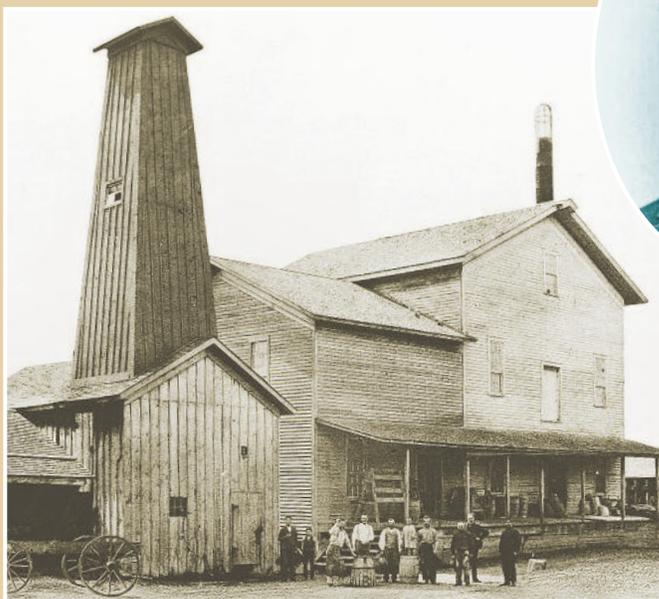


A NATIONAL HISTORIC  
CHEMICAL LANDMARK

# FIRST COMMERCIAL PRODUCTION OF BROMINE IN THE UNITED STATES

MIDLAND, MICHIGAN  
MAY 29, 1997



AMERICAN CHEMICAL SOCIETY  
Division of the History of Chemistry and  
The Office of Public Outreach

H. H. DOW.  
PROCESS OF EXTRACTING BROMINE.

No. 460,370.

Patented Sept. 29, 1891.



Replica of the Evens Mill which now houses the Herbert H. Dow Museum.

**T**his booklet commemorates the designation of the first commercial production of bromine in the United States as a National Historic Chemical

Landmark. This designation was conferred by the American Chemical Society, a nonprofit scientific and educational organization of more than 152,000 chemists and chemical engineers. A plaque marking the event was presented at the replica of the Evens Mill, which now serves as the home of the Herbert H. Dow Museum in Midland, Michigan. The inscription reads:

“In the original of this building about one mile east of this site, on January 4, 1891, Herbert H. Dow succeeded in producing bromine electrolytically from Midland’s rich brine resources. In the years that followed, this and other processes developed by Dow and the company he founded led to an increasing stream of chemicals from brines. The commercial success of these endeavors helped to promote the growth of the American chemical industry.”

**Acknowledgments:**

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*Witnessed*  
On the cover: Herbert H. Dow in 1888;  
Midland Chemical Company workers,  
1894; the Evens Mill.

*Herbert H. Dow*  
*1888*

*Herbert H. Dow*  
*1888*

# A TURNING POINT IN CHEMICAL HISTORY

In the late 19th century, chemical production in the United States was still in its infancy. Much of the nation's chemical supply was imported from Europe, especially from powerful producers in Germany and Great Britain. This state of affairs prevailed largely until World War I, which marked a turning point for chemical production in this country. With European imports cut off, American producers could, for the first time, make and market their chemicals without interference from the European cartels, which established prices and production quotas for the makers of key products.

In the early 1890s, pioneers of the U.S. chemical industry had begun to form a technological basis for competing with the European giants. Herbert H. Dow was one of the earliest of these trailblazers. As a college chemistry student in Cleveland, Ohio, he became interested in the brine deposits that underlie much of the American Midwest. Here was an almost inexhaustible pool of chemical materials deposited by the evaporation of prehistoric seas, just waiting, he perceived, to be exploited. In fact, where these deposits lay close to the earth's surface, enterprising

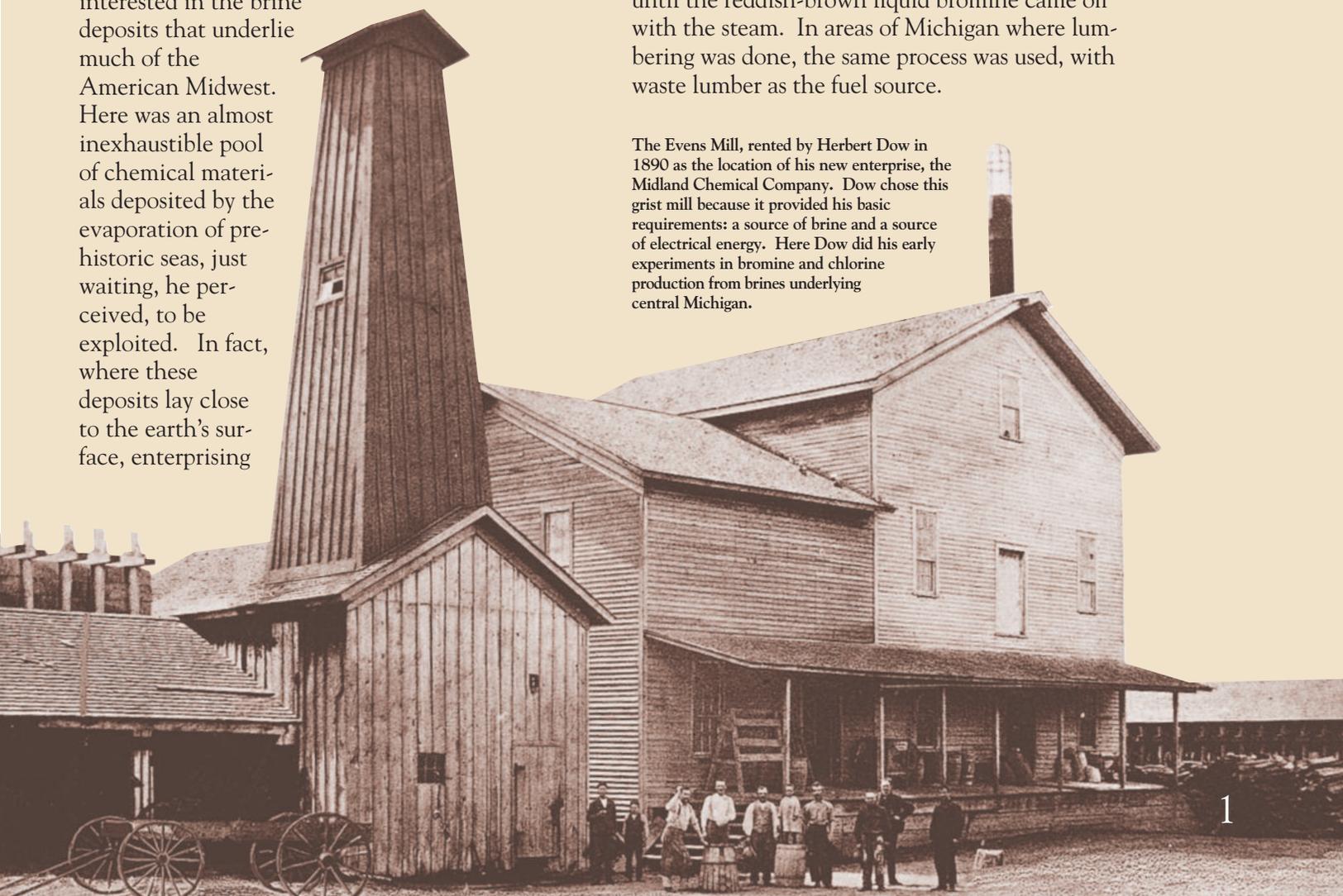
scientists had already begun to use crude production methods to mine them for chemicals.

To manufacture bromine, for example, a main component of the patent medicines of the day, brine wells were being drilled near West Virginia and Ohio coal mines. After chemicals such as sulfuric acid and bleaching powder were added to free bromine from other elements in the brine, waste from a neighboring coal mine was used to boil the brine until the reddish-brown liquid bromine came off with the steam. In areas of Michigan where lumbering was done, the same process was used, with waste lumber as the fuel source.



Herbert H. Dow in 1888, when he graduated from the Case School of Applied Science in Cleveland, Ohio.

The Evens Mill, rented by Herbert Dow in 1890 as the location of his new enterprise, the Midland Chemical Company. Dow chose this grist mill because it provided his basic requirements: a source of brine and a source of electrical energy. Here Dow did his early experiments in bromine and chlorine production from brines underlying central Michigan.



# THE IMPORTANCE OF ELECTROCHEMISTRY

While he was still a schoolboy, Herbert Dow invented a “blowing-out” method of extracting bromine from the brine. Instead of boiling the treated brine solution, he trickled it over a burlap curtain and blew a current of air through it. “By passing the bromine-laden air through a body of iron turnings,” Dow said in his patent, “the bromine and iron will chemically unite, forming a bromide of iron known as ferric bromide.” Because the air was moist, the ferric bromide was in a solution that was an “article of commerce.”

Not content with this improvement, Dow tried to use an electric current instead of a chemical treatment to free the bromine from its combined form in the brine. After many failures, he succeeded in obtaining bromine by this method, but he still used the blowing-out technique to transform the elemental bromine into a salable product. Since the original ferric bromide solution was not the form desired by most customers, Dow then converted the bromine into solid products such as zinc, sodium, and potassium bromides. Herbert Dow thus became a late-19th-century successor to the 18th-century pioneers who had established electrochemistry—among them

Luigi Galvani, Alessandro Volta, Humphry Davy, and Michael Faraday. His electrolytic cell was the earliest devoted specifically to chemical manufacture, although numerous other such cells were developed in the 1890s, mostly in the Niagara Falls, New York, area where low-cost electricity became available.

Dow became the world’s most efficient bromine manufacturer through his successful application of electrochemistry. By 1897, when he established The Dow Chemical Company, he had



Most of the work force of the Midland Chemical Company, where Herbert Dow first manufactured bromine by electrolysis, 1894.

sufficient experience and financial backing to enter the world market for bromine. However, he soon found himself in competition with the German master chemists who found it difficult to believe that an American could produce bromine in the backwoods of Michigan more cost-effectively than they.

In 1905, alarmed by The Dow Company’s intrusion on their markets, the German chemical community determined to crush this newcomer through the *Deutsche Bromkonvention*, the worldwide bromine cartel. The Dow enterprise survived this effort only by secretly purchasing the cheaper bromides with which the cartel flooded the U.S. market. Dow repackaged the bromides and sold them in Europe, where the cartel maintained a good price for them. This stratagem worked, and the Germans withdrew from the U.S. bromine market. For the first time, an American chemical firm battled the big German chemical companies and won; and by 1909, Herbert Dow was the leading manufacturer of bromides.

(No Model.)  
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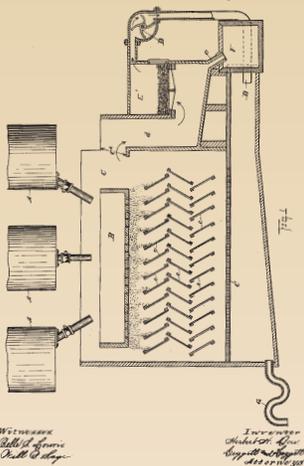
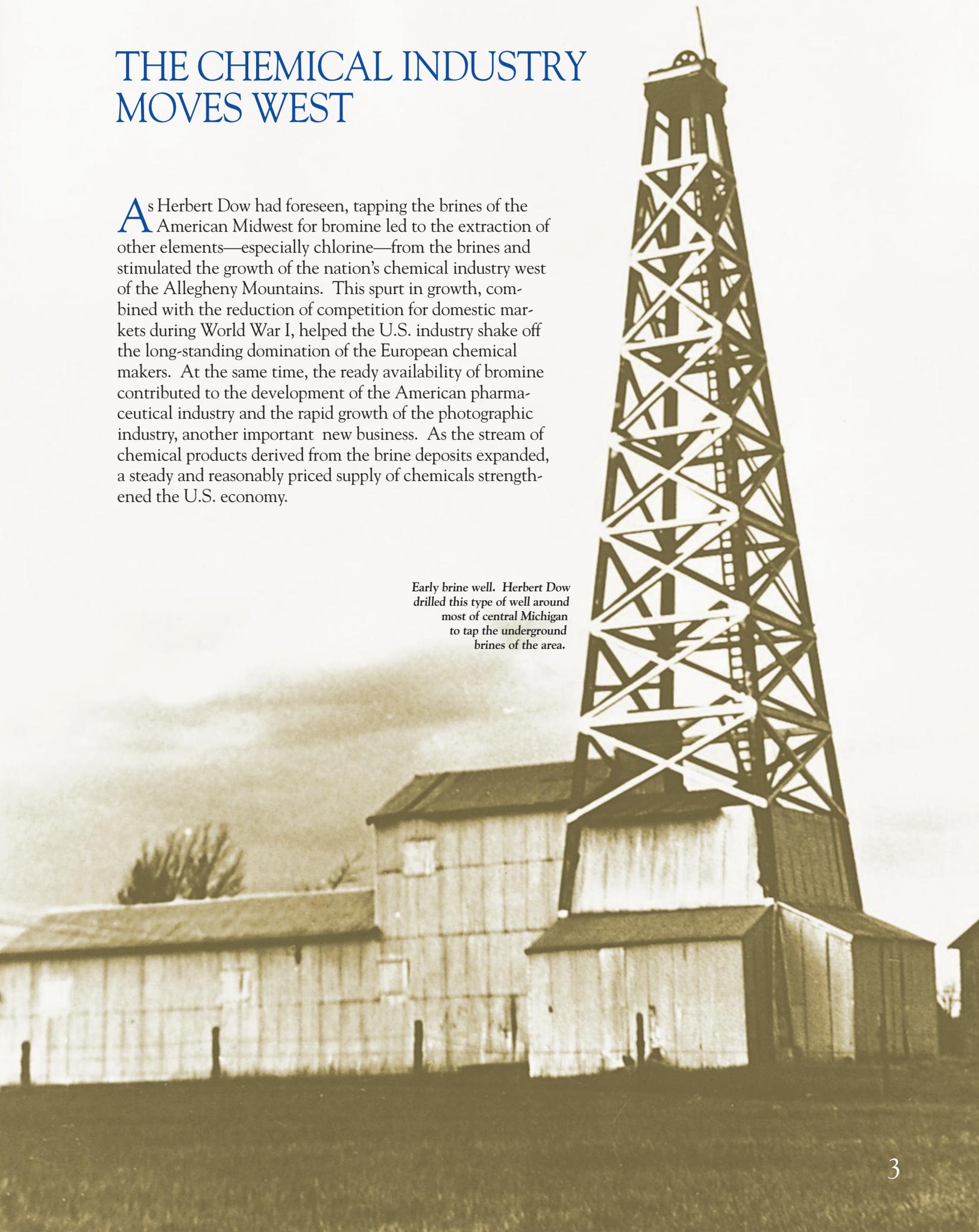


Illustration from Herbert Dow’s “Process of Extracting Bromine,” patented in 1891.

# THE CHEMICAL INDUSTRY MOVES WEST

As Herbert Dow had foreseen, tapping the brines of the American Midwest for bromine led to the extraction of other elements—especially chlorine—from the brines and stimulated the growth of the nation's chemical industry west of the Allegheny Mountains. This spurt in growth, combined with the reduction of competition for domestic markets during World War I, helped the U.S. industry shake off the long-standing domination of the European chemical makers. At the same time, the ready availability of bromine contributed to the development of the American pharmaceutical industry and the rapid growth of the photographic industry, another important new business. As the stream of chemical products derived from the brine deposits expanded, a steady and reasonably priced supply of chemicals strengthened the U.S. economy.

*Early brine well. Herbert Dow drilled this type of well around most of central Michigan to tap the underground brines of the area.*



# HERBERT HENRY DOW (1866–1930)

Herbert H. Dow, born in Belleville, Ontario, Canada, was reared to a life of enterprise and invention by his father, J. Henry Dow, a tinkerer and inventor best remembered for the Dow turbine, a device that powered U.S. Navy torpedoes during much of the 19th century. He grew up in Cleveland, Ohio, and graduated from the Case



Herbert H. Dow, 1924

School of Applied Science in 1888, having studied chemistry with the renowned Edward W. Morley and physics with Albert A. Michelson, the first U.S. Nobel laureate (1907). Dow's senior thesis, a study of the composition of northern Ohio salt brines, initiated a lifelong interest in "mining" the chemicals stored in underground brines. By graduation, he had devised his "blowing-out" process for liberating bromine from the brine and received the first of 107 patents he eventually was granted.

In 1889, Dow formed the Canton Chemical Company (Canton, Ohio) to exploit his invention. The company failed because the process was not economically feasible. Dow then began experiments using electrolytic cells. In 1890 he moved to Midland, Mich., and established the Midland Chemical Company, where he first produced bromine electrolytically. Once this firm was operating successfully, Dow began extracting other elements from the brine, beginning with chlorine. His backers, however, refused to fund these efforts, and he was fired in 1894. Undaunted, he returned to the Canton area and formed the Dow Process Company, where he worked in great secrecy to perfect his electrolytic cell to extract chlorine from brine. In 1897, with the help of supporters in Cleveland, he formed The Dow Chemical

Company, using his new chlorine cell to make bleach as its original product. The company was an immediate success and in 1900 absorbed the Midland Chemical Company.

In succeeding years, during which Dow continued his work at the lab bench, the company made and marketed a growing number of products derived from the brine stream, ranging from chloroform and sodium benzoate to calcium chloride and Epsom salts. During World War I, the company succeeded in extracting magnesium metal from the brines and was the first in the United States to synthesize indigo, a key dyestuff cut off from U.S. markets by the war in Europe.

After World War I, Charles F. Kettering and Thomas Midgley, Jr., of General Motors, the developers of tetraethyl lead, came to Herbert Dow with a technical problem. Their desire to make tetraethyl lead, or "ethyl" gas (which prevented knocking in automobile engines), available to U.S. motorists would require huge volumes of ethylene dibromide and therefore more bromine than anyone in the world could produce. "Perhaps more bromine than exists in the world," Midgley said. "Then we'll have to go to the oceans for it," Dow told them. The ocean waters, he explained, were simply "diluted brines."

By 1929, he was ready to build a plant to extract bromine from seawater, but death intervened. (Dow died on Oct. 16, 1930.) His work was completed in 1934 by his son and successor as the company's president, Willard H. Dow.



Main Street in Midland, Michigan, as it appeared about 1898.

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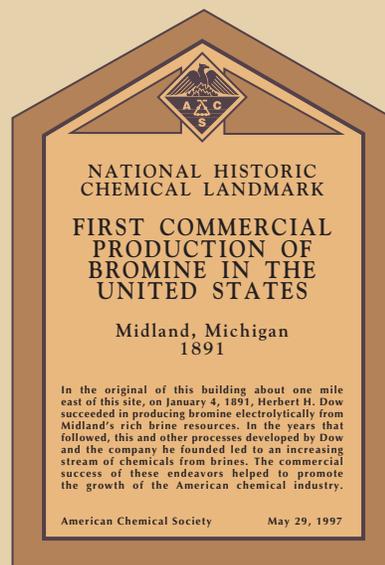
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## THE NATIONAL HISTORIC CHEMICAL LANDMARKS PROGRAM OF THE AMERICAN CHEMICAL SOCIETY

The ACS National Historic Chemical Landmarks Program recognizes our scientific and technical heritage and encourages the preservation of historically important achievements and artifacts in chemistry, chemical engineering, and the chemical process industries. It provides an annotated roster to remind chemists, chemical engineers, students, educators, historians, and travelers of an inspiring heritage that illuminates both where we have been and where we might go when traveling the diverse paths to discovery.

An ACS Historic Chemical Milestone designation marks a landmark step in the evolution of the chemical sciences and technologies. A Site designation marks the location of an artifact, event, or other development of clear historical importance to chemists and chemical engineers. An Historic Collection designation marks the contributions of a number of objects with special significance to the historical development of chemistry and chemical engineering.

This program began in 1992, when the Division of the History of Chemistry of the ACS formed an international Advisory Committee. The Committee, composed of chemists, chemical engineers, and historians of science and technology, works with the ACS Office of Public Outreach and is assisted by the Chemical Heritage Foundation. Together, these organizations provide a public service by examining, noting, recording, and acknowledging particularly significant achievements in chemistry and chemical engineering. For further information, please contact the ACS Office of Public Outreach, 1155 Sixteenth Street, N.W., Washington, DC 20036; 1-800-ACS-5558, ext. 6274.



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