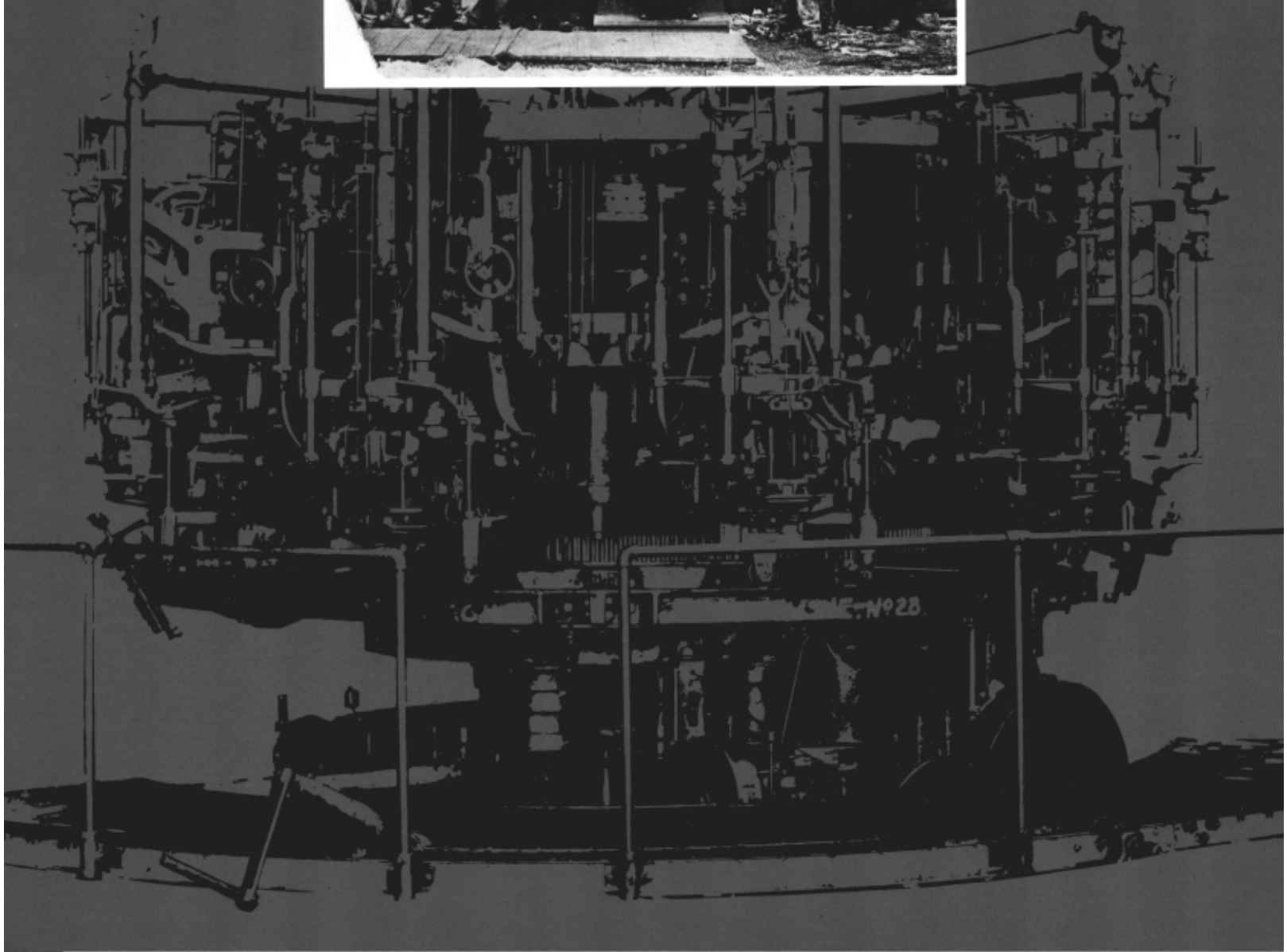
The American Society of Mechanical Engineers

Designates the Owens "AR" Bottle Machine As An International Historic Engineering Landmark

May 17, 1983



American manufacturers produce an estimated 46 billion glass containers annually for domestic use, averaging 200 containers for every man, woman, and child in the United States. In addition, approximately 288 million bottles are shipped abroad.

The average American home is filled with glass jars and bottles, containing everything from food and beverages, to pharmaceuticals, household products, toiletries, and cosmetics. In fact, the array of uses is so vast, and the supply so cheap and plentiful, that Americans and people the world over take them for granted.

Few people realize that this has only been the situation for the last eighty years. Fewer still know that Michael J. Owens, who started his career in a glass factory in Wheeling, W. Va., at the age of 10, is largely responsible for the safety, standardization, quality, and convenience of glass containers which millions of consumers around the world purchase every day.

Mike Owens' invention of the automatic bottle-making machine in 1903 was the most significant advance in glass production in over 2000 years. The origin of glass making is lost in antiquity, although historians speculate that the basic process may have been discovered accidentally by Phoenician sailors who rested their cooking pots on lumps of soda ash over a fire built on a sandy shore.

After this nebulous beginning, the people of the Eastern Mediterranean are credited with the discovery of the blowpipe in approximately 300 B.C. Methods of creating glassware changed little between then and 1608 A.D., when John Smith established a glass factory as the first industry in North America at Jamestown.

In the nineteenth century glassware was still produced by human skill and lung power. Working in "shops" of three skilled glass blowers with three or four boys serving as helpers, craftsmen used a blowpipe and a few crude tools to create glasses, jars, bottles, bowls, and vases.

To produce relatively uniform containers for beverages, food, drugs, and other products, glass workers learned to use metal molds. For example, a bottle was produced by gathering a "gob" of molten glass on the end of a blow pipe and lowering the glowing mass into a mold. By blowing into the pipe, the glass worker formed a bubble that conformed to the sides of the mold. After the glass was removed from the mold, the neck and shoulder of the bottle was finished with hand tools.

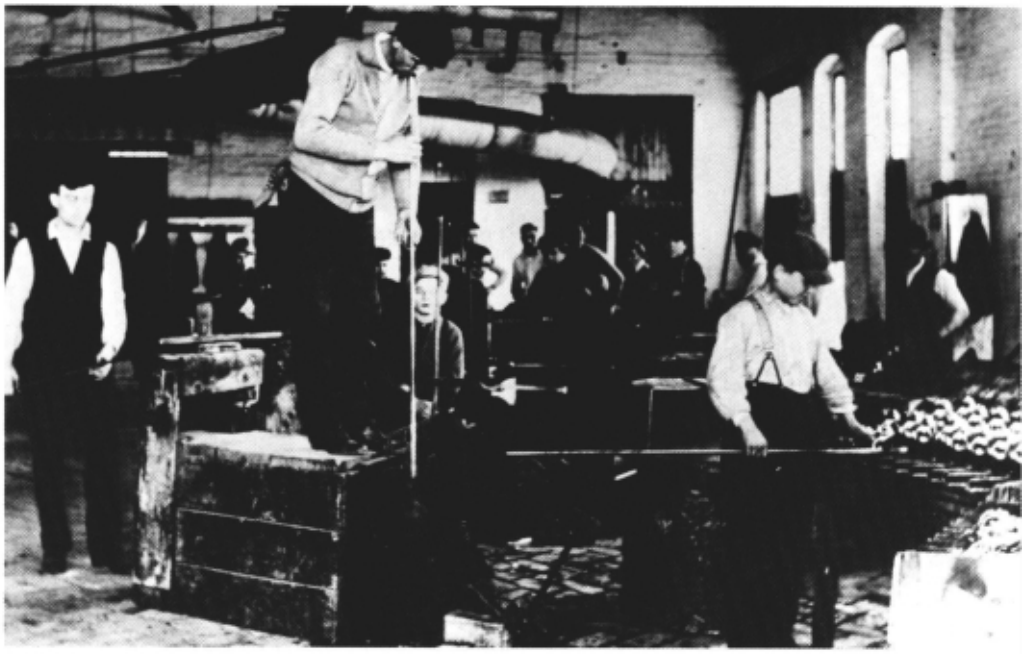
Mechanization of the glass industry occurred in the latter part of the Industrial Revolution due to problems with the physical properties of glass and the dexterity and flexibility of the hand worker. But the increasing demand for bottles by major packaged-goods manufacturers was a strong stimulus to develop a mechanical means of producing glassware.

Inventors in the United States, the United Kingdom, France, and Germany tried to create a bottle-making machine. The earliest known bottle-making machine patent, dated March 17, 1859, was issued to Alexander Mein of the United Kingdom. British inventors Josiah C. Arnall, H.M. Ashley, and J.R. Windmill, as well as Americans Philip Arbogast, and James S. and Thomas B. Atterbury, all patented semi-automatic bottle machines in the late 1800's.

Each of these machines required three skilled workman and two boys to operate. Although the designs were not completely commercially successful, as the development of the semi-automatic machines continued, reducing the number of workers necessary to operate them and increasing the rate of production, their popularity grew. Only 20 machines were in operation in 1897, compared to 250 eight years later.

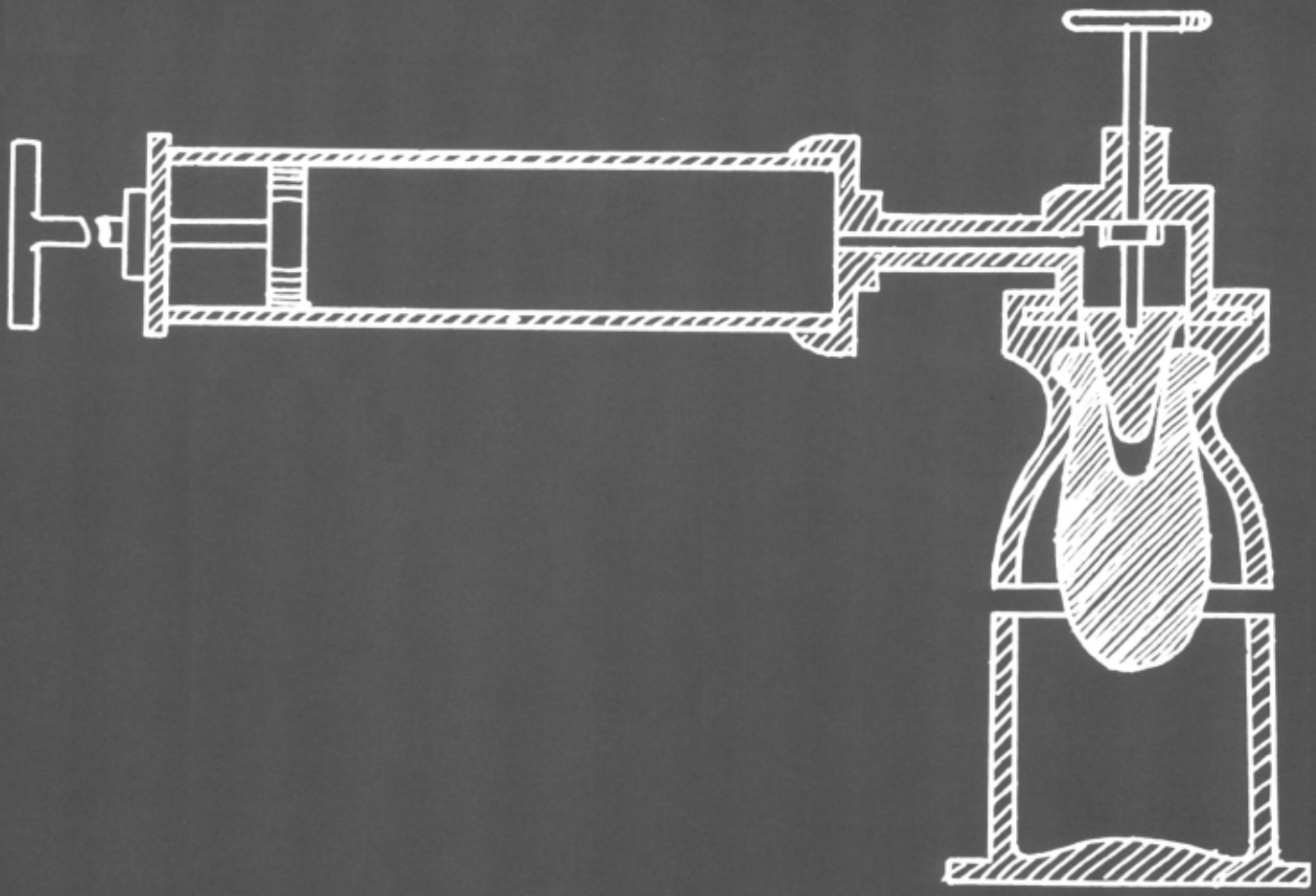
The Owens machine was the logical extension of the semi-automatic machines. Mike Owens, whose inventions were financed by Edward Drummond Libbey, produced the first commercially successful, fully automatic bottle-making machine in 1903, a goal towards which inventors had been working for more than 40 years. His machine could make bottles quicker, cheaper, and better than the semi-automatics.

A shop of men and boys at the Libbey Glass Company plant in 1910 made glass light bulbs by hand. Three years later light bulbs were being made by the Westlake automatic light bulb-blowing machine which was modeled after the successful Owens automatic bottle machine.



Edward Drummond Libbey, moved his New England Glass Works from East Cambridge, Mass., to Toledo in 1888, renaming it the Libbey Glass Co. in 1892. His business enterprises made Toledo the "glass capital of the world."

This diagram of the Owens suction device was drawn by Richard LaFrance, Owens' chief engineer from 1910 to 1927. Christened the "bicycle pump," the device proved that glass could be mechanically gathered and blown to form a bottle.



Owens had already developed semi-automatic machines to manufacture light bulbs, drinking glasses, and lamp chimneys. However, all of these machines still required that the glass be gathered by hand for each piece and on a separate blow pipe, just as in the old hand practice.

In 1899, Owens turned his attention to the biggest challenge of all—a fully automated machine. The greatest obstacle was finding a way to machine-gather the glass in the proper quantities. His ingenious solution, christened the "bicycle pump" because that is what it resembled both in form and function, gathered the glass by suction.

Withdrawing the piston rod on the crude hand pump created a vacuum that sucked up a charge of glass into a mold which formed the neck of the bottle. Suspended by the neck, the gather was then placed in a body mold, where the return stroke of the plunger blew the glass into the proper shape.

The first attempts to blow a bottle with the "bicycle pump" yielded distorted "freaks," but successive tries produced a perfect four-ounce petroleum jelly jar. With the principle proven, work proceeded on the construction of a complete machine.

In 1903, the machine and a specially designed revolving gathering "pot" were ready for trial. This machine, called Number "4," had five of the "bicycle pumps" known as heads or arms mounted on a circular rotating frame. Each of these heads was a complete unit which dipped individually to suction up its gather of glass as it passed over the pot. Each head carried a blank mold, a neck mold and plunger for forming the neck, and a finishing mold.

In its first test, the number "4" made eight pint beer bottles a minute. What was remarkable about this test was not only did this machine make a satisfactory bottle, but a narrow-necked one. Previously even the semi-automatics were confined to the production of wide-mouthed ware.

The first commercial model, offered in 1905 for production and license, was the "A." This design used the experience gained in production runs and demonstrations of the number "4." The model "A" carried six heads each with the same blank mold, neck mold and plunger, and finishing mold of the number "4." but the "A" was built much more ruggedly. The parts were operated by stationary cams attached to the framework. The entire revolving machine oscillated up and down each time when a head came in contact with the molten glass to suction another gather.

The "A" machine could manufacture twelve pint bottles per minute or 17,280 in a 24-hour period. This compared with approximately 2,880 produced in a day's time by a shop of six men and boys. The machine was operated by two men on 12-hour shifts at a cost of 10 to 12 cents per gross. Hand blown bottles cost $1.80 per gross to produce.

Producing bottles in such large quantities required a new method of annealing, or tempering. Bottles allowed to cool too quickly shatter easily; the function of an annealing lehr is to provide a controlled environment where the glassware cools gradually. Instead of boys carrying the bottles to the lehr, an automatic conveyor was devised. The finished glassware was discharged onto an automatic conveyor, and slowly passed through a long heated tempering oven.

After the machine had been kept in operation long enough to insure that it was a commercial success, Libbey, Owens, William S. Walbridge, Clarence Brown, and Frederick L. Geddes formed the Owens Bottle Machine Company for the purpose of building and licensing bottle-making machines. They also applied for the patent rights in all of the countries outside the U.S. where glass was made, and formed the Owens European Bottle Machine Company in 1905 for these international operations.

Within a few years, Owens machines were in production in England, Germany, Holland, Austria, Sweden, France, Denmark, Italy, Norway, Hungary, Scotland, Ireland, and Japan. Patent rights had also previously been sold for Canada and Mexico.

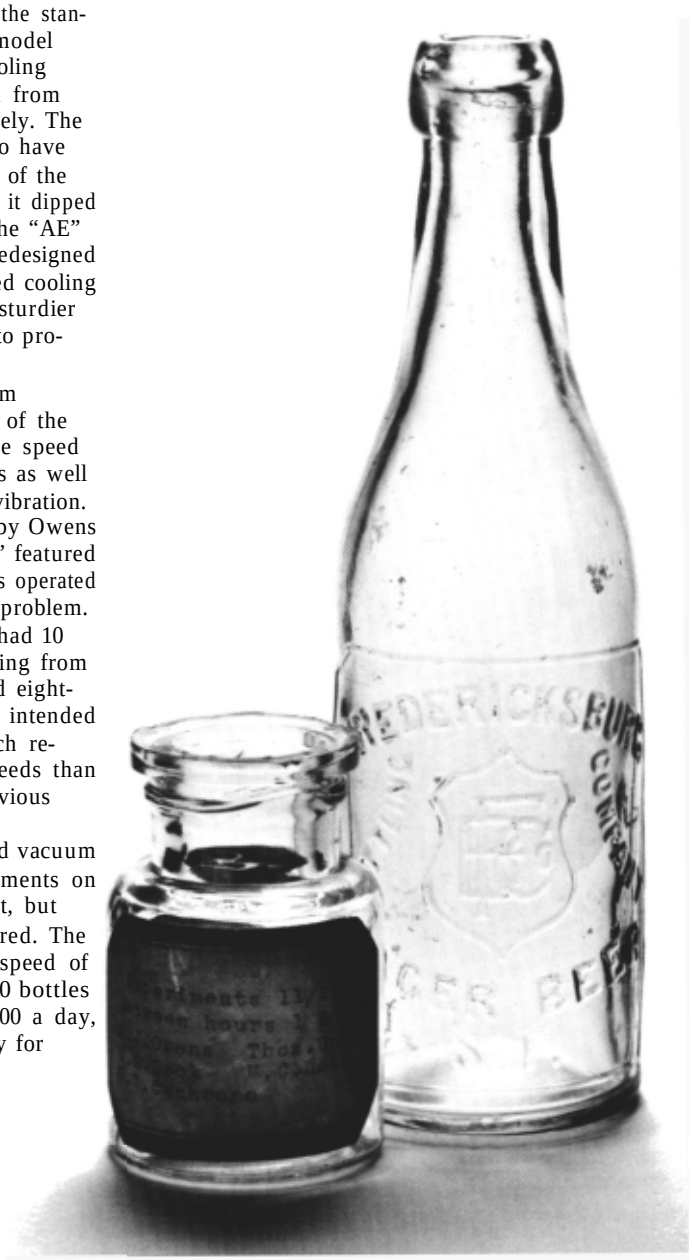
The "A" machine remained the standard until 1908 when the "AC" model was developed with a longer cooling time which prevented distortion from discharging the bottles prematurely. The 1909 "AD" model was the first to have 10 heads, but the greater weight of the machine caused more vibration as it dipped up and down. That same year, the "AE" machine was developed with a redesigned base accommodating an improved cooling system for the molds. Another, sturdier version, "AL," was built in 1911 to produce gallon packers.

However, one chief problem remained—the constant dipping of the entire machine which limited the speed at which it could produce bottles as well as causing excessive wear and vibration. In 1912, an entirely new design, by Owens and Richard LaFrance, the "AN," featured individually dipping suction molds operated by cams, which eliminated the problem.

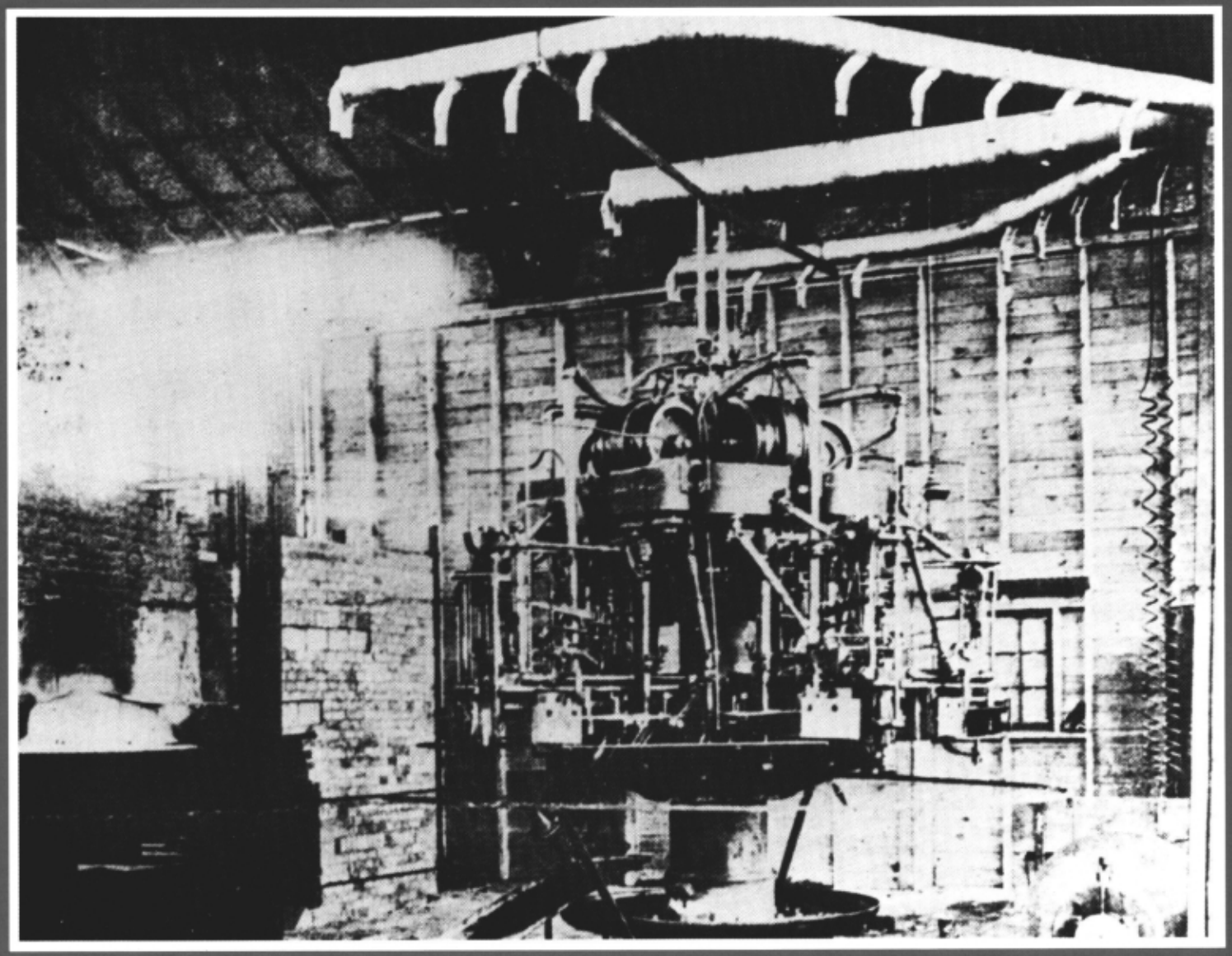
The new "diphead" model had 10 arms and produced bottles ranging from a fraction of an ounce to around eight-ounce capacities. The "AN" was intended to make prescription ware, which required higher manufacturing speeds than had been possible with the previous slower models.

It also had improved air and vacuum distribution systems, and adjustments on each head permitted 10 different, but similar, bottles to be manufactured. The improved design increased the speed of the machine to an average of 50 bottles a minute, or approximately 72,000 a day, with a maximum of 86,400 a day for half-ounce bottles.

Early bottles produced on the Owens Machine. The bottle on the left bears the date November 29, 1899.



The first commercial "A" Owens bottle machine was developed in 1903. It produced an unprecedented nine bottles a minute.



Also designed and built in 1912 was the original "AR" machine. Generally, it was an enlargement of the "AN," adapted to manufacture bottles of greater weight and capacity than prescription ware, such as beer and catsup bottles. It had an average production of 50,400 bottles per day.

The result of nine years of experimental and commercial design, the larger "AR" was less limited in the design of molds, and permitted greater cooling facilities. Improvements extended its range from prescription ware to gallon packers, making it a general purpose machine. It entirely replaced the outdated "AD" and "AE" machines, and even displaced the limited "AN" design.

The "AR" design was enlarged to accommodate 15 arms, resulting in the "AQ" machine in 1914. It was identical to the "AR" except for the larger frame and additional heads, producing the same range of bottles, only in greater quantities. The development of plural cavity molds further increased the production of these models.

Between the years 1905 and 1926, 317 Owens bottle-making machines were put into production, with 64 shipped abroad. This included models "A," "AC," "AD," "AE," "AL," "AN," "AQ" and "AV." In addition, 119 "AR" machines were manufactured between 1912 and 1941, with 28 shipped overseas.

In 1923, just 20 years after the successful trial of the number 4 machine, a study commissioned by the National Association of Bottle Manufacturers reported that 94 out of every 100 bottles in the U.S. were being made by machinery —either semi-automatic or automatic.

The Owens machine not only revolutionized the glass industry, but had a great impact on society. The bottle-making machine drastically reduced the price of glass containers, making them readily available to the public for packaging and preserving food and beverages, pharmaceuticals, household cleaners, and other products.

The Owens machine made a superior quality product, producing glass containers that were more uniform in weight and content than those made either by hand or semi-automatic machines. This had two far-reaching effects. First, the government was able to establish standard specifications and requirements through the Pure Food and Drug Administration that helped safeguard health as well as guaranteeing a specific measure of product in the container. In addition, the uniform height and capacity of the Owens-made bottles allowed high-speed packing and filling lines to be developed.

Owens' invention also ended child labor in the glass industry. The long apprenticeships and carefully guarded trade secrets of glass blowing made it one of the most highly paid crafts of the nineteenth century. To reduce costs, glass manufacturers hired boys to assist the skilled workers. In 1880, when glass blowers were earning $200 a month, 6000 boys between the ages of 10 and 15, constituting one quarter of the total work force, worked 10-hour days for as little as 30 cents a day.

The Owens Company received a letter in 1913 from the National Child Labor Committee of New York City commending the Owens machine. They reported that the rapid introduction of the automatic machine did more to eliminate child labor than they had been able to do through legislative efforts.

Glass manufacturing was one of the first automated industries. Since the Owens machine was really six, 10, or 15 identical machines amassed into one large one, the Owens Company mass produced interchangeable parts, a principle pioneered just a few years earlier at General Motors.

Over the years, the A-series machines continued in service, producing bottles for commercial use. The last two Owens machines in production, 15-arm "AQ" models, were operated at Gas City, Indiana, until December 17, 1982.

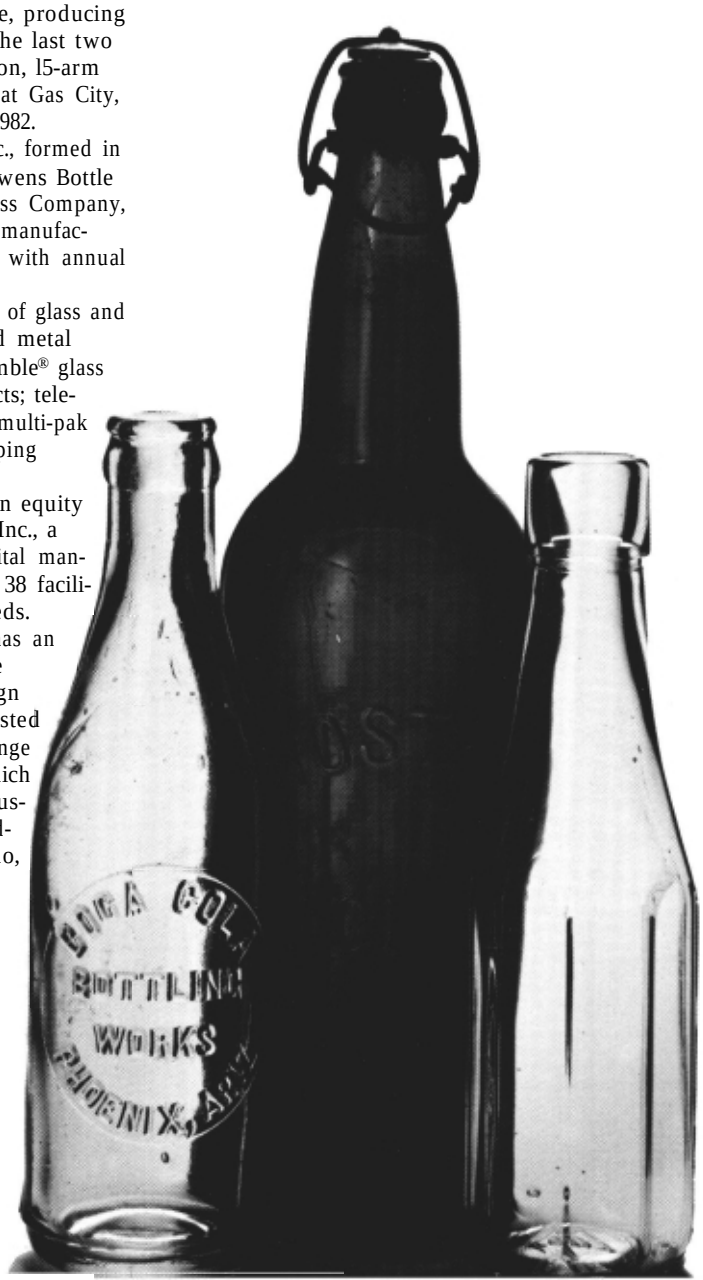
Today, Owens-Illinois, Inc., formed in 1929 by the merger of the Owens Bottle Company and the Illinois Glass Company, is one of the world's leading manufacturers of packaging materials, with annual sales approaching $4 billion.

O-I is a leading producer of glass and plastic containers; plastic and metal closures; glass tableware; Kimble® glass and plastic laboratory products; television bulbs; package labels; multi-pak carriers; and corrugated shipping containers.

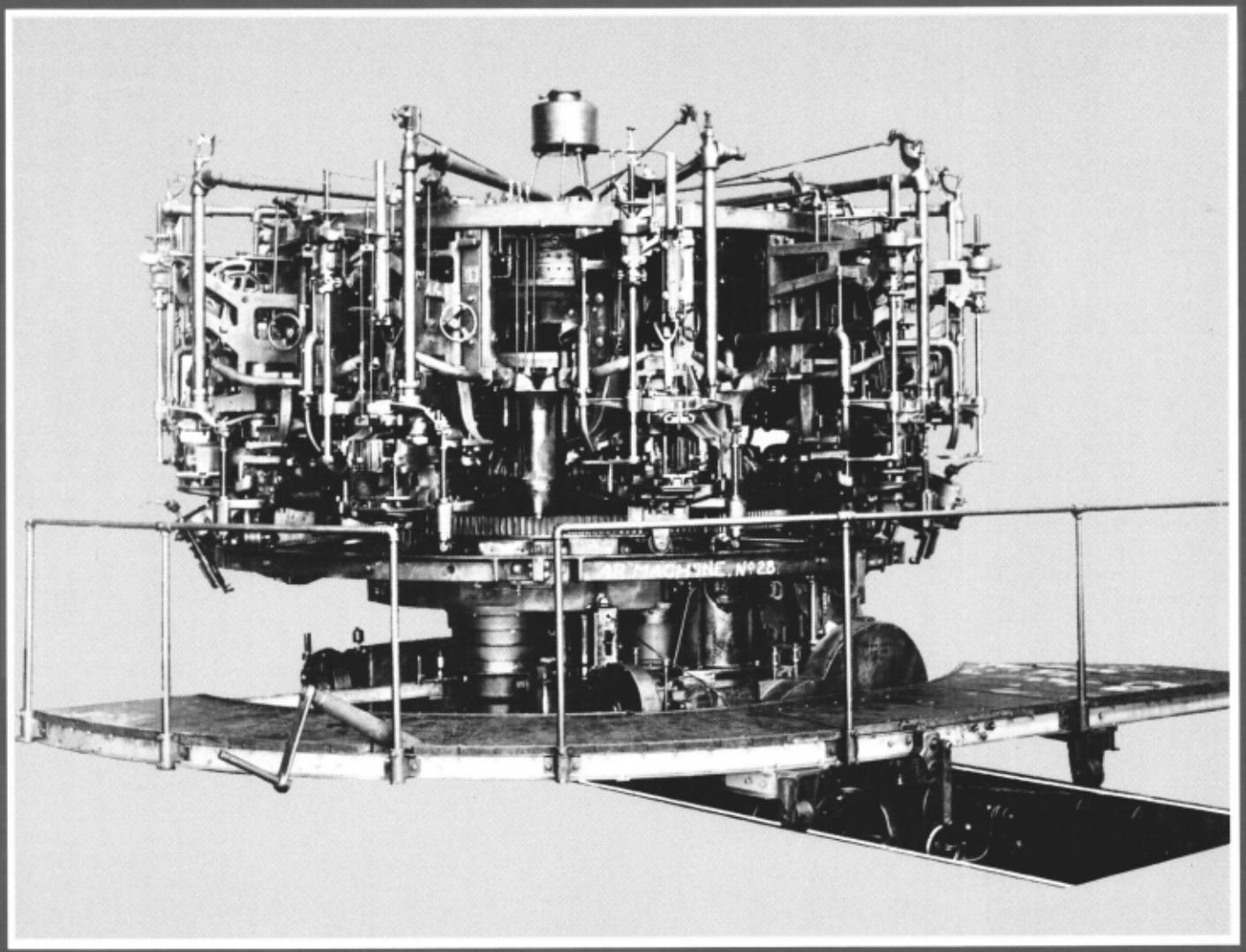
The company also has an equity investment in Health Group Inc., a rapidly growing private hospital management company operating 38 facilities with more than 4,200 beds.

Owens-Illinois owns or has an interest in 200 facilities in the United States and in 22 foreign countries. The company is listed on the New York Stock Exchange and is one of the 30 firms which make up the Dow Jones Industria1 Average. Corporate headquarters are located in Toledo, Ohio.

Bottles produced on the early Owens machines.



The 1912 “AR” model was the most versatile of the first Owens machines developed, with the ability to produce bottles ranging in size from prescription ware to gallon packers.



Michael Joseph Owens

Michael Joseph Owens was born January 1, 1859, in Mason County, West Virginia. His parents immigrated to the United States from County Wexford, Ireland, in the 1840's and his father found work in the coal mines of West Virginia.

To help support their large family, Mike went to work at a glass factory in Wheeling in 1869 when he was only 10 years old. Working ten hours a day gave him little time to acquire a forma1 education. Hardy and industrious, he used his lunch hours and break periods to practice blowing glassware, using the techniques he had observed as he assisted the glass workers.

Two years before he died, Owens recalled those early days for journalist Keene Sumners, "In the factory, I went through all the jobs which boys performed; and I enjoyed every bit of the experience. I wanted to learn everything there was to be learned."

He began at age 10 by shoveling coal into the furnace, called "firing in the glory hole." At 11 he was a "carry-in boy," transferring newly-blown glassware to the annealing lehr, and at 12 a "carry-out boy" taking the cooled glass out. He also worked as a "mold hold boy," opening and closing the mold for the master blower, and as a gatherer, skillfully collecting a "gob" of glass on the end of a blowpipe.

It is ironic that the man who is credited with eliminating child labor in the industry, remembered his own early years in the glass factory with great fondness. His attitude was that as long as a person had enough food and proper rest that "work never hurt anyone."

By the time he was 15 he had mastered the glass-blowing process and worked side by side with adult glass blowers. He had spent 18 years working in glass factories before he joined Edward Drummond Libbey in 1888 at the New England Glass Works in Toledo, Ohio.

With the faith and support of Libbey, Owens' inventive genius realized its potential. Libbey's belief in Owens was such that he backed him financially during long years of tria1 and error before success was reached. Owens was persistent, experimenting until solutions to various engineering problems could be devised.

Lacking forma1 education or technical training, Owens surrounded himself with a talented engineering staff that helped to make his visions reality. He hired William Emil Bock to build the "bicycle pump" which proved the workability of the theory. When Bock showed Owens his first set of blueprints, Owens was unable to understand them and told him simply to "put it in iron."

Bock and C. William Schwenzfeier used Owens' original design concepts to build the "A" bottle-making machine. Richard LaFrance became Bock's assistant in 1901 and succeeded him as chief of engineering in 1910. As the company's success grew, so did the engineering staff.

Although Owens could not build the machines by himself, he could graphically describe the design concepts to his engineers. He would sketch his ideas on a blackboard, allowing the engineers to work out the details.

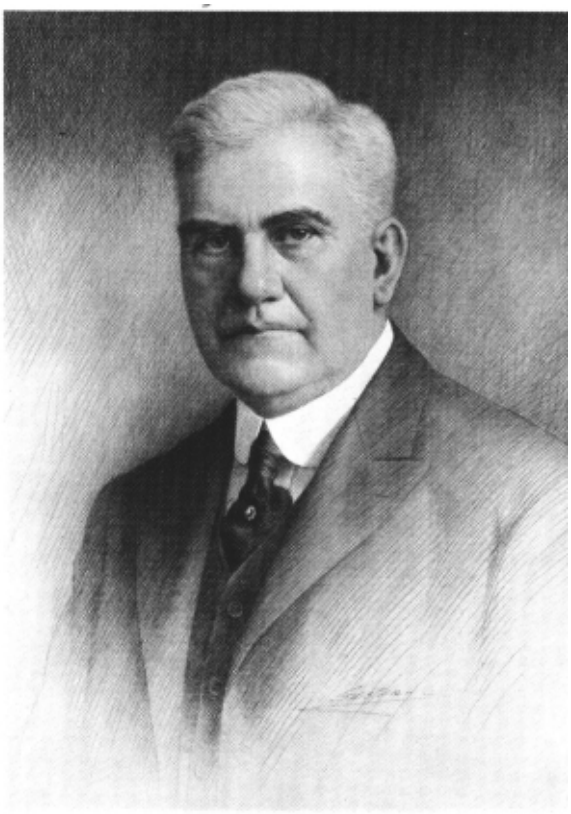
Once the machine was built, he could easily tell what was wrong with it—the molds were holding the bottle too long or the glass hadn't cooled enough before discharge. He had a unique and unorthodox role as an inventor, because his lack of technical training prevented him from personally being able to build machines in the same way he had mastered glass-working.

LaFrance, who worked with Owens for 22 years, described their relationship, "Owens was an inventor. He was no designer, but could direct engineers. He let them use their own designs usually without interference. He did not invent mechanisms. He decided on methods. He knew a good or bad design when he saw the finished machine and could see faults in engineering and make suggestions when he saw a machine operate. I considered him to have an engineering mind and discussed problems with him and was glad to get decisions."

A modest man, Owens once summed up his role as the inventor of the bottle-making machine, "The basic ideas were mine. The patents are in my name. But the achievement is like the machine itself. That has thousands of parts, each representing someone who has had a hand in it."

In education as well as invention, Owens was largely a self-made man. He studied nights and joined a debating club to help him learn to speak effectively. He was known later in life to be an especially talented and convincing orator.

Owens' enthusiasm for work continued throughout his life, even during his last years when his health began to fail. He attended a meeting of the board of directors of the Owens Bottle Company (the Word "Machine" was deleted in 1919 because the company had started producing bottles as well as the machines that made them) on the morning of December 27, 1923, requesting more funds to develop his latest project. Around noon he asked to be excused for a moment and left the room. He collapsed in the hallway and was taken to an adjacent office where he died of a heart attack a short time later.



Michael J. Owens, sixth from left, posed for this photo with other members of the original organization of the Owens Bottle Machine Co. Mr. Owens credited much of the success for the development of the Owens bottle machine to engineers who could translate his ideas "into iron."

About The Landmarks...

The Owens Automatic "AR" Bottle Machine is the thirteenth International Historic Mechanical Engineering Landmark to be designated since the program began in 1973. Since then, sixty-five National and six Regional Landmarks have been recognized by the Society. Each represents a progressive step in the evolution of mechanical engineering and each reflects its influence on society.

The Landmarks program illuminates our technological heritage and serves to encourage the preservation of the physical remains of historically important works. It provides an annotated roster for engineers, students, educators, historians and travelers, and helps establish persistent reminders of where we have been, where we are, and where we are going along the divergent paths of discovery.

The Northwest Ohio Section gratefully acknowledges the efforts of all who participated on the landmark designation of the Owens Automatic "AR" Bottle Machine, particularly the officers and staff of Owens-Illinois, Inc.

International Landmarks

- Cooperative Fuel Research Engine, Waukesha, WI.
- Holt Caterpillar Track-Type Tractor, Stockton, CA.
- 100-Inch Telescope, Mount Wilson, Pasadena, CA.
- Edison Experimental Recording Phonograph, West Orange, NJ.
- Le Creusot Steam Hammer, Creusot, France.
- Rotating-Arm Model—Test Facility, Hoboken, NJ.
- Steam Turbine Yacht Turbinia, Newcastle-upon-Tyne, England.
- The Newcomen Steam-Atmospheric Engine, Dartmouth, England.
- FMC Continuous Rotary Pressure Sterilizer, Santa Clara, CA.
- Corning Ribbon Machine, Corning, NY.
- FMC Whole Juice Extractor, Lakeland, FL.
- Shoreside Container Handling Crane, San Francisco, CA.
- OwensAutomatic "AR" Bottle Machine, Toledo, OH.