

**REGISTER OF THE BERNARD A. BEHREND COLLECTION
1830-1982, bulk 1890-1932**

Bernard Arthur Behrend, 1875-1932

**Mss 240, 52 boxes (28.29 cu. ft.), 11 oversize folders,
10 boxes (4.066 cu. ft.) and 1 oversize folder
of photographs, 25 artifacts**

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INTRODUCTION

This collection consists of the personal papers of Bernard Arthur Behrend, which document his long career as an electrical engineer, inventor, scholar, and author, including material relating to Mr. Behrend's book, *The Induction Motor*. In addition, the collection includes material on subjects of which he had an interest as a scholar and hobbyist. There is correspondence between Behrend's widow and donor of the Collection, Margaret Chase Behrend, and the author Julia Peterkin, and with Clemson College officials. The Bernard A. Behrend Collection reflects the world of science and electrical engineering from the period of the late nineteenth century to the early twentieth century. The collection was processed by Laurie Varenhorst and student assistant Melissa Paulk in 2001. The register was written by Laurie Varenhorst in 2001. The material in the collection was accessioned as 85-24, 88-150, 89-111, 90-16, 91-6, and 94-17.

BIOGRAPHICAL NOTE

Bernard Arthur Behrend was born on May 25, 1875, in Villeneuve, Switzerland, the youngest of seven surviving children, to Moritz and Rebecca (Wolf) Behrend. His family had been long associated with the paper manufacturing business; his father was involved in the early development of the sulphite process in papermaking and founded the Hammermill Paper Company in Germany and, at a later date, in Erie, Pennsylvania. Because of his precocity Behrend's education was for the most part self-directed and informal. After his first early training under an English tutor, Behrend attended educational institutions in Germany, France, and England, studying at will under chosen leaders of scientific thought, including Hermann von Helmholtz, Augusta Kundt, Alois Riedler, Adolf Slaby, and Gisbert Kapp. Also, during his time in England, Behrend became an earnest student of English literature and of the writings of Thomas Henry Huxley, Charles Darwin, and John Stuart Mill. He studied civil engineering and mechanical engineering at the Polytechnic Institute in Charlottenburg, Germany, and the University of Berlin, from which he graduated in 1894 with a C.E. degree. In the following year, Behrend worked in England as an engineering assistant to Gisbert Kapp designing power plants.

Behrend joined the Oerlikon Company, Switzerland, in January 1896, where he was the assistant to the chief engineer in charge of the Experimental and Testing Departments while there he worked on the development and design of alternating-current and direct-current electrical machinery and the design of the Jungfrau Railway. During this period, Behrend

originated and developed the circle diagram for calculating the performance of induction motors in a simple and direct manner. In the summer of 1898, he immigrated to the United States and immediately applied for citizenship, and was granted naturalization in 1903. While getting settled in his new country, Behrend did some consulting work and gave a series of lectures on the theory and design of induction motors at the University of Wisconsin in Madison, at the invitation of Dugald Caleb Jackson in 1899. He was also a non-resident lecturer at Leland Stanford, Jr. University, San Francisco, California; McGill University, Montreal, Quebec, Canada; and the Massachusetts Institute of Technology in Cambridge. In addition, Behrend organized the first engineering training classes in Cincinnati, Ohio, under A. G. Wessling in 1901.

Behrend became associated with the Bullock Electric Manufacturing Company of Cincinnati in January 1900, and was shortly thereafter appointed its chief engineer. Until that time Bullock had manufactured only direct-current machinery but under Behrend's guidance the company successfully produced alternating-current machinery, including alternating-current generators and induction motors. He built Bullock's first turbo-alternator, which won a grand prize at the Louisiana Purchase Exposition in 1904 and brought Behrend a gold medal. In addition, the largest power unit of the exposition, a 96-pole, 3500 K.W. alternator, was also designed by him, and earned the name "Old Reliable" because the unit continued to work while others malfunctioned.

At the beginning of 1904, the Bullock Company was acquired by the Allis-Chalmers Manufacturing Company. Behrend became the chief engineer of the combined electrical departments. A few years later Behrend and his staff were transferred to the main plant at West Allis, near Milwaukee, Wisconsin. He retained his position as chief electrical engineer, but he was also made a consulting engineer to the Allis-Chalmers Bullock, Limited, of Montreal, Quebec, Canada. Behrend directed the designing and construction of many large alternating-current generators, which were driven by hydraulic turbines, steam turbines, or gas engines. Also, in collaboration with Ralph D. Mershon, Behrend brought about the first successful paralleling of several large power stations connected through transmission systems and synchronous frequency changers between Lachine Rapids and Shawinigan Falls.

In 1908 the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pennsylvania invited Behrend to take charge of the power division of their engineering department. The plate rotor for turbo-generators was one of the outstanding developments introduced by Behrend during this period. Two years later, due to health problems, Behrend moved to Boston, Massachusetts and opened an office as a consulting engineer and was retained in that capacity by the Westinghouse Company for many years. He designed large gas-engine-driven alternators for the power houses of Indiana Steel Company, Illinois Steel Company, United States Steel Corporation, and American Steel & Wire Company; the electric generating units for several electric power companies, notably a group of units for Niagara Falls, and the steam-turbine units of the Brooklyn Edison Company and the Brooklyn Rapid Transit Company. Behrend gave up the Boston office in 1926 and continued his consulting business from his new self-designed home and laboratory at Wellesley Hills, Massachusetts.

Behrend published a book, *The Induction Motor: A Short Treatise on Its Theory and Design*, in 1901, which was based on his 1899 lectures at the University of Wisconsin. Translations of this book appeared in French (1902), German (1903), and some sections

later even in Japanese. In 1921, he brought out a new edition, considerably enlarged and revised, entitled, *The Induction Motor and other Alternating Current Motors*, which Behrend dedicated to his friends Nikola Tesla, Gisbert Kapp, André Blondel, and C. E. L. (Charles Eugene Lancelot) Brown. In addition, Behrend was the author of numerous monographs and articles, among which were: "The Debt of Electrical Engineering to C. E. L. Brown" (1901); "Engineering Education" (1907); "The Career of Oliver Heaviside" (1925); "The Work of Oliver Heaviside" (1928); and "Recent Developments in Precision Bench Tools" (1923).

Behrend was a fellow of the American Institute of Electrical Engineers and served on a number of their committees, such as the Edison Medal Committee and the Electrical Machinery Committee (Chairman). Also, he was a Senior Vice-President of the Institute and was active on the Board of Directors. In addition, Behrend was a Fellow of the American Association for the Advancement of Science; the American Physical Society; the American Academy of Arts and Sciences; and a member of the American Society of Civil Engineers; the American Society of Mechanical Engineers; the Institute of Electrical Engineers (British); the Franklin Institute; and the Society for the Preservation of New England Antiquities. He was also a member of the Engineers Clubs in New York City and Boston, and the Athletic Club in Pittsburgh, Pennsylvania.

Behrend was granted over 80 patents, most of which were assigned to the companies that he represented. In 1912 the city of Philadelphia, Pennsylvania awarded him the John Scott Medal, with the recommendation of the Franklin Institute, for meritorious achievements in high-speed machinery. In 1931 the University of Darmstadt in Germany conferred upon Behrend the honorary degree of Doctor of Engineering, "in appreciation of his meritorious development of electrical machinery, particularly of polyphase and single-phase induction motors".

Bernard Behrend married Margaret Plummer Chase (born October 7, 1895) of Brookline, Massachusetts in 1926. He died on March 25, 1932 at his home in Wellesley Hills, Massachusetts. Margaret Behrend married Dr. Dudley Phelps Sanford in 1944, but, later in the forties, she divorced him and reclaimed the Behrend name. Margaret Chase Behrend died on July 21, 1982 in Carmel, California.

SCOPE AND CONTENT

The Bernard A. Behrend Collection covers the time period from 1830 to 1982, with the bulk of the records dating from 1890 to 1932. Included in this collection are blueprints, conference papers, correspondence, notes, magazine and newspaper articles, manuscript drafts, memorabilia and photographs. The folders are arranged alphabetically by subject and then chronologically within each folder.

The majority of the Behrend Collection consists of the material that he used in his work as an electrical engineer and inventor. Cost summaries, winding specifications, diagrams, test sheets, notes, some correspondence and memos, as well as reports on different types of generators and motors, such as alternating current generators and variable speed motors, can be found in the Allis Chalmers-Bullock material. In addition, there are two contracts and some correspondence regarding the construction of a heavy-duty engine for the Hammermill Paper Company in Erie, Pennsylvania; and information on the Niagara Falls Hydraulic Power and Manufacturing Company and its generators. There are printed bulletins with pictures and

diagrams, which describe equipment connected with electrical motors and generators that were manufactured by Bullock Electric Manufacturing Company, General Electric Company, and Westinghouse Electric and Manufacturing Company. The collection contains numerous handwritten notes and diagrams concerning mechanical and electrical engineering, which were used by Behrend in his laboratory work.

Correspondence related to the Bullock Electric Company and Westinghouse, as well as Allis-Chalmers, pertaining to discussions of various aspects of engineering and work related matters such as arranging meetings, reducing work forces and expenses, and moving Bullock from Cincinnati, Ohio to Milwaukee, Wisconsin, are filed in the collection. There is correspondence related to Bernard Behrend's work as a consulting engineer, which includes companies and organizations such as American Institute of Electrical Engineers, The Hendey Machine Company (Torrington, Connecticut), Massachusetts Institute of Technology, and Maschinenfabrik Oerlikon (Zurich, Switzerland). However, a majority of the correspondence is with Carl Richard Soderberg, a mechanical engineer at Westinghouse. In addition, engineering correspondence with C. E. L. (Charles Eugene Lancelot) Brown of A. G. Brown, Boveri & Cie [Company], Baden (Schweiz), Germany, as well as a couple of letters from John Perry, a professor of engineering at the Royal College of Science in London, can be found in the correspondence with notables.

Behrend wrote numerous articles and conference papers which were printed in English, French, and German publications, and covered topics such as electric currents, electric generators and motors, electric machinery, induction curves, steam turbines, turbo generators, theories of the regulation of alternators and long distance transmission lines, and engineering education. In addition, a number of conference papers on experimental and theoretical physics of electricity and electronic motors by Comfort Avery Adams, Ernest F. Alexanderson, Frederick Bedell, André Eugene Blondel, Benjamin Garver Lamme, John Perry, and Carl Richard Soderberg are filed in the collection. Also included are a number of United States patents on different motors and generators such as alternating current motors, dynamo electric generators, electromagnetic motors, and steam motors. The folders are arranged alphabetically by the type of motor and generator, as well as by the names of the inventors. There is a bound volume of Bernard Behrend's United States patents and inventions.

Material on Behrend's book, *The Induction Motor*, include notes, diagrams, test sheets, as well as some patents, correspondence, and memos, which relate to the second edition. Also included are printed and typed drafts, and book galleys of the second edition. In addition, there are book reviews about the first and second editions of the book. Besides writing engineering publications, Behrend wrote a few addresses and papers on other topics such as food reform and vegetarianism, science and technics, scientific research, and evolution and struggle between science and technology, as well as tributes to C. E. L. (Charles Eugene Lancelot) Brown, Oliver Heaviside, Thomas Henry Huxley, and Andrew Dickson White. He wrote an autobiographical essay, "Reminiscences", which was never published. All of these items are included in the Papers.

The collection contains articles pertaining to Oliver Heaviside, Thomas Henry Huxley, Lord William Thomson Kelvin, Goldwin Smith, Andrew Dickson Smith, Nikola Tesla, and Walt Whitman. In addition, there is correspondence related to Oliver Heaviside, Goldwin Smith, and Andrew Dickson White. Also included is some correspondence from Henrietta Anne Huxley to Bernard Behrend, as well as drafts of his letters to her. Furthermore, there

is a poem by Mrs. Huxley and her obituary from *The Times*. A printed draft and book galleys of *Heaviside's Operational Calculus* by Ernest Julius Berg (1929), as well as course notes which were used for a class at the Massachusetts Institute of Technology, are filed in this collection. There are some books by Goldwin Smith, which include *The European Crisis of 1870*, *A Trip to England*, and *Cowper*. Andrew Dickson White's lectures, addresses, and papers cover topics such as the Constitution and American education, evolution vs. revolution in politics, reforming the U.S. diplomatic service, and Russia. Finally, there is a little information about Otto von Bismark, Alexander Graham Bell, Charles Darwin, Thomas Ava Edison, Albert Einstein, Ralph Waldo Emerson, Michael Faraday, Abraham Lincoln, John Stuart Mill, Isaac Newton, Will Rogers, Bernard Shaw, Henry David Thoreau, and Booker T. Washington.

Materials relating to Behrend's interests as a scholar and hobbyist can be found within the collection. Behrend kept files on the European War (1914-1918) which include clippings from American newspapers, and a pamphlet of a reprinted letter to the editor of *The Sun* in which Behrend expresses his views about the war. Also included are two booklets on German proclamations posted in occupied Belgium and France, and the reasons why the four nations went to war. His interest in the heavens is documented by articles on the newly discovered planet Pluto and other aspects of astronomy. Moreover, correspondence and invoices related to purchasing rare books of science and literature are included in the collection. In connection to the rare books, there is material on William Makepeace Thackery whom Behrend highly regarded. Among this material are newspaper articles concerning the sales of letters of Thackery and Charlotte Bronte, as well as two articles in which Thackery states his views on slavery, *Vanity Fair*, and novels in general. Furthermore, there is an article that discusses the greatness and decline of Thackery, and a list of the Thackery Collection which was donated by Mrs. Behrend to Clemson. Behrend also had an interest in architecture; he designed his own residence and laboratory in Wellesley Hills, Massachusetts, the blueprints for which are in the collection. Also included are some drawings of the house and a few articles on early American furniture.

Material related to Margaret Chase Behrend is filed within this collection. There is some correspondence from Julia Mood Peterkin to Mrs. Behrend, as well as a black-and-white print of Julia Peterkin's profile which was signed by the South Carolina author. In the miscellaneous correspondence folders, a number of these letters are to Mrs. Behrend from Rollo Appleyard, a British engineer, physicist, and inventor. Considerable correspondence between Margaret Behrend and Clemson College can be found in the collection. It was the desire of the late Bernard Behrend that his wife donate his collection of rare books and personal laboratory to a small college. The correspondence deals with setting up the Behrend Laboratory at Clemson College, the donation of his rare books, a bookplate contest, and the donation of the Julia Peterkin letters. Some of the Clemson College notables mentioned in the correspondence are S. B. (Samuel Broadus) Earle, Dean of Engineering; Clemson Presidents Robert F. Poole, E. W. Sikes, and Robert C. Edwards; and Gordon Gourlay, Library Director. In addition, there are a few newspaper articles concerning Behrend's laboratory and rare book collection, as well as the bookplate contest. Finally, the collection has a cross-reference index file which was created by the Clemson College librarians when the papers were donated. The index is arranged alphabetically by subject and author.

The Behrend Collection contains an interesting group of black-and-white photographs, most showing electric motors, generators, and related electrical equipment. They include photographs showing electrical machinery and work scenes at Allis-Chalmers, Bullock, Westinghouse, and equipment at companies such as Kern River, Maschinenfabrik Oerlikon, Niagara Falls Power, North Mountain Power, Pratt & Whitney, Waltham Machine Works, and Turner Falls. There are also photographs of individuals, including Bernard Behrend, Otto von Bismarck, Charles Darwin, Henrietta Anne Huxley, Thomas Henry Huxley, Lord William Thomson Kelvin, Lady Frances Kelvin, Goldwin Smith, and Andrew Dickson White. The collection has some glass plate negatives which show the rooms of Behrend's home in Massachusetts and a generator plant disaster, as well as glass plate slides showing an eclipse of the sun, turbo-generators, and diagram charts. Among the oversize photographs are two of, and autographed by, Nikola Tesla.

Oversize materials include drawings of Thomas Henry Huxley, Charles Darwin, and William Makepeace Thackeray, as well as articles on Albert Einstein and Walt Whitman. In addition, there are articles on astronomy and Niagara Hudson, bookplates from a contest at Clemson College, and German newspapers concerning World War I. There are blueprints of Behrend's residence in Massachusetts, and many blueprints of various electric motors, generators, and related electrical equipment. Included in the artifacts are several medals, pins, nine mental test bars likely used in the investigation of a generator explosion, and engraved portraits of Lord William Thomson Kelvin and Edward Dean Adams.

The Bernard A. Behrend Collection will be especial interest to researchers interested in electrical engineering and science from the late nineteenth century to the early twentieth century. This collection contains a great deal of information about electrical motors and generators, as well as other areas of electrical engineering and related sciences. In addition, the collection gives a glimpse of the philosophy and the ideas of that time period. Bernard Arthur Behrend was an innovative electrical engineer and inventor whose revolutionary theories and discoveries became guiding principles for succeeding designers. The Behrend Collection reflects the important contributions that Bernard Behrend made to the development of electrical engineering in the United States.

It should be noted that more information on Julia Mood Peterkin, Oliver Heaviside, and Samuel Broadus Earle can be found in Mss 63, Julia Mood Peterkin Correspondence, 1922-1964; Mss 174, Oliver Heaviside Collection, 1918-1919; and Clemson University Archives Series 16, Samuel Broadus Earle Presidential Records, 1924-1925. Also, there are two positives of Bernard Behrend and two negatives of Margaret Chase Behrend in the Clemson University Archives Series 100—Photographs.