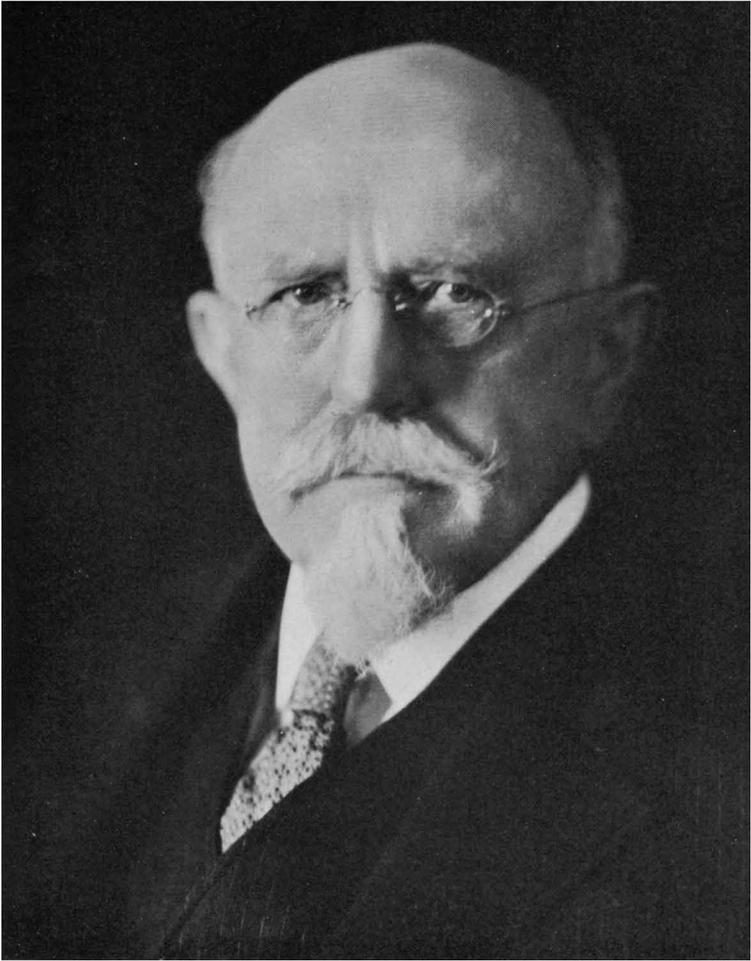
JOHN RIPLEY FREEMAN

1855-1932

BY

VANNEVAR BUSH

PRESENTED TO THE ACADEMY AT THE AUTUMN MEETING, 1935



John R. Freeman

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John Ripley Freeman, distinguished here and abroad as a civil engineer, hydraulician and pioneering expert in fire prevention and control, was born on his father's farm, West Bridgton, Me., July 27, 1855, and died at his own home in Providence, R. I., October 6, 1932. His professional life of fifty-six years was crammed with useful and largely original work—eagerly undertaken, thoroughly and brilliantly completed—which won for him the respect and liking of colleagues, the loyalty of co-workers, and grateful public appreciation.

Fortunate in possessing a vigorous body and a penetrating mind, he used these talents with unremitting zest: there was no lost motion in the running of this rugged and nicely adjusted mechanism of muscle, heart and nerve, over which ruled a will tensed for sustained effort and an intelligence that united insight with precision and force. He set a stiff pace for others, but spared not himself. If he exacted hard stints from his helpers, he inspired them, too, by enthusiasm and example; in the midst of a demanding job he kept no working hours, and scarcely knew how to call a day a day. Though the pressure of the drive was relentless, he stayed in the van through the toughest going. And to these qualities of character—industry and leadership—a third was added, integrity.

A distinctive gift of Dr. Freeman's was engineering intuition. Without the full mathematical equipment available and necessary to engineers of the new generation, he could nevertheless arrive, as by constructive shorthand, at clear concepts and dependable results. This was by no means guesswork: it was rather a function of his critical faculty, by means of which he could quickly find the soft spots in an engineering paper and would center upon the essentials of any undertaking. Thoroughness, almost to the point of skepticism, forced him

to review and test the findings of predecessors and colleagues alike; he was unwilling to accept others' views at second hand.

It was Dr. Freeman's critical faculty that led him to note how far engineers had failed to give due weight, in construction work, to geological formations, and he became intimately acquainted with the problems of engineering geology. Again, criticism showed him, early in his career, the need of trying out the principles of hydraulics concretely in the laboratory, by the use of scale models. This made him the determined advocate of a national hydraulic laboratory to be devoted to such work. His arguments and plans resulted in the establishment of the River Hydraulic Laboratory at the Massachusetts Institute of Technology and the National Hydraulic Laboratory in connection with the U. S. Bureau of Standards. His views in this field also were influential in the design of the River Hydraulic Laboratory at Vicksburg, Miss., constructed by the U. S. Army Engineer Corps as an aid in its river and harbor work.

In his later life, under the spur of ruinous losses from earthquakes in Japan, in California and elsewhere, he undertook, successfully, to discover what construction changes, at what added cost, were necessary to safeguard buildings from such losses. In this research he displayed, as always, his conspicuous skill in assembling and ordering all pertinent information; so that one product of this effort was a compendium of fact and interpretation in the field of seismology which serves as an indispensable handbook. And by his generous initiative he brought from Japan one of the outstanding authorities on earthquakes and earthquake damage, that this expert's special knowledge might be made available to workers in this country.

Dr. Freeman's career was notable also for the extent and value of his public services, and for his generous and devoted support of professional education; so that to review the scope and importance of his studies and contributions in these fields is to marvel at the sustained productivity of the man no less than at the quality of the product.

Yet, quite apart from engineering, Dr. Freeman enjoyed, so to speak, a second life, a life of distinguished attainment in a

separate field. From 1896 to the end, as head of a large group of fire insurance companies whose policies covered industrial structures, he effected economies and devised safeguards in fire protection which gained for him an international name. Indeed he was wont to say that insurance was his vocation, engineering his avocation; and his working time was about equally divided between these broad groups of activity.

Except for photography, in which as an amateur he delighted to interest himself, Dr. Freeman had no hobbies. He had, in fact, no recreations except those which most men might have counted as another sort of work. His visits abroad were not all diversion, for his itinerary always included the principal places where research work in hydraulics or hydraulic construction was carried on, and especially those places where Freeman scholars were engaged upon studies of which the results were later to be brought back for the benefit of American engineers.

Extraordinary notice was taken of Dr. Freeman's accomplishments and a fine tribute to his personal character was paid when, on April 21, 1931,—only a little more than a year before his death,—a testimonial dinner was given in his honor at Providence, R. I., sponsored by the Providence Engineering Society. Here, even in his own lifetime, Dr. Freeman received, capping his many academic honors and scientific awards, a very personal and intimate recognition from every quarter into which his many-sided labors had extended. He was prophetic and unconventional in much of his thinking and his downright and straightforward habit, his forceful and convincing personality, and his unquestioned achievements, raised him to a position of prominence and broad influence that all could and did respect.

After attending the country schools in his home town, Freeman continued his preparatory education in the public schools of Portland, Me., and Lawrence, Mass. In 1872 he entered the Massachusetts Institute of Technology, from which he was graduated in 1876 as a Bachelor of Science, from the Department of Civil Engineering. He then entered the service of the Essex Company, a water power company of Lawrence, Mass., where he acted in a double capacity as principal assistant to the company and chief aid of Hiram F. Mills, the company's engineer. Mills was a gifted pioneer in hydraulics, and through him Freeman

was soon in intimate association with other leading engineers of the time, among whom were Charles S. Storrow, James B. Francis, Joseph P. Davis, and John C. Hoadley.

At the Providence testimonial dinner Dr. Freeman, responding to the presentation of a memorial gift, told of the benefits he had derived from knowing and working with such men. He referred to an address by former President Faunce of Brown University, the printed title of which was: "Temptations Upward." "I have been wonderfully fortunate," said Dr. Freeman, "in the way I happened to be situated so as to be tempted upward by the men with whom I was thrown in contact, particularly in my earlier years."

While with the Lawrence company Dr. Freeman profited by his personal work with Mr. Mills, who then had a varied consulting practice that included, besides water power projects, problems of foundations and of factory construction. This period was, in substance, a well-rounded apprenticeship of ten years' duration.

At the end of this time, namely in 1886, Dr. Freeman resigned and came to Boston, Mass., as Engineer and Special Inspector for the Associated Mutual Fire Insurance Companies. Here he began those studies and innovations in measures for fire prevention and control that were to make him famous in this industrial field. Reorganization of these companies' inspection service was one step toward greater efficiency and reduction of fire losses. Another was a series of experiments designed to improve and standardize fire-prevention apparatus. A third took the form of scientific investigation of the causes of fires. He presented to the American Society of Civil Engineers, for example, a paper on "Experiments Relating to the Hydraulics of Fire Streams," for which he received the Norman Medal of the Society in 1890, and another on "The Nozzle as an Accurate Water Meter," for which he received the Norman Medal in 1891.

"While in Boston," relates the same Society's memoir of Dr. Freeman, he "arranged to give one-half of his time to a consulting practice in water power, municipal water supply, and factory construction. There he also began his long career in public service, to which he gave so much of his life. He was a member of the Water Board of Winchester, Mass., where he made his home,

and in 1895 and 1896 he was Engineer Member of the Metropolitan Water Board of Massachusetts, which was then engaged in preparing plans for a development of a large additional water supply from the Nashua River for the Boston Metropolitan District."

In 1896 Dr. Freeman was chosen President and Treasurer of the Manufacturers' Mutual Fire Insurance Company and Associated Companies. The offices were in Providence, and he left Boston for Providence to take up this work, which was to be a major concern of his life until the end. Here his business gifts were brought into full play, to the great gain of policy-holders. Between 1896 and 1932 the business of his companies increased more than forty-fold, while losses were reduced to one-fourteenth of their amount in 1896 and returns to policy-holders in dividends rose to 96 per cent of the premiums. At the same time he continued his efforts to reduce loss of life and property through fire. Especially worthy of note were two writings of his during this period: "The Safeguarding of Life in Theatres" (1905) and a paper on "The Fire Protection of Cities," which was presented to the International Engineering Congress at San Francisco, Calif., in 1915.

Dr. Freeman was always deeply interested in city water supplies and his engagements on problems involving such supplies, as phrased in the memoir that accompanied the award of the John Fritz Medal, "included the greatest enterprises of a half century." In addition to the project for the Boston Metropolitan District already mentioned, certain others in a long list are outstanding. In 1899 he was invited to study water-supply problems of New York City. This resulted in a notable report and in an invitation to serve as chief engineer of the Department of Water Supply, Gas and Electricity, which he declined. He served as member of the Commission on Additional Water Supply of New York City. This was the board of three members, commonly referred to as the Burr-Hering-Freeman commission, which directed the building of the great Catskill Mountain water supply system. Dr. Freeman would not accept the post of chief engineer on this project, but all three members were consulting engineers and Dr. Freeman, who had been highly influential from its beginning, continued his services till his death. In 1907

and 1908 he was also senior consulting engineer to the New York State Water Supply Commission.

San Francisco, Los Angeles, San Diego, Mexico City, Baltimore, Md., Seattle, Wash., and Denver, Colo., were others of the leading cities in which Dr. Freeman's advice on water supply problems was sought and obtained. Among water storage projects which he studied, was one for a reservoir on the Sacondaga River, in the Adirondack region, New York, which has since been constructed.

Water power projects upon which he was consulted included the Massena development on the St. Lawrence River for the St. Lawrence Power Company and its successor, the Aluminum Company of America. He also aided the Aluminum Company in power developments on certain Southern rivers and on the design and construction of new smelting works at Niagara Falls, N. Y. He made investigations on power development for the Canadian Government in Alberta, Manitoba, and British Columbia, and designed dams for the Mexican Northern Power Company and for the Pacific Gas and Electric Company at Lake Spaulding, California. He designed and supervised the construction of a high masonry dam on the Missouri River at Holter, Mont.

"Not the least of Dr. Freeman's contributions in the broad field of hydraulic engineering," says the memoir of the American Society of Civil Engineers, "were those on problems of river control and navigation. Among his writings on these matters was a paper on 'Flood Control of The River Po in Italy,' which was presented at the meeting of the Society in June, 1928, and for which he received the J. James R. Croes Medal on January 21, 1931."

As chief engineer of the Charles River Dam Commission, of Massachusetts, Dr. Freeman prepared in 1903, a report recommending that the lower estuary of the river be converted into a fresh-water lake—the now familiar and much admired Charles River Basin. This report was an admirable example of Dr. Freeman's thoroughness, critical judgment and clear and cogent reasoning. The recommendations, in almost all particulars, were followed.

In the account of Dr. Freeman's work in the memoir of the American Society of Civil Engineers, appears the following:

"In 1904, he reported to the Massachusetts Metropolitan Park Commission on the improvement of the Mystic River and the improvement of the Fresh Pond marshes. In 1905, 1908, and 1915, Dr. Freeman was appointed by the President of the United States a member of Engineering Boards to report on a sea-level *versus* a lock canal and on problems of dam and lock foundations, and earth slides that blocked the Isthmus of Panama several times. From 1917 to 1920, he acted as consulting engineer to the Chinese Government on the improvement of the Grand Canal and the prevention of disastrous floods on the Yellow River and the Hwai River, organized a staff of engineers to investigate these problems, and went to China himself in 1919. Between 1924 and 1926, Mr. Freeman was a member of the Engineering Board of Review of the Sanitary District of Chicago and prepared a program for the regulation of the Great Lakes. His report on these matters included exhaustive studies of winter evaporation from the Great Lakes and of minor earth movements or tilting affecting the problem of lake levels."

As Dr. Freeman's professional pre-eminence was in hydraulic engineering, it is of particular interest to note and to emphasize his determining influence in bringing about the establishment of hydraulic laboratories in this country, as briefly set forth in the foregoing. He had been a member of the American Society of Civil Engineers for forty years when, as newly chosen president, he made an address at the annual convention of the Society at Portsmouth, N. H., on June 21, 1922, in which his initiative on this subject is traced to its very source. The address, covering 52 typewritten pages, is in its entirety a good illustration of Dr. Freeman's comprehensive method of dealing with his subject, in this case an outline history of progress in hydraulics. But, especially, it reveals that it was as early as 1912 that Dr. Freeman had dreamed his hydraulic laboratory dream. He said:

"For ten years past I have been thinking of the benefits that might come from a hydraulic laboratory, built on a large scale, in which sundry important observations could be made, and nine years ago [1913], I visited the New Flussbau Laboratorium of the Technische Hochschule at Dresden, Germany. Three years

ago, I urged the value of such a laboratory on a group of members of the Society gathered at lunch in San Francisco, Calif., urging that, if established at their great University of California, it would contribute greatly to the economic solution of some of the problems of the Sacramento River and of the problems presented by some of the torrential streams that at times rush down the Pacific delta cones. . . . On several occasions I have suggested the value of such a laboratory *somewhere* in the United States." He was led to believe, he added, "that *now is the time* to urge the importance of immediately constructing a National Hydraulic Laboratory, on a large scale, in some locality where it will be in a scientific atmosphere (for, in addition to many simple matters of experiment and observation, there are some very obscure phenomena of intricate hydrodynamics, colloidal physics, and other abstruse matters to be considered), which shall be at the service of whatever branch of the Government may need it. First, for a season, say, in the service of the River and Harbor Engineers; next, perhaps, of the Hydrographic Branch of the U. S. Geological Survey; next, possibly, for some months, in the hands of the Reclamation Service; and, next, perhaps, serving the Department of Agriculture; and sometimes serving a special purpose outside the Government service. Such a laboratory, operated in close parallel to studies on the real river, can be made to give a new impetus to several extremely important branches of hydraulic science, and give precise data which we lack in important fields."

Further on in this address Dr. Freeman sketched the work done in European hydraulic laboratories he had visited.

During later visits, in 1924, to hydraulic laboratories in Europe, Dr. Freeman proposed the compilation and publication of a German work in which these establishments should be described and their practice and achievements set forth. This suggestion was urged by him upon the engineers in charge—Professors Engels, de Thierry, Rehbock and Smrček—and upon Dr. Conrad Matschoss, Secretary of the Society of German Engineers, all of whom agreed to it. The result was the publication, in 1926, of "The Hydraulic Laboratories of Europe" ("Die Wasserbau Laboratorien Europas"), a work of 431 pages, for which Dr. Freeman himself wrote the introductory chapter. An

English translation of this volume, brought down to 1929, was published in that year. Additions had expanded it to 868 pages, and more than one-half the cost of translation and publication was borne by Dr. Freeman, as gracefully acknowledged by Professor de Thierry at the time of Dr. Freeman's death. This book, of which the English title is "Hydraulic Laboratory Practice," is referred to and used widely as a standard reference by workers in hydraulics.

The importance of Dr. Freeman's influence upon engineering education has been intimated at many places in the foregoing record. It is not, however, to be fully understood without more detailed references to his distinguished services in this field. Dr. Freeman was offered the Presidency of the Massachusetts Institute of Technology, and his declination was due solely to a conviction that his main strength lay rather in the professional and the business domains. Moved by like considerations, he twice declined invitations to serve at Harvard as professor of civil engineering. His only teaching activity was as lecturer on the subjects of hydraulics, and of fire protection and fireproof construction, at the Institute, during the years 1890-1902. And yet it may justly be said that his educational activity, both direct and indirect, was prodigious. His sponsorship of "Hydraulic Laboratory Practice," and his previously mentioned compilation on seismology, "Study of a Rational Basis for Earthquake Insurance"—a volume of 904 pages, called by a colleague an "Encyclopaedia of Seismology"—would in themselves, for example, prove his title to the name of educator; many others of his writings and reports would confirm it. But Dr. Freeman did far more than such studies could do to promote the extension of knowledge and to aid both students and teachers.

On October 11, 1893, Dr. Freeman was elected to membership on the Corporation of the Massachusetts Institute of Technology. From that time till the time of his death he served regularly and faithfully on Visiting and Advisory Committees. He was always especially interested in the Department of Civil Engineering and in work in hydraulics, to which he made such notable contributions. In 1912 he was in charge of the committee to investigate the interior arrangements of the new Institute buildings in Cambridge.

Again, Dr. Freeman contributed generously to technical education when in 1923 he gave \$25,000 to each of three engineering societies—the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the Boston Society of Civil Engineers—for travelling scholarships in hydraulics, open to young engineers and junior professors.

Through his interest in seismology, and his generosity, Dr. Freeman brought to this country as a lecturer, the distinguished Japanese seismologist already referred to, Kyoji Suyehiro.

Dr. Freeman's public services as consulting engineer, to which reference has been made, were supplemented by other public services. These are numbered by the Freeman memoir of the American Society of Civil Engineers in the following words:

“. . . Dr. Freeman was active during the World War as a member of the National Advisory Committee for Aeronautics, and reported at that time on the Hog Island Shipyard. He was also a member of the Visiting Committee of the Bureau of Standards, Washington, D. C. In Providence, which became his home after 1896, he identified himself with many local activities. In 1911, he made a study of city planning for the east side of Providence, including new highways, parkways, and parks. He also carried on as a private venture a large real estate development of higher character in the vicinity of his home. He served for ten years as a Director of the Rhode Island Hospital Trust Company and of the National Bank of Commerce, in Providence; in 1904, he was a member of the Rhode Island Metropolitan Park Commission; and during the war, served as President of the Providence Gas Company.”

At the testimonial dinner of April 21, 1931, the following telegram was read by U. S. Senator Felix Hebert of Rhode Island:

“The White House,
Washington, April 9, 1931

“Honorable Felix Hebert,
Providence, Rhode Island
My Dear Senator Hebert:

“I deeply regret that public business prevents my attending the dinner being given to Mr. John R. Freeman. I would be glad if you would convey to Mr. Freeman's friends the high apprecia-

tion which I and every engineer hold, not only for Mr. Freeman's great technical accomplishments, but for his many public services.

"Yours faithfully,

"HERBERT HOOVER."

Dr. Freeman, in 1888, married Elizabeth Farwell Clark. They had six sons, Clarke, Hovey T., John R. Jr., Evert W., Roger M., and Nathaniel D., and one daughter, Mary Elizabeth, now Mrs. Mary Elizabeth Freeman Clifford. Roger M. Freeman and Nathaniel D. Freeman are deceased.

DEGREES AND HONORS

Bachelor of Science, Massachusetts Institute of Technology, Department of Civil Engineering, Boston, Mass., June, 1876.
Elected Honorary Member Phi Beta Kappa at Brown University, 1901.
Doctor of Science, Brown University, 1904.
Doctor of Science, Tufts College, 1905.
Member National Academy of Sciences, 1918.
Doktor Ingenieur, Ehrenhalber, der Sächsischen Technischen Hochschule, Dresden, Germany, June, 1925.
Honorary Member, Marsaryk Academy of Works, Czecho-Slovakia, 1926.
Doctor of Science, University of Pennsylvania, 1927.
Ehrenbürger (Honorary Member) der Badischen Technischen Hochschule, Karlsruhe, Germany, January, 1929.
Doctor of Science, Yale University, 1931.
Mitglied des Wissenschaftlichen Beirats des Forschungs-Institutes in München und Walchensee, Bavaria, Germany, January, 1931.
Fellow of the American Academy of Arts and Sciences.

MEDALS

Norman Medal of the American Society of Civil Engineers, November, 1890.
Norman Medal of the American Society of Civil Engineers, June, 1891.
Gold Medal of the American Society of Mechanical Engineers, December, 1923.
J. James R. Croes Medal of the American Society of Civil Engineers, 1931.
Awarded the John Fritz Medal posthumously in December, 1934.

RECIPIENTS OF THE JOHN R. FREEMAN TRAVELLING SCHOLARSHIP

American Society of Civil Engineers

Professor Lorenz G. Straub, Experimental Engineering Laboratories, University of Minnesota, Minneapolis, Minn.

- Professor F. T. Mavis, University of Iowa, Iowa City, Iowa.
Professor M. P. O'Brien, 228 Mechanics Building, University of California, Berkeley, Calif.
Professor C. E. S. Bardsley, Missouri School of Mines and Metallurgy, University of Missouri, Box 88, Rolla, Mo.
Professor J. G. Woodburn, State College of Washington, Pullman, Wash.
Captain Hans Kramer, U. S. Engineer Office, Memphis, Tenn.
Mr. Herbert H. Wheaton, Fresno State College, Fresno, Calif.
Mr. Donald P. Barnes, 1596 Monte Vista Street, Pasadena, Calif.

American Society of Mechanical Engineers

- Mr. Herbert N. Eaton, Bureau of Standards, Department of Commerce, Washington, D. C.
Professor Blake R. Van Leer, Dean of Engineering, University of Florida, Gainesville, Fla.
Professor Robert T. Knapp, California Institute of Technology, Pasadena, Calif.
Mr. Reginald Whitaker, U. S. Naval Torpedo Station, Newport, R. I.
Mr. G. Ross Lord, University of Toronto, Toronto, Ontario, Canada.
Captain Hugh Casey, U. S. Army, Corps of Engineers, Washington, D. C.

Boston Society of Civil Engineers

- Professor K. C. Reynolds, Massachusetts Institute of Technology, Cambridge, Mass.
Mr. Samuel Schulits, U. S. Reclamation Bureau, Denver, Colo.
Mr. Clifford P. Kittredge, 815 Grosvenor Building, Providence, R. I.
Mr. L. L. DeFabritis, York Ice Company, York, Pa.
Mr. Leslie S. Hooper, Worcester Polytechnic Institute, Worcester, Mass.

BIBLIOGRAPHY

- Broadway draw bridge, Boston, Mass. M. I. T. C. E. Dept. Thesis 1876. 49 pp.
Percolation through Embankments. Trans. Boston Soc. Civ. Engrs., June 20, 1888. (In Assoc. Eng. Soc. Jl. v. 7, 1888, pp. 489-494.)
Prudence in Pillar Designs. Trans. Boston Soc. Civ. Engrs., Sept. 18, 1889. (In Assoc. Eng. Soc. Jl. v. 8, 1889, pp. 549-552.)
Experiments relating to the Hydraulics of Fire Streams. (A research upon the height and character of jets of water thrown from fire nozzles of many kinds. Also upon the flow of water and loss of head in fire hose of various kinds, over a wide range of velocities.) (Received the Gold Medal of A. S. C. E.) Trans. A. S. C. E., v. 21, 1889, pp. 303-482.
Comparison of English and American Types of Factory Construction. Trans. Boston Soc. Civ. Engrs., read Sept. 17, 1890, Jl. Assoc. Eng. Soc., v. 10, 1891, pp. 19-51.

- The Nozzle as an Accurate Water Meter. (Received the Gold Medal of A. S. C. E.) *Trans. A. S. C. E.*, v. 24, June, 1891, pp. 492-527.
- The Arrangement of Hydrants and Water-Pipes for the Protection of a City against Fire. *Jl. New England Water Works Assoc.*, v. 7, Sept. 1892, pp. 49-77.
- The Bursting of the Portland, Maine, Reservoir. Report of investigation of cause. *Jl. New England Water Works Assoc.*, v. 8, No. 3, 1893, March (pp. 148-154).
- Construction of Reservoir Embankments. Remarks at the Meetings of the Boston Soc. of Civ. Engrs. held Sept. 20 and Oct. 18, 1893.
- The Bursting of the Distributing Reservoir at Portland, Maine, August 6, 1893. *Trans. Boston Soc. Civ. Engrs. Assoc. Eng. Soc. Jl.*, v. 13, 1894, pp. 148-153.
- Report to the Town of Winchester, Mass., on the Improvement of Its Water Supply and Its Future Requirements. *Town Reports*, 1894.
- James Bicheno Francis: a memoir. (In collaboration with Desmond Fitzgerald and J. P. Davis.) (*In Assoc. Eng. Soc. Jl.*, v. 13, January, 1894, pp. 1-9.)
- Hoisting Apparatus of the Canal Head Gates at Sewall's Falls, N. H. *Trans. A. S. C. E.*, v. 32, Sept., 1894, pp. 278-294.
- Description of a New Form of Canal Waste Weir. *Trans., A. S. M. E.*, v. 15, June, 1894, pp. 669-684.
- Report upon New York's water supply with particular reference to the need of procuring additional sources and their probable cost with works constructed under municipal ownership. Made to Bird S. Coler, Comptroller. N. Y. 1900. 587 pp. (Preliminary study of ground water sources of Long Island.)
- Silas Whitcomb Holman, class of '76, M. I. T. *Technology Review*, v. 3, January, 1901, pp. 13-30.
- Report (in collaboration with F. P. Stearns and J. H. Schuyler) on the Future Water Supply of Los Angeles, Calif., 1902.
- New York's Need for Additional Water Supply. National Board of Fire Underwriters Annual Report, 1902, about 20 pp.
- Construction Details, Jerome Park Reservoir, New York Water Supply. Report to the Aqueduct Commissioners (with Wm. H. Burr and Rudolph Hering), July 28, 1903, 16 pp.
- Report of Commission on Additional Water Supply of City of New York (with W. H. Burr and Rudolph Hering). Nov. 30, 1903, N. Y. 1904, 15 + 980 pp.
- Report of the Committee on Charles River Dam . . . to consider the advisability and feasibility of building a dam across the Charles River at or near Craigie Bridge. Boston State Printer, 1903, 579 pp.
- Report to the Massachusetts Metropolitan Park Commission on the Improvement of the Upper Mystic River and Alewife Brook by means of tide gates and large drainage channels. September, 1904, 109 pp.

- On Contemporary Technical Education. (An address at the installation of President Charles S. Howe at the Case School of Applied Science, Cleveland, Ohio, May 11, 1904.) *Jl. Assoc. Eng. Soc.* v. 33, No. 2, August, 1904, pp. 58-72.
- On the Safeguarding of Life in Theatres: being a study from the standpoint of an engineer. (A comprehensive study of theatre fires, their causes and means of prevention.) N. Y. A. S. M. E. 1906, 106 pp. (A reprint.) Also printed in *A. S. M. E. Trans.*, v. 27, 1905-06, pp. 71-170.
- Reports relating to Providing an Additional Water Supply for the City of New York (with Wm. H. Burr and Rudolph Hering). A report to the Mayor and Board of Estimate, January, 1905, 36 pp.
- Concerning the Proposed Alliance between the Massachusetts Institute of Technology and Harvard College. *The Technology Review*, May 4, 1905, 30 pp. (A reprint.) Also in *Technology Review*, May 4, 1905, v. 7, pp. 26-52.
- Proposed Reservoirs on the Blackstone River. Report to a committee of mill owners, on river discharge, designs for dams, estimates of cost and many maps, tables and diagrams, October 30, 1906, about 30 pp.
- Reports to the New York State Water Supply Commission on investigations relative to feasibility and cost of construction of great dams on difficult foundations for water storage, flood relief and power development on the Hudson River at Sacondaga, and on the Genesee River at Rochester, N. Y., with designs and estimates. Albany, N. Y., State Printers, February, 1908, 250 pp.
- Lock or Sea Level? The Problem of the Panama Canal. *The Lock Canal. The Outlook*, v. 91, 1909, pp. 931-943. Also in the *Congressional Record*, 1909, 14 pp.
- The Conservation of Water. An address at a joint meeting called by the four National Engineering Societies: A. S. C. E., A. S. M. E., A. I. M. E., and A. I. E. E., New York, March 24, 1909, 13 pp.
- Water Supply of Baltimore, Md. (with F. P. Stearns) March 25, 1910, about 75 pp. with appendices.
- Reports . . . relative to Improved Highways and Parkways for the East Side of Providence. (Reports on improved highways, parks and parkways for the East Side of Providence, R. I. A study in city planning, with detailed designs and estimates of cost, April, 1911.) 1912. 128 pp.
- On the proposed use of a portion of the Hetch-Hetchy, Eleanor and Cherry Valleys . . . for the Water Supply of San Francisco, Calif., and neighboring cities. With especial reference to a supply from the Hetch-Hetchy Valley with location adapted for maximum water power development with detailed designs and estimates of cost. San Francisco, July, 1912, 401 pp.
- The Fire Protection of Cities. A paper presented at a meeting of the International Engineering Congress, 1915, in San Francisco, Calif., September 20-25, 1915. 19 pp.

- Hog Island Shipyard. Report to an investigating committee of the United States Senate, March, 1918, published in the Report of the Shipping Board Emergency Corporation, pp. 2355 to 2384.
- The Grand Canal of China: addresses at a dinner given in honor of Mr. John R. Freeman by J. Ripley, and at a dinner given Mr. Freeman by their Excellencies, Chin Yun-P'eng and Hsiung Hsi-Ling . . . at the Navy Club, Peking, October 25, 1919. Tientsin North China Star. 1919. 67 pp. (In English and Chinese.)
- Flood Problems in China. (A paper before the A. S. C. E. based on the writer's personal explorations and surveys along portions of the Yellow River, Hwai River, and the China Grand Canal, etc., including, also, tentative plan for flood relief in the Lower Hwai District.) Trans. A. S. C. E., v. 85, May, 1922, pp. 1405-1460.
- Progress in Technical Education: Specifications for a College President, Remarks . . . at Technology Alumni Banquet . . . Washington, D. C., February 2, 1922. Technology Review, April, 1922. 20 pp., including biographical sketch of J. R. F. (A reprint.) Also in Technology Review, v. 24, 1922, pp. 173-187.
- Address at the Annual Convention, Hotel Wentworth, near Portsmouth, N. H., June 21, 1922. (Presidential address, A. S. C. E. Subject: Recent progress in the development of the aims of the Society, and progress and development of hydraulic science from earliest times.) Proc. A. S. C. E., August, 1922. 28 pp. (A reprint.) Also in Proc. A. S. C. E., v. 48, 1922, pp. 1351-1380.
- The Fundamental Problems of Hydroelectric Development. An address at a joint meeting of the A. S. C. E., the A. S. M. E., and the A. I. E. E., New York, December 5, 1923, 31 pp. (A reprint.) Also in Trans. A. S. M. E., v. 45, 1923, pp. 527-566.
- The Need of a National Hydraulic Laboratory for the Solution of River Problems, etc. Trans. A. S. C. E., v. 87, 1924, pp. 1033-1097. Also same as a preprint. New Orleans A. S. C. E. 1923, 62 pp.
- General Review of Current Practice in Water Power Production in America. A paper presented at the First World Power Conference held in London, July, 1924, 36 pp.
- Report on the Water Supply of the City of San Diego, Calif., with estimates on available sources, studies of precipitation, storage, designs of dams, etc., for their development, and estimates of cost. A Municipal Report. May, 1923.
- Taming the Mississippi. (A presentation of some of the most important flood problems of the Mississippi River, with special reference to the floods of 1922 and 1927.) The Outlook, v. 146, June 8 and 15, 1927, pp. 182-186; 219-222.
- Sanitary District of Chicago. Engineering Board of Review on the Lake Lowering Controversy. (J. R. F., member.) Pt. 1. Recommendations including brief statement of findings and conclusions. 1924, 17 pp. Pt. 2. Technical bases for the Recommendations of the Board of Review. 1925, 109 pp.

- The Regulation of the Great Lakes. A report to the Sanitary District of Chicago. (A comprehensive study of fluctuations in elevation and discharge, also of the rainfall, evaporation and run-off of the Great Lakes region in the Northern United States. Designs of structures for regulating the discharge and the elevations of Lakes Michigan, Huron and Erie are presented with estimates of cost. A particularly interesting study is that of the winter evaporation from the vast water surface which has no ice cover. Also a study of the earth tilt now going on in this region.) May, 1927, 565 pp.
- Needed: More Science in Flood Control. (An address before the Faculty Club of the Massachusetts Institute of Technology.) *The Technology Review*, December, 1927. 8 pp. (A reprint.) Also in *Technology Review*, v. 30, 1927-28, pp. 95-102.
- Po River flood-control works: some observations. *Eng. News Record*, v. 100, 1928, pp. 506-507.
- Flood Control on the River Po in Italy. (A report of a recent tour of inspection and an historical review. It is shown that the reports that this river is constantly raising its bed by reason of the sediments carried and the confinement between levees, are erroneous.) *Proc. A. S. C. E.*, v. 53, 1928, pp. 957-992. Author's closure on above. *Proc. A. S. C. E.*, v. 55, 1929, pp. 1227-1231. Also in *Trans. A. S. C. E.*, v. 94, 1930, pp. 161-196.
- Hydraulic laboratory practice; comprising a translation, revised to 1929, of *Die Wasserbaulaboratorien Europas*, published in 1926 by Verein Deutscher Ingenieure, including also descriptions of other European and American laboratories and notes on the theory of experiments with models. N. Y. A. S. M. E., 1929, 868 pp.
- Progress in Hydraulic Laboratory Research. Paper No. 767, 8 pp. World Engineering Congress, Tokyo, Japan, 1929. *Proc. v. 14, Engineering Science*, Pt. 2. pp. 313-320. Also in *Association of Chinese and American Engrs. Jl.*, v. 10, 1929, pp. 40-49.
- Genesis and Evolution. *American Machinist*, Special No., April 3, 1930, pp. 551-573. (Condensed history of A. S. M. E. by 17 living past presidents, including J. R. F., p. 555.)
- Engineering Data Needed on Earthquake Motion, for Use in the Design of Earthquake-Resisting Structures. *Bull. Seismological Society of America*, June, 1930, v. 20, No. 2, pp. 67-86.
- The Italian Earthquake of July 23, 1930. *Bull. Seismological Society of America*, v. 20, No. 4, December, 1930, pp. 1-24.
- Ice as affecting power plants. Final report of Committee of Power Division. *Proc. A. S. C. E.*, v. 56, 1930, pp. 743-759. Same in *Trans. A. S. C. E.* v. 95, 1931, pp. 1134-1150.
- Design of National Hydraulic Laboratory . . . at the U. S. Bureau of Standards. Presented by Mr. Hebert. Senate document No. 208, 1930, 25 pp.
- National Hydraulic Laboratory, Progress Report. Senate document No. 308, 1931, 16 pp.

Earthquake damage and earthquake insurance; studies of a rational basis for earthquake insurance; also studies of engineering data for earthquake-resisting construction. N. Y. McGraw-Hill, 1932, 904 pp. "Some afterthoughts of J. R. F. and a few notes from the Suyehiro lectures, January 18, 1932." 3 pp. attached to inside back cover.

Researches on Flow of Water in Pipes, Elbows and Tees. Description of an extensive series of very accurate experiments upon loss of head in wrought iron pipes of all commercial sizes from $\frac{1}{4}$ inch to 8 inches in diameter, at velocities from 0.5 to upward of 20 ft. per sec. Also upon smooth brass pipes from $\frac{1}{2}$ inch to 4 inches in diameter. Also upon old and tuberculated pipe and pipe with an extremely rough lining of expanded metal lath. (In preparation, 1935.) (Mr. C. P. Kittredge, Freeman Eng. Corp., Providence, R. I., is continuing work on above.)