Northeast Historical Archaeology

Volume 41 Article 5

2012

Dates for Suction Scarred Bottoms: A Chronology for Early Owens Machine-Made Bottles

George L. Miller

Tony McNichol

Dates for Suction Scarred Bottoms: A Chronology for Early Owens Machine-Made Bottles

George L. Miller and Tony McNichol

For much of the 20th century the Owens automatic bottle-blowing machines were used to produce glass containers around the world. This machine and others revolutionized glass production and led to the end of hand production of commercial glass containers. Bottles produced on the Owens machines have distinct suction scars on their bases that make them easy to identify. Because of the way the rights to the Owens machines were licensed, these licenses have a great potential to establish the dates when the production of major categories of glass containers on the Owens bottle-blowing machine began. The first lease for the use of the Owens machine was issued in 1904, followed by a number of leases issued in 1905 and a few subsequent years. Thus 1905 is a good terminus post quem for suction-scarred glass containers. The last Owens bottle-blowing machine went out of production in 1982.

Les machines automatiques de type Owens pour la production mécanique de verre soufflé ont été utilisées pour la production de contenants de verre partout au monde. Ces machines, de même que d'autres modèles, ont révolutionné la production de verre et ont mené à la fin de la production manuelle de contenants commerciaux en verre. Les bouteilles produites par la machine de type Owens sont facilement identifiables grâce à leur marque de succion distincte sous la base. Les modalités de la licence pour l'utilisation de la machine Owens offrent un excellent potentiel pour mieux comprendre la date de production des catégories principales de contenants de verre produits par cette machine. Le premier bail pour l'usage de la machine Owens a été octroyé en 1904 suivi de plusieurs autres pendant quelques années dès1905. On peut donc considérer l'année 1905 comme le début de la production de contenants de verre portant une marque de succion. La dernière machine Owens a cessé sa production en 1982.

Introduction

The Owens bottle-blowing machine was one of a series of inventions by Michael Owens that included semiautomatic machines for blowing light bulbs, patented in 1894 (Scoville 1948: 152). This machine was modified so that it could also blow tumblers and lamp chimneys. Experimentation toward these developments had two key elements. One was the fertile mind of Michael Owens, a practical glass man who began as a boy laborer in the glass industry in West Virginia, advanced to being a glassblower, and became the manager of the Libbey Glass Company of Toledo, Ohio. The other factor was the patronage and backing of Edward Drummond Libbey, who was the owner and main stockholder of the Libbey Glass Company (Scoville 1948: 95–97). Mr. Libbey had inherited the New England Glass Works from his father and in 1888 had shut it down and moved his company to Toledo to take advantage of newly discovered natural gas wells that cut the fuel costs for the production of glass (Paquette 1994: 15).

The Libbey Glass Company and its predecessor, the New England Glass Company, had a long history as manufacturers of table glass, but they did not have experience in the production of container glass. After the Libbey Glass Company was established in Toledo, Ohio, it was approached by the Corning Glass Works in Corning, New York, to fulfill a contract for light bulbs for the Edison General Electric Company. The production of light bulbs at Corning had been interrupted by a labor strike in 1890 (Paquette 1994: 24). To undertake this contract, Libbey Glass Company leased a closed glass factory and put Michael Owens in charge of producing the light bulbs.

While overseeing the light bulb production Owens invented and patented a machine for the blowing of light bulbs. That machine was later modified to blow tumblers and lamp chimneys (Scoville 1948: 152). This invention and the potential for further developments caused Edward D. Libbey to express an interest in expanding into the area of glassblowing machines. However, some of the other investors and members of Libbey Glass Company were leery of expanding into that area. Part of the problem was that Michael

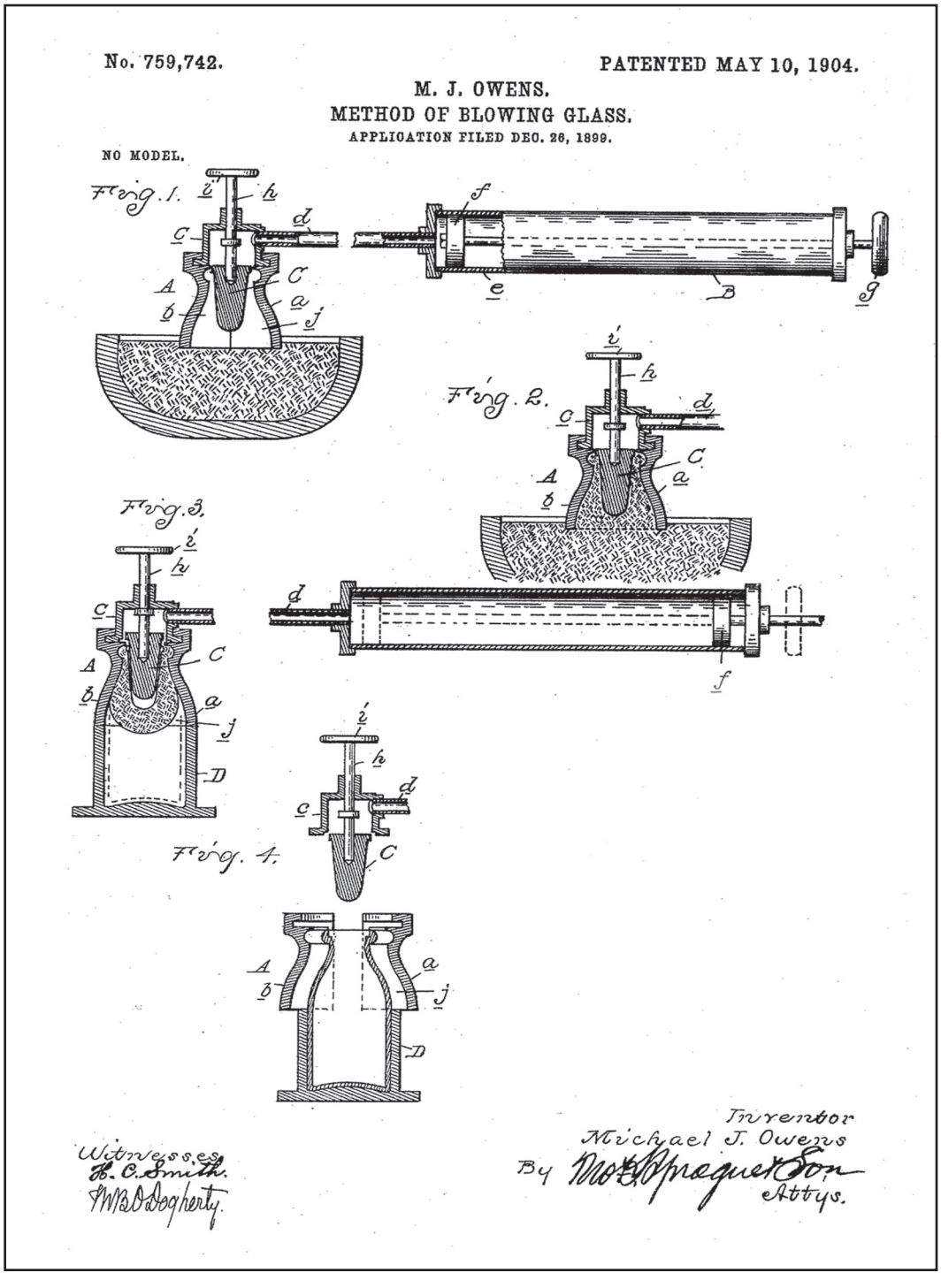

Figure 1. Handheld vacuum-pump machine, patent No. 759,742. The pump sucked up the molten glass into the upper half of the mold when the pump handle was pulled. When the upper half of the mold was full, it was carried to the bottom half of the mold and the handle was pushed in to blow the bottle. (Owens 1899)

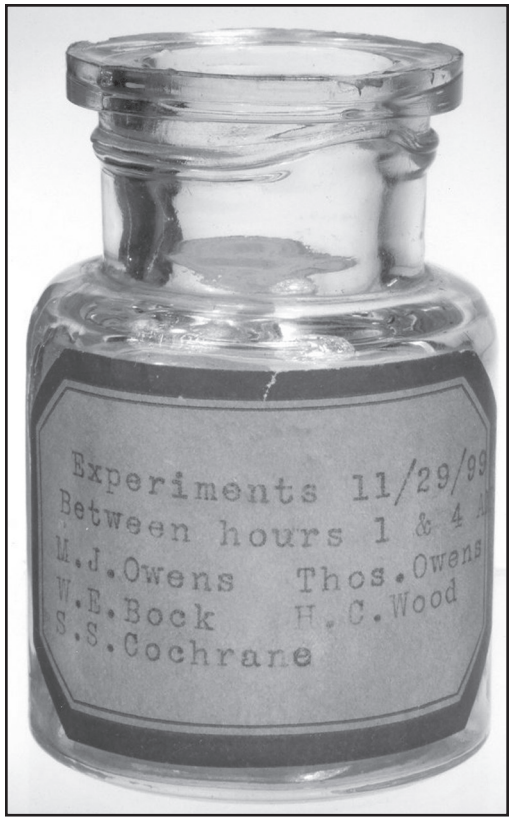

Figure 2. Photo of a bottle blown on the handheld pump machine. The paper label is dated "11/29/1899" (Floyd, Bowers, and Brownlee 2006). (Photo courtesy of the Owens-Illinois, Inc. Archives, MSS-200, Ward M. Canaday Center for Special Collections, University of Toledo.)

Owens was not an easy man to get along with and was rather gruff in dealing with those around him. While Michael Owens had a great understanding of working with glass and was visionary in terms of the mechanics of production, he was dependent on engineers and draftsmen to execute his ideas and on financial backing from Libbey to fund his experimentation and the development of the bottle-blowing machine (Paquette 1994: 21–26). Several of the more conservative partners in the Libbey Glass Company did not want to be involved with Michael Owens, nor did they want to take the risk of developing machines to produce glass containers (Scoville 1948: 279–281). Part of this reluctance may have been because, by this time, a number of semiautomatic machines had been developed and were already producing glass containers.

This led Edward D. Libbey, Michael Owens, and three other investors to establish the Toledo Glass Company in 1895 to follow up on the inventions of Michael Owens (Scoville 1948: 282–283; Paquette 1994: 31). The Toledo Glass Company built a factory with a 14-pot furnace and several machines for making tumblers. In 1897 the exclusive use of the tumbler machines in America was licensed to the Rochester Tumbler Company (Scoville 1948: 97–98). Later the Macbeth-Evans Glass Company purchased the rights to make lamp chimneys on the Owens machine (Paquette 1994: 31). Capital gained from the licensing of the production rights to tumblers and lamp chimneys, plus the investments made by Libbey and the other partners, enabled Michael Owens, the draftsmen, and an engineer the time needed to proceed with the development of bottle-blowing machines.

The first bottle-blowing machine Owens produced was submitted to the U.S. Patent Office in December of 1899, but the patent was not granted until May of 1904 (United States Patent Office 1904). This device was a handheld machine that used a long cylindrical pump to suck molten glass into the upper half of a bottle mold. When the half mold was filled with the hot glass it was hand carried to the bottom half of the mold. Once the two parts were connected the hand pump was reversed to blow the bottle (FIG. 1).

William Walbridge's book on American bottles illustrates a couple of small widemouthed jars blown on this handheld suction machine (Walbridge 1920: 61). One of the completed jars blown on this hand-pump machine is now in the Ward M. Canaday Center for Special Collections at the University of Toledo. A paper label on the jar reads: "Experiments 11/29/99 Between hours 1 & 4." The label goes on to list M. J. Owens, Thomas Owens, W. E. Bock, H.C. Wood, and S. S. Cochrane as witnesses to the production of the jars (FIG. 2). This handheld semiautomatic machine illustrated the principles and encouraged the further research that led to the fully automatic Owens bottle-blowing machines.

After establishing that a bottle could be made with the handheld suction device, the devise was mounted on a column on a three-wheeled cart that could be moved into the glass furnace to make the gather and then pulled back for completion of the bottle. This

second machine is also illustrated in Walbridge (1920: 60) (FIG. 3). While it was still semiautomatic, the principle had been established for production of bottles by the suction process. An English patent for the second machine was applied for in 1902 and granted 18 December 1903 (Toledo Glass Company of Ohio 1903). The amended patent has a header that reads: "Reprinted as amended in accordance with the decisions of the Comptroller General dated the 10th day August 1903, and the Law Office dated 18th day of November 1903." One of the added sections of this amended patent reads:

> I am aware that the use of suction to pick up measured quantities of molten glass from a pool into a ladle or tool is not new, and that the use of suction for the purpose of removing air from the ends or portions of moulds so as to enable glass which has been poured into the moulds to penetrate into small parts or extremities is also old, and I make no claim to any such use of the process of suction. (Toledo Glass Company of Ohio 1903:7)

A device called a "tallyho" or "sucker-upper" was used in the Libbey Glass Company to consistently gather a given quantity of glass for tableware production (Scoville 1948: 327). Given that Michael Owens was a manager of this plant, he would have been familiar with this device and that may have been where he picked up the idea of gathering glass by suction to make bottles. The American patent on this machine was filed on 13 April 1903; Michael Owens filed a patent application for the first fully automatic bottle-blowing machine. It does not have the disclaimer on the previous use of suction devices to gather glass. That patent (No. 766,768) was granted on 2 August 1904 (Owens 1903) (FIG. 4). In September of 1903, Libbey, Owens, and others incorporated the Owens Bottle Machine Company to manufacture and license the newly developed automatic bottle-blowing machine (Scoville 1948: 101). It was the first and only automatic bottle-blowing machine at the time (Turner 1938: 257–258). The semiautomatic bottle-blowing machines then in use were limited to producing widemouthed jars, mostly fruit canning jars and packers' ware. The early semiautomatic machines used the press-and-blow process that did not work well with narrow-neck bottles (Miller and Sullivan 1991: 101).

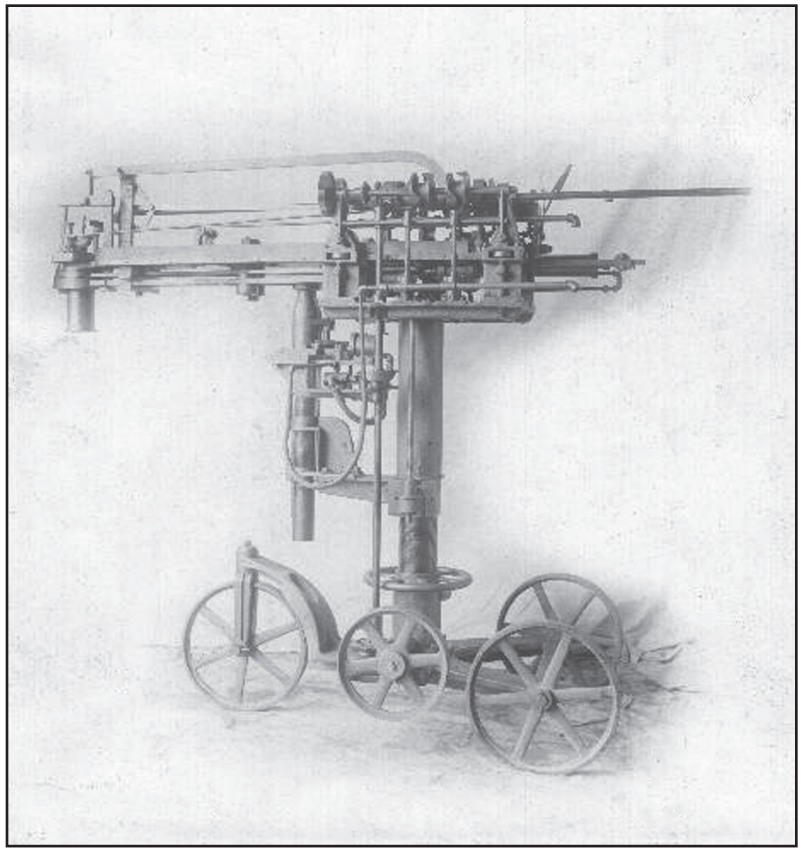

Figure 3. The second Owens bottle-blowing machine, which is the vacuum pump mounted on a three-wheel carriage—still a semiautomatic machine (Floyd, Bowers, and Brownlee 2006). (Photo courtesy of the Owens-Illinois, Inc. Archives, MSS-200 in the Ward M. Canaday Center for Special Collections, University of Toledo.)

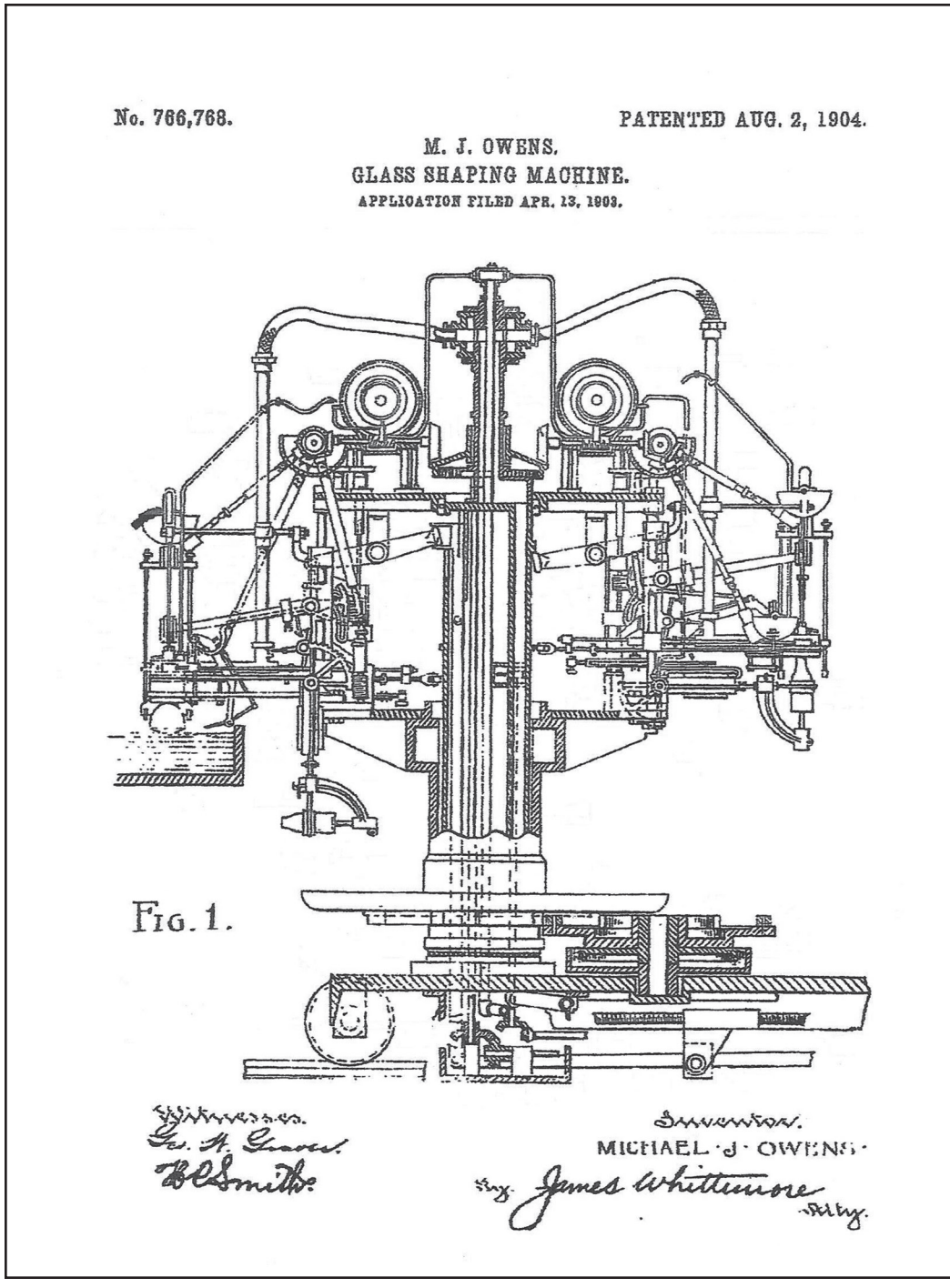

Figure 4. The first fully automatic Owens bottle-blowing machine, patent No. 766,768 granted 2 August 1904. Notice the blank mold on the left side of the machine resting on the surface of the molten glass in position to fill the mold and the blow mold below it. On the right side of the machine, the blow mold has been drawn up to replace the blank mold after the machine has rotated. (Owens 1903).

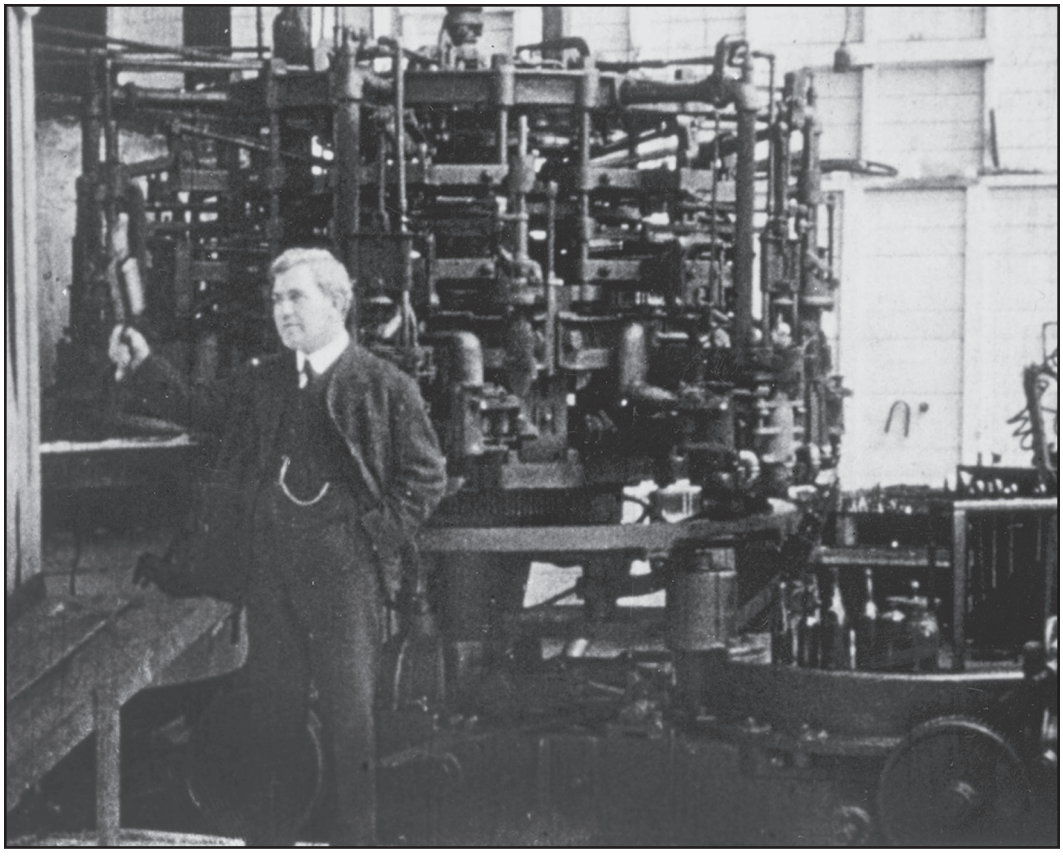

Figure 5. Photograph of Michael Owens holding a bottle taken hot off an Owens bottle-blowing machine (Floyd, Bowers, and Brownlee 2006). (Photo courtesy of the Owens-Illinois, Inc. Archives, MSS-200 in the Ward M. Canaday Center for Special Collections, University of Toledo.)

The Owens machine could produce narrow- and widemouthed bottles and jars, and because it was not dependent on skilled glassworkers to fill its molds, it had a much higher rate of production than was possible on the handfed semiautomatic machines (FIG. 5). When the Owens Bottle Machine Company was organized in 1903, the owners had limited capital and planned to maintain a demonstration plant in Toledo and to issue exclusive licenses to different glass manufacturers to produce limited ranges of bottle types on the Owens machine. Manufacturers that leased an Owens bottle machine would be given the exclusive license to produce a given type of bottle on that machine. In addition to the licensing fee, the companies receiving the lease would pay royalties equal to half the amount saved over the cost of hand production of the bottles they produced (Scoville 1948: 107). In August of 1903, Frank M. Gessner from the *National Glass Budget* visited the Toledo Glass Company plant as part of a demonstration of the Owens automatic bottle-blowing machine. His description of the machine, its advantages and potential, is quite informative:

> [The Owens machine] gathers its glass, forms its blank, transfers the blank from the gathering to the blow mold with a finished lip and ring, blows the bottle, and delivers the bottle automatically, without the touch of a human hand. ... Not only that, but it puts the same amount of glass into every bottle of the same exact length, finish, weight, shape and capacity. It wastes no glass, uses no pipes, snaps, finishing tools, glory-holes, oil, rosin, charcoal, and requires neither gatherer, blower, mold boy, snap boy, or finisher, and still makes better bottles, more of them, at a lower cost, than is possible by any other known process. (Gessner 1903a: 1)

He goes on to say that

> [w]arm weather does not reduce the factory output. The scarcity of blower or boys no longer results in spare pots and places. There is no wasted glass on the pipe-head, or the blow-over. There is no idle period between turns, and every hour of the 24 is continuously utilized, since the machine never gets hot enough to "horse," does not stop for lunch nor rest during dinner hour, registers no grievances, requires neither holiday nor summer stop, needs not glory-hole, and resorts to no strike for increased wages or less work. (Gessner 1903a: 4)

The average labor cost of the 7,877,308 gross of bottles made in the United States in 1902 was $1.53 per gross, and Gessner quotes the Owens company as saying that they could reduce the labor cost to produce bottles down to $0.06 per gross (Gessner 1903a: 1).

In 1903 and later, a number of bottle manufacturers were invited to attend demonstrations of the Owens machine producing bottles. Although impressed with the machine's capability and potential, manufacturers were slow to take up licenses. The only Owens machine in operation from 1903 through 1904 was the one at the Owens Bottle Machine Company demonstration factory in Toledo (Walbridge 1920: 99). While bottle manufacturers could clearly see the potential of the machine, it appears that none wanted to be the first company to take the plunge. Significant production of bottles on the Owens machine did not begin until 1905.

The Owens Bottle Machine Company would only license the use of its machines. Licenses came with an exclusive right to produce designated types of bottles. Some companies took out options on licenses but let them expire. For example, options on licenses to produce fruit jars were taken out in 1907 by James A. Chambers and later by the Ball Brothers Glass Manufacturing Company. Both of these companies let their options expire. Ball Brothers later purchased the Greenfield Fruit Jar Company for four times the cost of the original option to secure the rights to use the Owens machine for the production of their canning jars (Scoville 1948: 105).

Setting up to produce bottles on the Owens machine was an expensive and complicated process. Special tank furnaces had to be built that had a revolving runoff area from which the machines sucked up the glass, and lehrs, or temperature-controlled kilns for annealing the glass, had to be built to accommodate the machine. The first three manufacturers to be licensed for the Owens machine built new plants designed around the Owens machine (Scoville 1948: 103). In 1938, the Congressional Committee on the Investigations of Concentration of Economic Power called William Levis, the head of Owens-Illinois Glass Company, as a witness. In response to a question from H. B. Cox, special assistant to the attorney general, about the cost of setting up production with an Owens machine, Levis gave the following statement:

> Very briefly, sir—we have always analyzed it—it costs about $500,000 per furnace to go into the glass-container business; that is, the furnace that melts the glass, the forming device to make the ware, and the annealing ovens, with their buildings, and packing-house facilities. Another $100,000 should be added to cover compressors and office facilities and machine shop, and about half a million dollars working capital, or $400,000 to make a round number, requiring about a million dollars invested capital, which you turn once in the production of the furnace, about a million dollars in sales. That wouldn't make any difference, sir, whether you had our suction machine, on it, or say, we put two suction machines to draw 100 tons, or whether we put six of seven Hartford machines on it to draw the same tonnage. (United States Congress 1939:474-488)

No doubt the cost was much lower in 1905, but licensing an Owens machine still would have been a major investment. The expenses associated with the machines made the cost of the new technology seem prohibitive. In addition to these problems, there was resistance from the glassblowers' unions. Because the Owens bottle-blowing machine did not require any skilled glassworkers, the machine was a great threat to the economic position of glassblowers, who were among the highest-paid skilled workers in the country. The Owens bottle-blowing machine would be the death knell for their trade (Scoville 1948: 205–206). Thus, the high cost of setting up the furnace and Owens machines, along with labor resistance, made it difficult to place the machines in existing factories.

It appears that the glassworkers' unions recognized that it was going to be useless to fight the bottle-blowing machines. Rather than

fight the introduction of the semiautomatic bottle-blowing machines, the Glass Bottle Association began bargaining with glass manufacturers in the 1890s. Bargaining with the Atlas Glass Works and the Ball Brothers Glass Works led to agreements that the union members would become the machine operators (Minton 1961: 21–22). By 1924–1925 the Glass Bottle Association reached agreements that extended its jurisdiction to 42 glass factories, however, there were 25 plants with automatic machines outside their jurisdiction (Minton 1961: 84–85).

William Walbridge, an early partner of the Owens Bottle Machine Company, wrote a company history in 1920 that illustrated one of the first bottles blown on the Owens automatic bottle-blowing machine. It was a beer bottle with a cork finish (Walbridge 1920: 65). This type of bottle was being produced in the demonstrations described in the *National Glass Budget* in 1903 and for the manufacturers who came to Toledo to see the new wonder machine. Unfortunately for the company, no one purchased a license until 1905, when three companies took out licenses and the number of Owens machines in production jumped from one to six (Scoville 1948: 115). For practical purposes, 1905 is probably a good *terminus post quem* (*TPQ*) date for the bottles blown on the Owens machine.

The Owens machine was an instrument of mass production best suited to making large quantities of standard bottles. The early machines had 6 arms with later machines having 10 and 12 arms. Each arm had a set of ring (the mold that created the finish), blank, and blow molds; changing molds on any one of these arms required shutting down the entire machine. This lack of versatility meant that the Owens machines were not well suited for short runs of specialty bottles for small merchants, such as bottles embossed with the names of small-town druggists. Thus the first products produced on the Owens machine were common types such as bottles for beer, ale, wine, liquor, ketchup, and milk. Because semiautomatic machines were producing widemouthed jars at the time the Owens machine was introduced, it appears that the Owens Machine Bottle Company and those licensed to use the machine concentrated on narrow-mouthed bottles, rather than widemouthed jars. The first license for jar production was issued in 1910 to the Greenfield Fruit Jar and Bottle Company (Scoville 1948: 105).

The first Owens machines could make bottles that ranged from 4 to 40 oz. in size (Meigh 1960: 33). Early licenses (APPENDIX 1: TAB. 1) do not list anyone having the rights for small bottles such as pharmacy wares. Because small bottles have thinner walls, they had to be made with glass at a higher temperature due to the glass setting up much faster through the loss of heat to the molds. The early six-arm Owens machines could not be run fast enough to produce bottles less than 4 oz. in size. The development of ten-arm machines and the adoption of dipping head molds in 1911 speeded up production and enabled the Owens machines to produce bottles under 4 oz. in size. This change gives archaeologists a *TPQ* of 1911 for Owens-made

Table 2. Start dates for production of Owens machine-made bottles (Table by George L. Miller, 2013.)

Year	Bottle type
1905	Beer, porter, ale, soda water, wine, brandy, milk, patent medicines
1906	Ketchup
1908	Vinegar, grape juice, narrow-mouthed food bottles, European bottles
1910	Fruit jars, packers' ware, prescription ware, ammonia bottles
1910	Heinz bottles
1911	Whiskey, gallon packers
1911	Small bottles from 1/2 oz. to 6 oz. capacity
1912	Carboys

bottles smaller than 4 oz. in size. The 1916 report to the stockholders of the Owens Bottle Company states that the Owens machine could produce bottles ranging from 1/10 oz. to 13 gal. in size (Owens Bottle Machine Co. 1916: 1). Because of the exclusive licensing system used for marketing the Owens machine, it is possible to assign other *TPQ* dates based on the type of bottle produced on Owens machines (TAB. 2); see Table 1 for citations.

The share of the glass-container market produced on the Owens machine expanded rapidly from 1905 into the 1920s. By 1917, half the bottles produced in the United States were produced on the Owens machine, and hand production has been estimated to have been reduced to less than 10% of the bottles being produced (Miller and Sullivan 1991: 105). Leases to the American Bottle Company, Ball Brothers, Thatcher Manufacturing Company, Hazel-Atlas Glass Company, Illinois Glass Company, and others had begun to change the nature of the American glass industry. Those glass manufacturers left outside the chosen circle having access to the Owens bottle-blowing machine were in a tough spot. This situation brought about experimentation by other glass manufacturers and engineers to develop a range of different automatic glass bottle-blowing machines and feeders that could convert semiautomatic machines to being fully automatic.

Semiautomatic bottle-blowing machines worked well, but their production speed was limited by how fast skilled glassworkers could hand feed gobs of the right size and temperature into the machines. An article by Gessner in 1903 states that "[a]bout ten gatherings per minute on articles weighing up to 8 oz. is all that can be maintained regularly by competent workmen under good factory conditions" (Gessner 1903b: 6). The solution was to build feeding devices that could take the place of the skilled glassworkers and convert the semiautomatics into fully automatic bottle-blowing machines. Development of feeding devices by Hartford-Fairmount (later to become Hartford-Empire) and others after 1915 provided the first stiff competition to the Owens machine (Scoville 1948: 185–186). Hartford-Fairmount began leasing its gob-fed automatic bottle-blowing machines in 1915. That machine was less expensive to operate than the Owens machines, and the company charged a lower initial licensing fee, along with a lower royalty fee on the number of bottles produced than that charged by the Owens Bottle Company (U.S. vs. Hartford-Empire Company 1939: 24). Hartford-Fairmount and its successor Hartford-Empire were in the business of developing and manufacturing bottle-blowing machines and feeders to bottle machines, and they did not go into the manufacturing of glass containers. Like the Owens Bottle Company, their leases were for specific types of bottles and sometimes included limits on the quantities that could be produced.

The Owens Bottle Company was also developing glass-feeding devices, and by the early 1920s it was involved in patent-infringement litigation with Hartford-Empire over the claims covered by the feeder patents. To resolve this problem the two companies formed a patent pool in April of 1924 entitled "General License Agreement" by which they cross-licensed each other's patents. The Owens patents for suction machines, however, remained limited to the Owens Bottle Company (U.S. vs. Hartford-Empire Company 1939: 26–27). Under this agreement, the two companies agreed to share the cost of purchasing patents from other companies and the cost of litigating patent infringement cases against other companies. The strength of this patent pool convinced most of the major glass-container producers to take out leases from Hartford-Empire. Part of the fees from these leases and royalties collected by Hartford-Empire were paid to the Owens Bottle Company. This revenue sharing led to the Hartford-Empire and Owens-Illinois companies, along with other companies, to be called before the Committee on the Concentration of Economic Power related to their abuse of patents to control the glass industry. These activities led to a U.S. Supreme Court case that forced the breakup of the patent pool and opened the use of the patents to anyone for a reasonable license fee (Hartford-Empire Co. et al. v. United States 1945).

After the Owens bottle-machine patents began to expire in the 1920s, anyone could build and use an Owens bottle-blowing machine, although the cost and learning curve would have been an impediment. By that time

the Owens bottle-blowing machine was being supplanted by Hartford Empire's individual section machine (the I. S. machine), which went on to become the dominant machine for the production of glass containers, as it still is today. The Owens Bottle Company began leasing Hartford Empire's I. S. machine.

The existing Owens bottle machines continued in use because they were excellent for the production of long runs of bottles, and those companies using the machines continued to benefit from their large initial investment in this technology. The last two Owens machines went out of production in December of 1982 at the Owens-Illinois Company factory in Gas City, Indiana (American Society of Mechanical Engineers 1983: 6). These machines ceased production as part of the permanent closure of 42 domestic and foreign plants by Owens-Illinois during an economic downturn (Paquette 1994: 276).

The Owens Bottle Machine Company began to transition into the manufacture of bottles shortly after it began licensing the use of the Owens automatic bottle-blowing machines to others. In November of 1904 Libbey and some of the other investors in the Owens Bottle Machine Company began the Northwestern Ohio Bottle Company in Newark, Ohio, licensed by their Owens Bottle Machine Company to produce wine, brandy, and a few special "branded" bottles (Scoville 1948: 104). The Owens Bottle Machine Company purchased all the stock in this company in 1908 (Toulouse 1971: 329). In 1909 the Owens Bottle Machine Company built a plant in Fairmount, West Virginia, that went into production in 1910 (Toulouse 1971: 394). Thus, by then it was well on the way to becoming a major glass-container manufacturer. The leases that had been issued to other companies for exclusive rights to produce certain types of bottles presented some limitations that were overcome by purchasing some of those companies (TAB. 3).

In 1919, the Owens Bottle Machine Company became the Owens Bottle Company (Lockhart et al. 2010: 51). The last lease granted by the Owens Company for use of an Owens automatic bottle-blowing machine was in 1918 (Levis 1938: 497). In 1929 the Owens Bottle Company merged with the Illinois Glass Company to form the Owens-Illinois Glass Company, which made it the largest glass-container manufacturer in the United States. In response to a letter written in 1935 asking about leasing an Owens machine, the assistant secretary to Owens-Illinois Glass Company responded as follows:

> Referring to your communication of June 8, this company is engaged in manufacturing and sale of glass containers, but we are not licensors of glass making machinery. We do construct certain glass-forming mechanisms, but such equipment is for use in our own factories exclusively. We are unable therefore, to render the service which you require. (Levis 1938: 517–518)

By the time the above letter was written, all the major patents on the Owens automatic bottle machine had expired. William Levis, in response to a question by counsel H. B. Cox about who controls the patents on the suction

Table 3. Companies having Owens Bottle machine leases later purchased by the Owens Bottle Company. (Table by George L. Miller, 2013.)

Company	Lease to produce	Date purchased by Owens Co.	Source
Northwestern Ohio Bottle Co.	Wines, brandy, and special branded bottles	1908	Toulouse 1971: 329
Whitney Glass Works, continued under the Whitney name until 1918	Prescription ware and ammonia bottles	1915	Toulouse 1971: 524
American Bottle Co.	Beers, porter, ale, and soda bottles	1916	Toulouse 1971: 30–31
Charles Boldt Glass Co.	Whiskies	1919	Toulouse 1971: 91

machines for producing bottles, answered that "we" (Owens-Illinois Glass Company) did, but "I don't think there is much left of them," and went on to state: "I would say we had no very important patents after 1929" (Levis 1938: 467). After the patents had expired, anyone could have built an Owens-style suction machine if desirous of expending the funds to do the engineering to accomplish this task. However, by that time the Hartford-Empire Company's I. S. machine was beginning to replace the Owens machines. The last Owens suction machines were built in 1941 for the company's use (American Society of Mechanical Engineers 1983: 6).

Owens Bottle-Blowing Machines and the Suction Scar

Bottles made on the Owens machine are easy to identify because of their distinct suction-scarred bottom. With the Owens machine, the blank (or parison) mold is dipped into a revolving tank of molten glass from which it sucks up the glass to fill the mold. When the blank mold is full, it is lifted off the molten glass and a knife comes across the base of the mold to sever the glass in the mold from that in the tank. That cutting action drags glass across to one side of the base of the mold and creates what is called an Owens or suction scar. Suction scars are rarely centered on the base of the bottle. This is because the rotation of the machine causes the semi-liquid parison to move about and be off center when it is enclosed by the blow mold. Another factor is that the parison molds are round in cross section, and when the parison is blown into an oval or square bottle the suction scar commonly comes up on the side of the bottle. The visibility of the suction scars can range from being very obvious to being difficult to see. They are often more obvious on larger and earlier bottles. Some of the factors involved are described in the following quote:

> The cut-off will give trouble. The principal trouble is a dirty cut-off, resulting from bad condition of the blank noses, and a defective knife. The glass is not cut-off cleanly, and the flaky pieces remain on the bottom of the parison molds, and on the knife, and are incorporated in the next cut-off, fusing in on the bottom. The knife may be blunt, may be of the wrong angle, may be loose, and may not be cutting closely to the blank bottom. (*Glass Industry* 1928: 147)

The blank mold that creates the parison and the blow mold both join to the ring mold that forms the finish of the bottle. Where the blank and blow mold join the ring mold, the mold lines are in alignment, i.e., the lines from both molds will be on top of each other where they join the ring mold that creates the finish. However, because the parison is rarely centered when the blow mold closes around it, the mold lines from the blank mold will be out of alignment with those of the blow mold near the base of the bottle. This results in faint mold lines that are partly compressed by the surface of the blow mold. These parison mold lines are often referred to by bottle collectors as "ghost" mold lines. Parison mold lines are present on almost all machine-made bottles, so they cannot be used to identify an Owens suction machine-made bottle. To separate an Owens bottle from other machine-made bottles, one has to have the base of the bottle. Figure 6 shows the mold-filling sequence for an Owens machine (FIG. 6).

It is worthwhile to get to know what a suction scar looks like because it, in combination with the known information on licensing, can be used to provide some fairly tight *TPQ* dates for early Owens machine-made bottles. Figures 7 and 8 show very clear examples of Owens suction scars on bottles, but not all scars are this obvious (FIGS. 7 & 8). For more examples of Owens scars see Lockhart et al. (2010: 56–59) and Miller and Sullivan (1991: 111).

The Owens machine remained an important producer of bottles into the 1950s and later. Beyond the dates of licensing for production and changes in the Owens machine, there are other factors that can help date all machine-made bottles. The first bottles to be produced by machine production were the most common types for which there would be long runs. It made little sense to produce the complex set of molds for a bottle type that would have a short run. For the Owens machine the early focus was on beer, wine, brandy, soda-water, liquor, and food bottles. Companies using the Owens machine first produced small-mouthed bottles because the semiautomatic machines could not produce such bottles. However, by 1910, the Owens machine was producing canning jars, food-packing jars, and common pharmaceutical

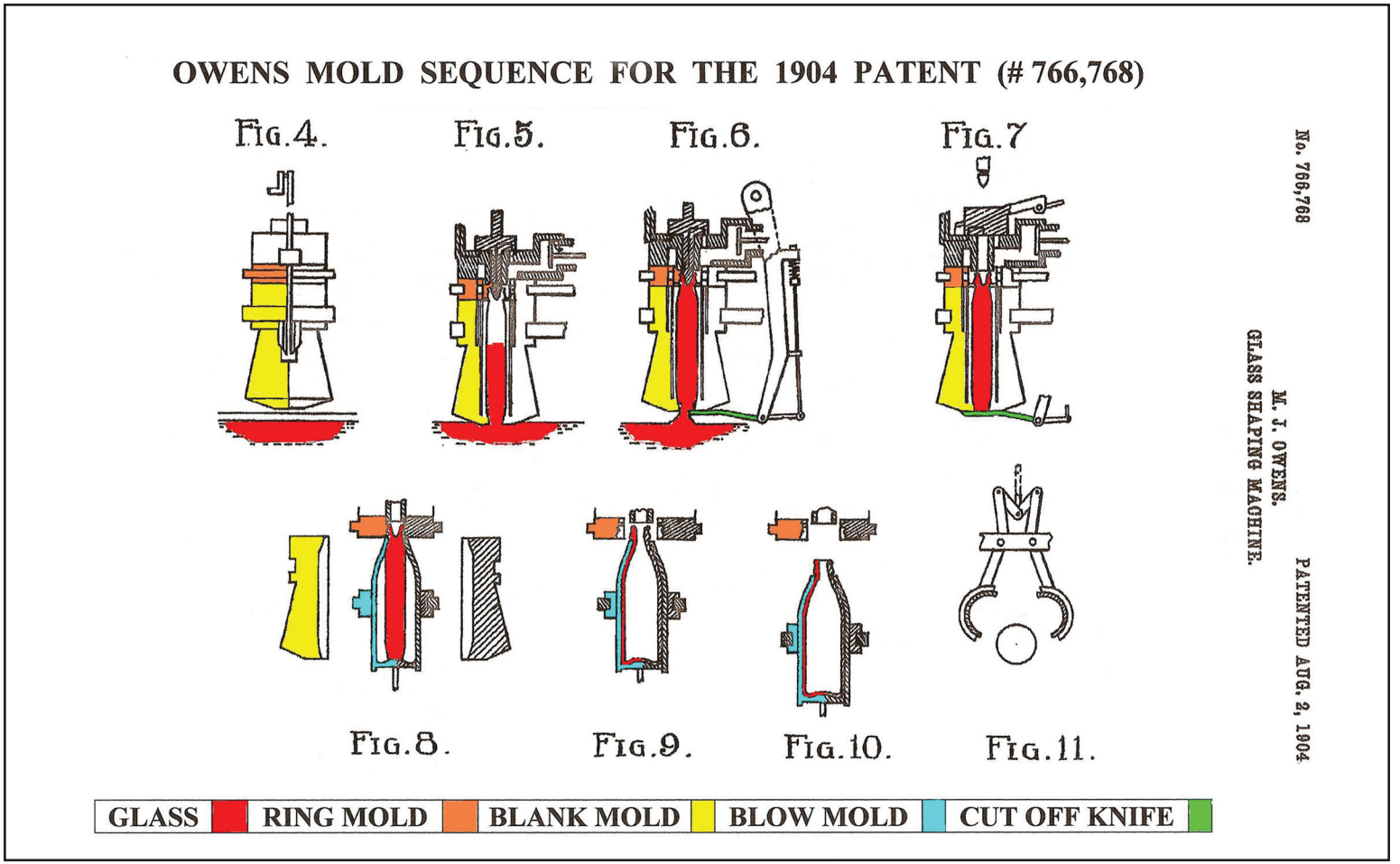

Figure 6. The Owens machine mold sequence: Fig. 4 shows the blank mold resting on the molten glass; in Fig. 5 the glass is being sucked into the blank mold. Fig. 6 shows the knife severing the glass from the furnace and the blank mold, which is then lifted in Fig. 7. Above Fig. 7 is a plug that creates the cavity in the neck for the blowing of the bottle. Fig. 8 shows the blank mold opening and the glass parison being held by the ring mold. Fig. 9 illustrates the bottle being blown in the blow mold. Fig. 10 shows the ring mold opening, and Fig. 11 depicts the blow mold opening to release the bottle. (Owens 1903).

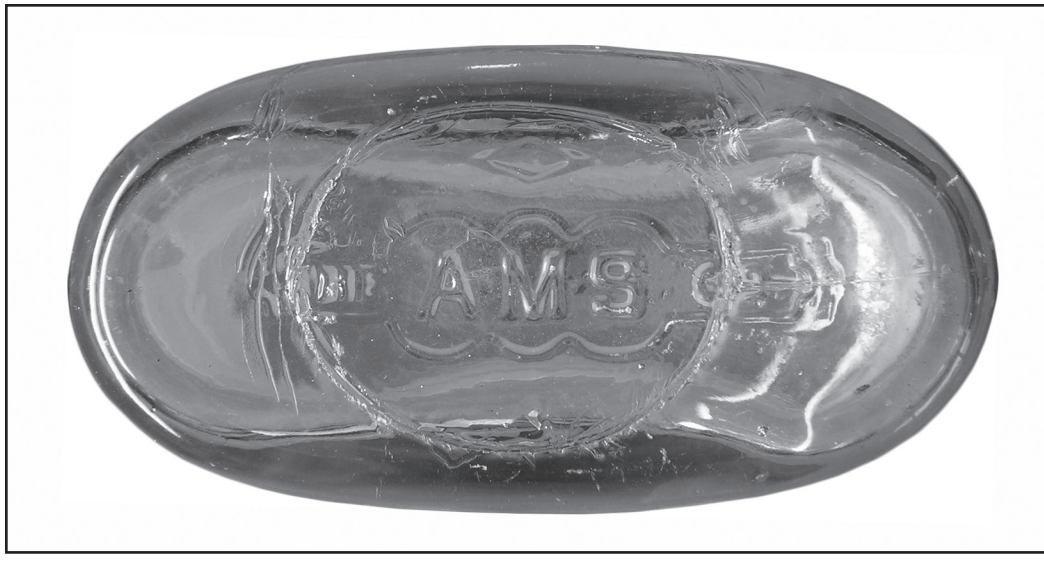

Figure 7. Owens suction scar on a "FULL PINT," cork-stopped, colorless glass liquor flask. There is a faint Illinois Glass Co. I-Diamond trademark above the bottler's mark: THE A.M.S. CO. (the American Medical Spirits Co.) which made medicinal whiskey during Prohibition. This information, plus the I-Diamond mark, dates the bottle to between 1919 and 1929. Notice the slightly oval mark, which is from the blank mold. The knife cutting off the glass created the Owens scar, dragging some of it off to the left side of the oval blank mold mark. (Photo by George L. Miller, 2013.)

bottles. Most of the early bottles are what were called stock types. That is, they were not being made for a particular proprietary brand. Bottles for proprietary products are known as private molds, and they were not far behind in production. An early example would be those bottles produced by the H. L. Heinz Company for its own products. Major companies such as Chesebrough Vaseline, Lydia Pinkham's medicines, and Sloan's Liniment were not far behind. The Owens machine was one of mass production, and to shut the machine down to change molds was limited as much as possible.

Because the Owens bottle-blowing machine was best at long production runs of bottles, it eliminated many older types of bottles that were blown with letter-plate molds for pharmacies, breweries, and other small enterprises. These smaller companies were not able to absorb the minimum order size for special bottles made on the Owens machines. Shutting down an Owens machine to change molds was not practical for short runs. Thus ended a colorful period of bottle production that began in 1867 when James Christie of Baltimore, Maryland, took out a patent for plate molds for bottles (Christie 1867). He referred to the plate as "a movable panel or slide." This is referred to as a "lettered plates" in the 1880 Whitall, Tatum & Company catalog (Whitall, Tatum & Co. 1971: 8–9). The plate mold led to many small pharmacies, breweries, and other companies ordering bottles with their names blown in the glass. These could be accommodated during the period of the mouth-blown bottles, however, the Owens and other automatic machines could not readily accommodate small orders because the changing of a mold would mean shutting down the machine. Minimum orders for machine-made bottles limited production to those companies that used large numbers of bottles. For a discussion of these changes see Miller and Pacey (1985: 41–44). Thus the period prior to the takeover of the Owens and the I. S. machines had many more varieties of bottles from smaller firms.

The second change that took place was in the color of the glass. When the Owens bottle-blowing machine began production the most common colors were a light green/aqua and amber brown. These colors came from iron that was commonly found in the sand that is used to make glass. The more iron in the sand,

the darker the color. Colorless glass became common slightly later. Sand with low iron content could be used to produce colorless glass by the addition of manganese dioxide to the batch. Bill Lockhart has written a history of the use of manganese dioxide to produce colorless glass (Lockhart 2006). His research has shown that commercial containers in colorless glass created with manganese dioxide were being produced by the mid-1870s, which is well before the introduction of machine-made bottles (Lockhart 2006: 54). Glass made colorless with manganese dioxide will turn a light purple when exposed to sunlight.

For manganese dioxide to work as a decolorizer of glass, the glass batch has to be in reduction rather than oxidation. If the glass batch is in oxidation the glass will have an amethyst to purple color (Scholes 1941: 13). If the glass in a crucible is in oxidation, this can be remedied by the introduction of organic material into the batch. Rosenhain states: "Thus, a glass having a slight tinge of pink or purple derived from manganese can be rendered entirely colourless by the action of reducing gases or by introducing into the glass a reducing substance, such as a piece of wood" (Rosenhain 1908: 192–193). He also states that the introduction of organic materials can be used to get rid of bubbles in the glass:

> The most usual method is to place a potato in the crook of a forked iron rod and then dip the rod with the attached potato into the molten glass; the heat at once begins to drive off the moisture and to decompose the potato, so that there is a violent ebullition of the whole mass. … It is, of course, further obvious that this process can only be usefully applied to glass melted in pots [crucibles], since the bulk of molten glass in a tank furnace could not be reached at all in this manner. (Rosenhain1908: 81)

The Owens machines pulled its gathers of glass from large tank furnaces. Controlling the reduction or oxidation of the batch in a tank furnace, as Rosenhain states, was not possible, as it was done in crucibles full of molten glass. Some early Owens-made bottles, such as milk bottles and pharmacy ware, were produced in glass that was made colorless by the use of manganese. These probably date before 1920. Another problem with manganese dioxide is that when it is exposed to high temperatures for prolonged periods, such as is common in a tank furnace, it tends to burn out in its ability to produce colorless glass (Angus-Butterworth 1948: 67).

The glass industry began switching to selenium as a decolorizer, which is much more

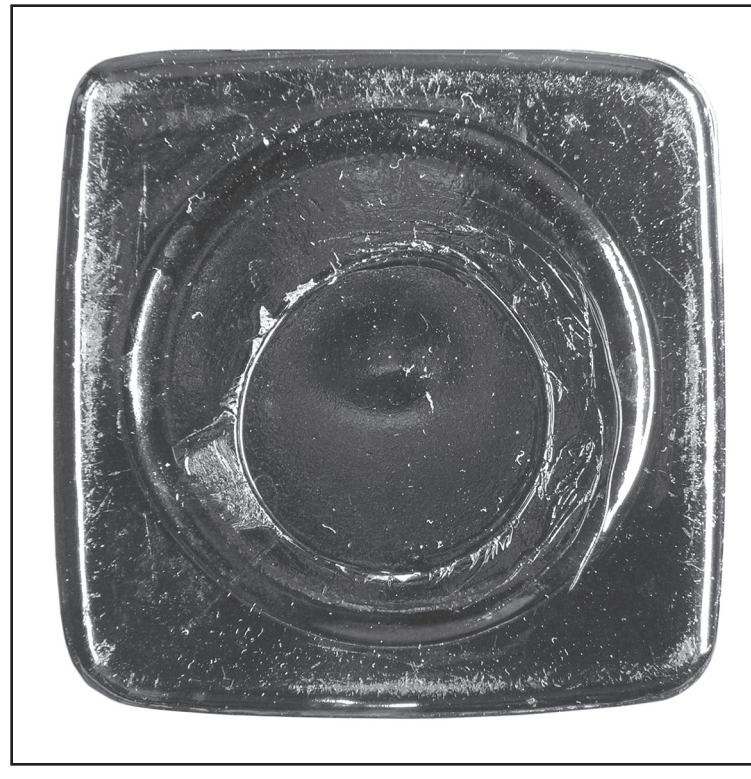

Figure 8. Owens suction scar on a dark-amber tapered gin bottle (Dutch gin bottle). No makers' or other marks. Probably made by the Illinois Glass Co. between 1910 and 1919. The slightly off-center round mark is from the blank mold. Again, one can see the glass dragged by the knife that cut the glass off when the blank mold was full. Not all Owens suction scars are this obvious; they are generally easier to see on larger bottles and those that are not round in cross section. (Photo by George L. Miller, 2013.)

stable under the conditions in tank furnaces full of molten glass. Information on selenium as a decolorizer was being published as early as 1911 (Angus-Butterworth 1948: 68–69). Selenium was more expensive that manganese dioxide, although not as much was needed to create colorless glass. Less than an ounce of selenium per ton of sand in the glass batch was needed, whereas it took 15 lb. of manganese per ton of sand, in addition to large amounts of nitrate that had to be added, to create the reduction for the manganese to produce colorless glass (McSwiney 1925: 54). In tank furnaces the quality of colorless glass obtained from manganese was inferior to that obtained by using selenium (McSwiney 1925: 53–25). Selenium, on the other hand, works well in a slightly reducing atmosphere that is common in tank furnaces (McSwiney 1925: 56). Probably by 1920 selenium had replaced manganese as a decolorizer in tank furnaces used to feed the Owens bottle-blowing machines. Although light-green, aqua, and amber bottles continued to be produced, colorless glass became the dominant type. A 1933 inventory of the Hamilton plant of the Dominion Glass Company lists thousands of bottles, and the dominant color is listed as "flint," which would be colorless non-lead glass (Miller and Pacey1985: 45).

The next big change in machine-made bottles related to closures. Most of the illustrations of early machine-made bottle catalogs show cork or crown closures on the products (Illinois Glass Company [1915]; Owens Bottle Company [1925]). In 1906 the lug-top finish was introduced as a common bottle and jar closure (Leif 1965: 22). The great majority of bottles produced on the Owens bottle-blowing machines would have cork or crown closures. Initially the bottle companies did not produce their own metal caps, and they would have been ordered from companies that produced metal products. The end of the cork closure appears to have been brought about by the shortage of supplies of cork during World War II (Riley 1946: 209). Today, corks are rarely used for bottles, other than for wine and some fancy gourmet foods.

The last major change that is fairly easy to spot is the development of the lightweight bottle. It is our experience that the early bottles produced on the Owens machines appear to be rather heavy. By 1911 the company had developed an Owens machine that could produce bottles under 6 oz. in size (Walbridge 1920: 89). These bottles had thinner walls, and this may mark the beginning attempts to produce lighter-weight bottles. Beginning in the 1920s, the Bureau of Standards of the Department of Commerce began working with bottle manufacturers, bottlers, and other groups to establish recognized standard bottle sizes and shapes. This was meant to cut down on the number of types being produced in a move toward efficiency and economy. For example, the Bureau of Standards met with the American Bottlers of Carbonated Beverages at their 1929 annual meeting and attempted to set up standards for the industry. The recommendation was to cut the 15 available capacities of bottles down to 3, and to cut the 78 heights of the bottles being used down to 6. The government published the standards for soda-water bottles and other types of containers in the 1930s. Because these standards were not enforced by law, most of them did not come into effect until required by the government during World War II as part of the rationing of resources and energy (Riley 1946: 140). During the war, the number of bottle sizes, weights, and types of closures was reduced to cut down on the use of fuel, glass, shipping weight, and needs for warehousing. Lightweighting of bottles began around 1935 when the beer can came into production and began cutting into the bottle market share. The glass industry responded by making a lightweight single-trip bottle or a throwaway. Glass engineers began doing studies as to the best weight and shape for bottles without compromising strength. These standards became established during World War II. Lightweight bottles will have a fairly even distribution of glass on the sides and bottom of the bottle. A machine-made bottle with an irregular distribution of glass in the base most likely dates from before World War II. The war was a major turning point in bottle production, as was summed up by Holscher, who stated:

> Prior to the war, there were many odd shapes and sizes of bottles. War standardization, and elimination of small sizes, provided an increased output with the same production machinery. Janssen stated in 1946 that a return to the pre-war pattern would cut output by 20% in grossage, or 40% in gallonage. (Holscher 1953: 375)

The wide range of sizes is well illustrated by the ca. 1925 Owens Bottle Company catalog. It lists 29 sizes of "Standard Tablet Blakes Wide Mouth" ranging from 1/6 to 28 oz. in size. Seven of these available sizes were less than 1 oz. in capacity (Owens Bottle Company [1925]: 37). The range of small bottles being made after World War II was greatly reduced, and today plastic bottles have taken their place.

Acknowledgments

The senior author owes an intellectual debt to his glass mentor Olive Jones. My research on machine-made bottles began at Parks Canada in the early 1980s under her direction. Many others have contributed to this research, including Jack Paquette, whose book, The Glassmakers: *A History of Owens-Illinois Incorporated*, was of great help, along with other information that he sent to me. Peter Schulz provided copious photocopies from trade journals on the development of the glass industry. Gail P. Bardhan of the Corning Museum of Glass Library was very helpful in providing copies of Owens Glass Bottle Company documents and suggesting references. Kimberly Hieronimus Brownlee of the Ward M. Canady Center for Special Collections of the University of Toledo, Ohio, was most helpful in getting permission to use images from the Owens-Illinois, Inc. archives. I would also like to thank Stephanie Johnston from corporate communications of Owens-Illinois, Inc. for granting permission to use photographs from their archives. Dick H. Cole of the Minnetrista Museum in Muncie, Indiana, provided information on the use of the Owens machine in the Ball Brothers works. James C. Coleman, who worked in the general research department of Owens-Illinois, shared a biography he produced on the life and work of Michael Owens with me and provided some helpful comments on an earlier draft of this paper. Charles Depew, who worked his way up into management for Owens-Illinois and had worked with Owens and other types of bottle-blowing machines, provided helpful comments on a much earlier draft of this paper. J. William Barrett II told me about working with the I. S. bottle-blowing machines and about what it was like to work in a glass factory. Glenn Vogel was able to supply me with some glass factory ephemera that was greatly appreciated. Christopher Hogue, who is using the process of production by the Owens machine to simplify the description of the molecule ATP phase in photosynthesis, provided some very thought-provoking discussions on the development of the Owens machine. I would like to apologize to those whom I have forgotten to mention for their thoughts and contributions to the development of this paper. The authors would also like to thank Bill Lockhart and two other reviewers for their comments on our study.

References

American Society of Mechanical Engineers
1983 *American Society of Mechanical Engineers Designates the Owens "AR" Bottle Blowing Machine as an International Historic Engineering Landmark*. American Society for Mechanical Engineers, New York.

Angus-Butterworth, Lionel M.
1948 *The Manufacture of Glass*. Pitman Publishing Corp., New York.

Birmingham, Frederick A
1980 *Ball Corporation:* The First Century. Curtis Publishing Co., Indianapolis, IN.

Christie, James J.
1867 Improved Glass-Bottle Mold. United States Patent 72,368, filed 10 October 1867, and issued 17 December 1867.

Coles, Jessie V.
1949 *Standards and Labels for Consumers' Goods*. Ronald Press Co., New York.

Floyd, Barbara, Ann Bowers, and Kimberly Brownlee
2006 Time in a Bottle: A History of Owens-Illinois, Inc. Ward M. Canaday Center for Special Collections, University of Toledo <http://utoledo.edu/library/canaday/exhibits/oi/OIExhibit/MainPage.htm>. Accessed 27 August 2013.

Franken, Richard B., and Carroll B. Larrabee
1928 *Packages that Sell*. Harper & Brothers, New York.

Gessner, Frank M.
1903a The Owens Bottle Machine. Its Demonstrated Economy and Efficiency. *National Glass Budget: Weekly Review of the American Glass Industry* 19(15): 1, 4.
1903b Weekly Review of the American Glass Industry. *National Glass Budget: Weekly Review of the American Glass Industry* 19(1): 6.

Glass Industry
1928 Aspects of Bottle Machine Operation. Glass Industry 9(7): 1,947.

Gooding, E. J., and Edward Meigh (eds.)
1951 *Glass and W. E. S. Turner* [1915–1951]. Society of Glass Technology, Sheffield, UK.

Holscher, Harry H.
1953 Feeding and Forming. In The Handbook of Glass Manufacture: *A Book of Reference for the Plant Executive, Technologists and Engineer.* Comp. and ed. by Fay V. Tooley, 229–388. Ogden Publishing Co., New York.

Illinois Glass Company
[1915] *Illinois Glass Co. Bottles,* "Diamond I" Products, General Catalog "A." Illinois Glass Company, Alton.

Leif, Alfred
1965 *Closeup on a Closure*. Glass Container Manufacturers Institute, New York.

Lockhart, Bill
2006 The Color Purple: Dating Solarized Amethyst Container Glass. *Historical Archaeology* 40(2): 45–56.

Lockhart, Bill, Pete Schultz, Carol Serr, and Bill Lindsey
2010 The Dating Game—the Owens Bottle Co. *Bottles and Extras* 21(1): 50–62.

McSwiney, D. J.
1925 The Decolorization of Glass. *Glass Industry* 6(3): 53–57.

Meigh, Edward
1960 The Development of the Automatic Glass Bottle Machine: A Story of Some Pioneers. *Glass Technology* 1(1): 25–50.

Miller, George L., and Antony Pacey
1985 Impact of Mechanization in the Glass Container Industry: The Dominion Glass Company of Montreal, a Case Study. *Historical Archaeology* 19(1): 38–50.

Miller George L., and Catherine Sullivan
1991 Machine-Made Glass Containers and the End of Production for Mouth-Blown Bottles. *In Approaches to Material Culture Research for Historical Archaeologists.* Comp. by George L. Miller, Olive R. Jones, Lester A. Ross, and Teresita Majewski, 99–126. Society for Historical Archaeology, California, PA.

Minton, Lee W.
1961 *Flame and Hearth: A History of the Glass Bottle Blowers Association of the United States and Canada*. Merkle Press, Washington, DC.

Moody, B. E.
1963 *Packaging in Glass.* Hutchinson and Co., London.

Owens Bottle Company
[1925] *Proprietary Owens Bottles: Owens Machine Made by Owens, Stock Catalog No. 2.* Owens Bottle Company, Toledo, OH. No. 30550, Corning Glass Museum Library, Corning, NY

Owens Bottle Machine Company
1916 Owens Capital Now $50,000,000. *National Glass Budget: Weekly Review of the American Glass Industry* 31(47): 1–3.

Owens, Michael J.
1899 Method of Blowing Glass. U.S. Patent 759,742, filed 26 December 1899, and issued 10 May 1904.

Owens, Michael J.
1903 Glass-Shaping Machine. U.S. Patent 766,768, filed 13 April 1903, and issued 2 August 1904.

Paquette, Jack K.
1994 *The Glass Makers: A History of Owens-Illinois Incorporated*. Trumpeting Angel Press, Toledo, OH.

Paul, John R., and Paul W. Parmalee
1973 *Soft Drink Bottling: A History with Special Reference to Illinois*. Illinois State Museum Society, Springfield.

Riley, John J.
1946 *Organization in the Soft Drink Industry: A History of the American Bottlers of Carbonated Beverages.* American Bottlers of Carbonated Beverages, Washington, DC.

Rosenhain, Walter
1908 *Glass Manufacture.* D. Van Nostrand, New York.

Scholes, Samuel R.
1941 *Handbook of the Glass Industry: A Book of Reference for the Factory Engineer, Chemist and Plant Executive*. Ogden-Watney, New York.

Scoville, Warren C.
1948 *Revolution in Glassmaking: Entrepreneurship and Technological Changes in the American Industry,* 1880–1920. Harvard University Press, Cambridge, MA.

Toledo Glass Company of Ohio
1903 Improvements Relating to the Production of Articles of Glass and Apparatus Therefore. British Patent 20,148, issued 1902, and amended specifications 18 November 1903. British Patent Office, London. Collection of George Miller, Newark, DE.

Tooley, Fay V.
1953 *Handbook of Glass Manufacture: A Book of Reference for the Plant Executive, Technologist and Engineer*. Ogden Publishing Co., New York.

Toulouse, Julian Harrison
1971 *Bottle Makers and Their Marks*. Thomas Nelson, New York.

Turner, William E. S.
1938 The Early Development of Bottle Making Machines in Europe. *Journal of the Society of Glass Technology* 22(52): 250–258.

Tutton, John
1994 *Udderly Delighful*: A Guide to Collecting Milk Bottles and Related Items. 3rd ed. John Tutton, Front Royal, VA.

United States Congress
1939 *Investigations of Concentration of Economic Power: Hearings before the Temporary National Economic Committee, Congress of the United States, Seventy-Fifth Congress, Part 2, Patents: Automobile Industry, Glass Container Industry*. United States Congress, Washington, D.C.

District Court of the United States
1939 *United States of America v. Hartford Empire Company et al., Complaint*. Civil Action No. 4426, District Court of the United States for the Northern District of Ohio, Western Division. Filed 11 December.

United States Supreme Court
1945 Hartford-Empire Co. et al. v. United States, 323 U.S. 386. Reargued and submitted 9 & 10 October 1944, decided 8 January 1945. Findlaw for Legal Professionals http://caselaw.1p.findlaw.com/scripts/getcase.pl?=us&vol=323&invol=368. Accessed 24 May 2005.

Walbridge, William S.
1920 *American Bottles Old and New: A Story of the Industry in the United States*. Owens Bottle Company, Toledo, OH.

Whitall, Tatum & Co.
1971 *Whitall,* Tatum & Co. 1880. Pyne Press, Princeton, NJ.

Author Information

George L. Miller
Retired
Newark, Delaware
miller.ccindex@gmail.com

Anthony J. McNichol
Principal Investigator
Chrysalis Archaeological Consultants
Brooklyn, NY
amcnichol@chrysalisarchaeology.com

Appendix 1: Table 1: Dates for Owens Machine-Made Bottles. (Table by George L. Miller, 2013.)

Year	Company	Products	Source
1903	Owens Bottle Machine Co.	Organized with a capital of $3,000,000, took over the Toledo Glass Co. factory to set up a demonstration facility.	Walbridge 1920: 67
1903	Owens Bottle Machine Co.	Pint and quart **beer bottles**, demonstration of the machine described in National Glass Budget in August of 1903.	Walbridge 1920: 67
1904	Owens Bottle Machine Co.	Only one Owens machine in operation.	Walbridge 1920: 99
1904 16 Sept	Baldwin-Travis	License for **milk bottles** to Baldwin-Travis. It merged with Thatcher Manufacturing Co. less than a year later.	Scoville 1948: 104
1905	Thatcher Manufacturing Co.	Thatcher Manufacturing Co. was a distributor of milk bottles from different manufacturers to dairies. They merged with Baldwin-Travis to acquire the rights to produce **milk bottles** on the Owens machine. They installed a No. 6 machine in a factory in Kane, PA.	Walbridge 1920: 72 Toulouse 1971: 497
1904 1 Nov	Ohio Bottle Co.	For exclusive rights to produce **Beer, porter, ale, and soda-water bottles** on the Owens machine. They used their license to bargain for a merger with Streator Bottle & Glass Co. and Adolphus Busch Glass Manufacturing Co. This license was consigned to this consortium called the American Bottle Company 7 Sept. 1905.	Walbridge 1920: 72 Scoville 1948: 104 Toulouse 1971: 399–400
1905 7 Sept.	American Bottle Co.	Product of a merger to have access to the license for the production of beers, **porter, ale, and soda bottles** on the Owens machine. Combination of the Ohio Bottle Co. with the Streator Bottle and Glass Co. and Adolphus Busch Glass Manufacturing Co. Owens Bottle Co. purchased American Bottle Co. in 1916. It continued to use the American Bottle Co. name until 1929 when Owens merged with Illinois Glass Co. Prohibition killed the demand for beer bottles.	Walbridge 1920: 72 Toulouse 1971: 30–31, 373
1904 1 Nov.	Northwestern Ohio Bottle Co.	"On Nov. 1, 1904 Libbey entered the bottle-making business as the Northwestern Ohio Bottle Co. of Toledo. The company had an exclusive license to make **wines** and **brandies** and a few "branded" (or "**proprietary" medicine**) bottles." Owens Bottle Machine Co. bought all of their stock in 1908. They added another furnace, two more Owens AD machines, and began making **vinegar, grape-juice, ketchup**, and other **narrow-neck food bottles.**	Walbridge 1920: 72 Scoville 1948: 104 Toulouse 1971: 329
1904–1912	Owens Bottle Machine Co.	Made **beer and sodas** for its licensee American Bottle Co. in 1905 and 1906 and then turned to **ketchups** until 1912, when it added **pharmaceutical and proprietary medicine**.	Toulouse 1971: 393
1905 19 Oct.	Owens European Bottle Machine Co.	The Owens European Bottle Machine Co. was formed to sell the machine to European manufacturers.	Walbridge 1920: 73 Scoville 1948: 118–119
1906	James A. Chambers	Took an option on a license for making **fruit jars**, but let the option expire.	Scoville 1948: 105
1906	Greenfield Fruit Jar Co.	"The former Greenfield Fruit Jar & Bottle Co. . . . installed Owens machines about 1906, had been acquired by Ball Bros. in 1912 and resold to Owens Bottle Co. In 1917." **Fruit Jars**.	Toulouse 1971: 396
1907 1 Feb.	Rhein-Ahr Glasfabrik	Rhein-Ahr Glasfabrik Gesellschaft mit beschränkter Haftung, license for making **Apollinaris** and other **mineral water bottles** only to make bottles for their own bottled mineral waters.	Walbridge 1920: 74 Scoville 1948: 122

Appendix 1: Table 1: Dates for Owens Machine-Made Bottles. (*continued*)

Year	Company	Products	Source
1907 1 Oct.	Owens European Bottle Machine Co.	Plant at Trafford Park, Manchester, England, opened to demonstrate to European manufacturers. Turns $58,000 profit over operating expenses in 11 months.	Walbridge 1920: 73 Scoville 1948: 121
1907	Ball Brothers	Took an option on a license for making **fruit jars**, but let it expire. They later purchased the right as an assignee from Greenfield Fruit Jar Co. in 1909, and it cost them more than four times the original license cost.	Scoville 1984: 105
1909 2 Jan.	Greenfield Fruit Jar Co.	Louis Hollweg took out a license for fruit jars and assigned the rights to Greenfield Fruit Jar & Bottle Co. in November. They sold the rights to Ball Brothers a week or so later.	Scoville 1948: 105
1909 Nov.	Ball Brothers	Purchased the license rights to the Owens machine for making fruit jars from Greenfield Fruit Jar and Bottle Co. in November.	Scoville 1948: 105
1909 20 May	Hazel-Atlas Glass Co.	For most kinds of **packers' ware**	Walbridge 1920: 79 Scoville 1948: 105
1909 19 July	H. J. Heinz Co.	For bottles to pack their own merchandize. **Heinz bottles**.	Walbridge 1920: 79 Scoville 1948: 105
1909	Owens-West Virginia Bottle Co.	Northwestern Glass and Owens-West Virginia consolidated with Owens Bottle Machine Co. A large factory was set up to make **prescription ware** in Clarksburg WV.	Scoville 1948: 110
1909 27 Dec.	Owens-West Virginia Bottle Co.	License for certain kinds of **beverage bottles**.	Scoville 1948: 105
1909 Dec.	Dec. Whitney Glass Works	For druggists' ware, had exclusive rights to **oval ammonia bottles**, but not exclusive rights to **"prescription ware."**	Walbridge 1920: 79 Scoville 1948: 106–107
1910	Whitney Glass Works	First to produce varied sizes on one six-arm machine: five **squares,** and one **oval** of three weights, three heights, and three capacities.	Walbridge 1920: 82
1910 11 June	Illinois Glass Co.	Licenses were issued to Illinois glass on 11 June 1910, 18 Jan. 1911, and 22 May 1914. **Whiskies**.	Scoville 1948: 106
1910 11 June	Charles Boldt	**Whiskies**.	Walbridge 1920: 79 Scoville 1948: 106
1911	Name changed to Owens Bottle Co.	United Owens-West Virginia and Northwestern Ohio Bottle Co. under the name Owens Bottle Co.	Toulouse 1971: 394
1911	Owens Annual Report	New machine to make **siphon bottles**.	Walbridge 1920: 89
1911	Owens Annual Report	New machine to make **gallon packers**.	Walbridge 1920: 89
1911	Owens annual report	Machine to make bottles ranging in size from **1/2 to 6 oz**	Walbridge 1920: 89
1911	Owens annual report	Machine to make **bottles** up to 8 in. in diameter and 17 in. height, larger than heretofore made.	Walbridge 1920: 89

Appendix 1: Table 1: Dates for Owens Machine-Made Bottles. (*continued*)

Year	Company	Products	Source
1912	Owens annual report	Licensed to manufacture **prescription and proprietary ware**, to the Owens Eastern Bottle Co.; the plant was later acquired by Owens Bottle Co.	Walbridge 1920: 91
1912	Owens annual report	Projected development of a machine to make 5 to 13 gal. **carboys.** When developed, the lease went to Illinois Glass Co.	Walbridge 1920: 93
1912	Owens annual report	133 machines in production with a capacity of 7,000,000 bottles.	Walbridge 1920: 95
1913 Dec.	Maryland Glass	**Blue glassware**, particularly **Bromo-Seltzer bottles** license to Maryland Glass Corp. Illinois Glass Company contested the right of Maryland Glass to make Bromo-Seltzer bottles.	Walbridge 1920: 95–96 Scoville 1948: 106
1914	Owens Bottle Co.	Owens Bottle Co. purchased Owens Eastern Bottle Co. They had a non-exclusive license to make prescription and **proprietary** bottles.	Walbridge 1920: 101
1916	Owens Bottle Co.	Owens Bottle Co. purchased American Bottle Co., the largest manufacturers of **beer, carbonated-beverages, soda**, and **water bottles**. Their annual capacity was 2,000,000 gross.	Walbridge 1920: 104
1916	Owens annual report	Owens Bottle Co. sales of 613,959,696 bottles, a 66% increase over 1915. Became the foremost bottle producer in the country.	Walbridge 1920: 105
1917	Owens annual report	Total production on Owens machines by the company and licensees was 1,588,996,416 bottles.	Walbridge 1920: 108
1918	Owens Bottle Co.	Opened its Charleston, West Virginia, plant producing **prescription, proprietary, pharmaceuticals, household and chemical, toilet, and cosmetic bottles, and foods.**	Toulouse 1971: 397
1919	Box 0 trademark	The Box 0 trademark was registered on 16 March 1919.	Lockhart et al. 2010: 57
1919	Charles Boldt Glass Co.	Acquired by Owens Bottle Co.	Toulouse 1971: 397
1925	Thatcher Manufacturing Co.	They built a third furnace for their Elmira, NY, plant to install a **Hartford Empire Machine**. Thatcher Manufacturing Co. purchased other **milk-bottle** producers to secure the rights to use the Hartford milk-bottle machine and the Hartford feeder.	Toulouse 1971: 498
1941	Last Owens machine built	The last Owens suction machine built for the company's use was in 1941.	American Society of Mechanical Engineers 1983: 6
1982	Last two Owens machines	"The last two Owens machines in production, 15-arm 'AQ' models, were operated at Gas City, Indiana, until December 17, 1982." Gas City was an Owens-Illinois plant that probably was one of the 42 plants that Owens-Illinois permanently closed in 1982 during an economic downturn.	American Society of Mechanical Engineers 1983: 6 Paquette 1994: 276