



## CHAPTER XL

### AMERICAN GLASS INTERESTS

THE products of the glass-furnace, according to the ancient records, date back from four to six thousand years. Rawlinson states that glass was known in Egypt in the pyramid period, which he places at 2450 B.C.; and from that period down to the Christian era there is no doubt that the art had reached a high state of perfection, from the beauty of the specimens that are still in existence. Glass making has always attracted much attention, and had made much progress in Europe before the discovery and settlement of America. One of the first articles manufactured in this country was glass. Mr. Joseph H. Weeks, who has had charge of the glass interests for the census of 1880 and 1890, says, in a carefully prepared history of glass making in this country, that the first American glass was made within a mile of Jamestown, Va., in 1608. The hope of sudden wealth from the discovery of gold and silver was doubtless the chief cause for the formation of the London Company and its first attempt to colonize Virginia. It was, however, a commercial venture with the hope of profit; and, with the shrewdness characteristic of the English merchant not only of that but of other periods, this company did not forget the possibilities that were near at hand in its search for what it believed would be greater ones in the near future. The vessel which carried Captain Newport on his second voyage in 1608 brought out also eight Poles and Germans to make pitch, tar, glass, mills, and soap-ashes, and the first exports of manufactures from what is now the United States were the results of the trials made at the first furnace erected in this country. It is said the works were destroyed at the massacre in 1622.

In 1795, the time from which this record is to be made, there is no record of any glass-works in Virginia. In the census of 1810 Virginia does not appear as a glass-making State. In the census of 1820 a glass-works is reported in Brooke County. It made that year \$20,000 worth of glass; had \$12,000 capital;

paid out \$8000 for wages and \$12,000 for materials and contingent expenses, or exactly the value of the product. It employed 14 men and 12 boys in 1827. It is reported that glass decanters of great beauty were made at these works, and white-flint and green-glass wares were made that rivaled the foreign. At the Tariff Convention in 1831 there were two flint-furnaces, with twelve pots, reported in operation in Wellsburg, and one, with six pots, at Wheeling, Va. Two window-glass furnaces were also reported at Wheeling. In 1840 one glass-works is reported in Brooke County (the Wellsburg), and three in Ohio County (the Wheeling).

The first mention of a glass-works in Pennsylvania is found in a letter written by William Penn, in August, 1683, to the Free Society of Traders. In this letter he alludes to their tannery, sawmill, and glass-works. Where these works were located, or what kinds of glass they made, is not known. In 1795 there was doubtless some glass made in Pennsylvania. A glass-house was sold on March 6, 1800, to Joseph Roberts, Jr., James Rutlans, and James Rowland, for \$2333, subject to \$15 ground-rent. They carried on these works under the firm name of James Rowland & Company, and in 1801 had their store at 80 North Fourth Street. The works were afterward carried on by several parties, and finally, in 1833, were sold to Dr. Thomas W. Dyott. In eastern Pennsylvania, prior to 1831, a number of attempts seem to have been made with but little success, and the works carried on by Dr. Dyott were evidently looked upon as being of national importance. It is stated that President Jackson visited this establishment, which in 1833 consumed 15,000 barrels of rosin for fuel. From 250 to 300 men and boys were constantly employed; five furnaces were operated, which used both wood, coal, and rosin, melted 8000 pounds of batch a day, and produced about 1200 tons of glass a year, which was blown into apothecaries' vials, bottles, and shop-furniture. Dr. Dyott failed in 1838, and

the works passed into other hands, and at this time are operated in the manufacture of green glass, and have quite a reputation for the making of demijohns.

Of early glass making in western Pennsylvania full accounts are given. It is claimed that Albert Gallatin commenced the first glass-works there at his settlement of New Geneva, ninety miles south of Pittsburgh, on the Monongahela River. It seems to be generally accepted that the works were started in 1797, and were used for the manufacture of window-glass. The furnace was a small one, with eight pots, using wood as fuel and ashes for alkali. The glass-house was forty by forty; three sides frame and one side stone. One man could lift the pots, while now it would require four men to lift the pots used in window-glass works. The title of the firm was Gallatin & Company, but was afterward changed to the New Geneva Glass-Works. It is said that for a time this enterprise was exceedingly profitable, there being but two or possibly three other window-glass works in the country, most of the glass for that purpose being brought from England. The glass was sold at \$14 per box of 100 feet, but was doubtless of inferior quality. A works at New Geneva was reported as late as 1832, but when they were finally abandoned Mr. Weeks was not able to learn.

In 1796 Major Isaac Craig and Colonel James O'Hara erected the first glass-house in Pittsburgh. It is claimed that these were the first works west of the mountains to make glass, and they are said to have started a month before those of Mr. Gallatin. These were the first works to use coal as a fuel, and were located at the south side of the Monongahela River, just above where it unites with the Allegheny to form the Ohio. The site, or part of it, has been continuously occupied as a glass-works, Thomas Weightman & Company occupying it until quite a recent date. The use of coal was an innovation, and even as late as 1810 this fuel was not used in any of the glass-works in the United States other than those in Pittsburgh. Messrs. O'Hara and Craig were the pioneers in its use, and to them should be given the credit. As was the custom in window-glass factories in those days, one or more of the pots were used for the making of bottles, and among Colonel O'Hara's papers, found after his death, was a memorandum in his handwriting, stating: "To-day we made the first bottle, at a cost of \$30,000."

As in all new enterprises, and particularly the making of glass, it is only men of perseverance and determination who succeed; and had not Messrs. Craig and O'Hara been men of that character the venture would have fallen the first year. As a rule,

the men who are secured from old-established glass factories are really not the best men; and not only did the early manufacturers suffer from a lack of experience, but also from the fact that their employees were not always capable of doing the work they were engaged to do. And it may be said that at the present time no new works, established in a location in which glass has not been made, can make a profit of any moment the first two or three years; and the first year must invariably be counted as a losing one. Major Craig wrote to Samuel Hodgson, of Philadelphia, August 5, 1803: "With respect to our glass manufacturing, the establishment has been attended with greater expense than we had estimated. This has been occasioned partly by very extensive buildings necessarily erected to accommodate a number of people employed in the manufacture, together with their families, and partly by the ignorance of some people in whose skill of that business we reposed too much confidence. Scarcity of some of the materials at the commencement of the manufacturing was also attended with considerable expense. We have, however, by perseverance and attention, brought the manufacture to comparative perfection. During the last blast, which commenced at the beginning of January, and continued six months, we made on an average thirty boxes a week of excellent window-glass, besides bottles and other hollow ware to the amount of one third the value of the window-glass, eight by ten selling at \$13.50, ten by twelve at \$15, and other sizes in proportion."

In the fall of 1807, Mr. George Robinson, a carpenter, and Mr. Edward Ensell, an English glass worker, commenced the erection of a flint-glass works in Pittsburgh, on the banks of the Monongahela, under the firm name of Robinson & Ensell. They appear, however, to have lacked capital, and were unable to finish the establishment, which, without being completed, was offered for sale. In August, 1808, Mr. Thomas Bakewell and his friend, Mr. Page, who were visiting Pittsburgh at the time, were induced to purchase this plant, on the representation of Mr. Ensell that he thoroughly understood the business. This was the beginning of the firm of Bakewell & Page, which by itself and successors continued in the manufacture of flint-glass until some time after the census of 1880. Mr. Bakewell experienced the trouble usual in a new business. The difficulties he met with would have disheartened a less determined man, and the lack of skill on the part of his workmen, and the inferiority of the materials, interfered at first with his success. His furnace was badly constructed; his workmen

were not highly skilled, and would not permit the introduction of apprentices; and his materials were received from a distance at a time when transportation was difficult and expensive, pearl-ash and red lead coming over the mountains in wagons from Philadelphia, and pot-clay from Burlington, N. J. The sand was obtained near Pittsburg, but was yellowish, and up to that time had only been used for window-glass and bottles. The saltpeter came from the caves of Kentucky until 1825, when the supply was brought from Calcutta. These difficulties in time were overcome; good clay was procured from Holland, and purer materials were discovered, and Mr. Bakewell rebuilt his furnace on a better plan, competent workmen being either instructed or brought over from Europe. Through his energy and perseverance the works became eminently successful, and there is no doubt that Mr. Bakewell is entitled to the honor of erecting and operating the first flint-glass works in this country. The furnace built or completed in 1808 held six twenty-inch pots; this was replaced in 1810 by a ten-pot furnace, and in 1814 another furnace of the same capacity was added to the works. The establishment was burned down in the great fire of 1845, but was immediately rebuilt. The site is now occupied in part by the Baltimore and Ohio Railroad depot.

During the last one hundred years Massachusetts has played a very important part in the production of glass, which was manufactured as early as 1639 at Salem. But, from all the records that exist, the history previous to the Revolution was one of failure. Shortly after the Revolution Boston again commenced the manufacture of glass, which for many years was one of the leading industries of Boston and Massachusetts. The new enterprise, the Boston Crown-Glass Company, which was really the first successful glass-works in this country, was greatly helped by the liberal action of the State. In July, 1787, Messrs. Whalley, Hunnewell, and others received from the legislature a charter conferring upon them the exclusive right to manufacture glass in Massachusetts for fifteen years, and imposing a fine of \$500 upon any one infringing on this right. The capital stock was exempted from all taxes, and the workmen from all military duty. To counteract the effect of the bounty paid by England on the exportation of glass from the kingdom, a bounty was paid for every table of glass made. Owing to the many difficulties incident to the starting of a new industry, the operation of making glass did not commence until 1792. The company commenced with the manufacture of crown window-glass, and in 1798

produced glass to the value of \$82,000 per annum. This concern was incorporated in 1809, and under the influence of the State bounty the proprietors were encouraged to continue their efforts, and became very successful. The glass was said to be superior to the imported, and well known throughout the United States as "Boston window-glass." These works were continued until 1826, when the company failed, from bad management. This early establishment led to the commencement of many others, but none of them could be considered successful. Many attempts have since been made in Massachusetts to establish the manufacture of window-glass. In 1860 a large establishment was erected for the manufacture of sheet window-glass, but its operation proved unprofitable, and at this time there is only one window-glass works in the State, which is located in Berkshire County, in the western part.

The manufacture of flint-glass grew out of the Essex Street works. Mr. Thomas Caines, who was an employee there, was also a skilful blower and metal mixer. He prevailed upon the management to allow him to build a small six-pot furnace in a part of their works at South Boston. This furnace was fully employed during the War of 1812, and was the beginning of the flint-glass industry in Massachusetts; but it was compelled to cease work, and although several attempts were made to operate it between 1820 and 1840, they all failed. About the time this furnace was started, the Porcelain and Glass Manufacturing Company was incorporated, and built a factory at East Cambridge. The furnace was a small one, containing six pots. Workmen were brought from abroad, but it proved a failure. The plant in 1815 was leased to a firm of workmen, Emmet, Fisher & Flowers; but they failed to agree, and in 1817 the Porcelain Company sold the property at auction to the New England Glass Company. This was the beginning of one of the most successful glass companies in this country. The works, when they commenced, had a small six-pot furnace, the pots holding about 600 pounds; 40 hands were employed, and they produced glass to the value of \$40,000. It was really the foundation of the flint-glass industry in the United States. The management was broad and liberal from the beginning; for fifty years they led in the production of flint and colored glass of all varieties. Workmen were brought from abroad, and every means employed that capital and skill could compass to produce results equal to anything in the world. In 1865, which was probably the highest point reached in their history, they operated five furnaces of ten pots each, each pot



JAMES GILLINDER.



holding 2000 pounds; 500 hands were employed, and glass to the value of \$500,000 was produced yearly. The influence of the New England Glass-Works has been felt all over the land, as many of their employees and managers have been the means of establishing the industry in other parts of the country. Fine-blown, cut, and pressed glass were made in great variety. The works are not now in existence.

When the Western manufacturer commenced to make lime-glass with bicarbonate of soda and lime, in place of lead and pearl-ash, the thought in the minds of the management of the New England Works was that its success would be only temporary, and they failed to meet the changed condition. A very large proportion of their production at this time was pressed glass, and for several years, in the attempt to meet the competition of the cheap products of the Western manufacturers with their more costly products, the works were run at a loss, which amounted during the last year they operated to more than \$40,000. In 1879 they ceased operation, after a successful career of sixty-two years, and were then leased by William L. Libbey & Son, and operated by them until August, 1888, when they moved to Toledo, O., and the old works were dismantled.

In 1825 a plant was established at Sandwich, commencing in a small way, with one eight-pot furnace, and melted 7000 pounds of glass. In 1865 it had been increased to four furnaces, ten pots each, and a melting capacity of 100,000 pounds weekly. It was in these works that the modern invention of pressing glass was first successfully introduced, in 1827. Of this I will speak later on. The same cause that brought about the failure of the New England Glass Company caused their failure, and in 1888, after several years of financial loss, the company suspended operation. They had built up quite a town at Sandwich, and up to 1865 had been prosperous and successful, employing for sixty-three years a large number of people, and making a fine line of cut, blown, colored, and pressed glass.

During the period in which these two Massachusetts factories were in existence they were in the lead, and while a number of others had been established, none had reached the success of these two noted works, which are now only a part of the record. Quite recently an attempt has been made to operate one of the furnaces at Sandwich, the success of which is yet to be demonstrated. At this time there are only four flint-furnaces operated in Massachusetts, two of them being at New Bedford, one at Somerville, a suburb of Boston, and one at Sand-

wich. There are, besides, the window and part-plate works at Berkshire. So that Massachusetts, that in 1860 led the flint-glass industry in this country, has almost ceased to be a factor at this time.

Maryland was quite an important State in the early production of glass, and the records show that the attention of Congress was called to the value of the industry by Mr. John Frederick Amelung, who petitioned Congress to extend its patronage to his works at New Bremen. A motion was made in Congress by Mr. Carroll to loan him not exceeding \$8000, on his giving security for its repayment. The motion was debated for several days, during which was brought out the fact that Mr. Amelung had spent over £20,000, and brought over from abroad over 200 workmen, in his attempts to establish the industry. The motion was defeated. We have an after record that in 1794 Mr. Amelung, with Mr. Whalley, of Boston, presented a petition for an increase of duties. These works appear to have been built at Fredericktown, but were afterward moved to Baltimore. They were not a success, and it is probable he crossed the mountains and helped to start the flint-works at Pittsburg. According to Howard, a plant was established for the making of window-glass in 1790, known as the Baltimore Glass-Works. These are the window-glass works operated by Baker Brothers until quite recently, and said by them to have been established in 1790. They have operated them since 1852. Maryland, however, since that period, has been quite a glass State. Window-glass and green and flint bottles have been made to a greater or less extent, and according to the census of 1890 the State has eleven works, producing wares to the value of \$1,256,697, and employing 1363 hands.

One of the earliest glass-works in this country was located at Allowaystown, in Salem County, N. J. It was the beginning of the glass industry in that State, and was built about the year 1760 by a German named Wister, who carried on the works until his failure in 1775. The workmen then went from this place to Glassboro, and established the industry there. Plenty of pine-wood for fuel was found in this locality, and a very fair grade of sand, which was good enough for bottles, jars, vials, and the common kinds of green glass made by them. Glass making has been carried on at this place ever since that time. The first establishment commenced with a six-pot furnace, but gradually extended until a town surrounded the works, and they now report a capital of \$1,106,499.95, and manufacture from 50,000,000 to 60,000,000 bottles each year. A member

of the present firm, Mr. John P. Whitney, is said to be a descendant of one of the original workmen who established the works.

Up to 1870 there were glass factories erected at thirty-seven different localities. Many of them ran for only a short period. The cheapness of wood and sand no doubt led to the building of many, and the fact that expensive buildings were not required, most of them being frame structures built of the cheapest materials. With the exception of a flint-works at Jersey City and one at Camden, the glass made in New Jersey was bottles, jars, vials, and window-glass, and in 1880, according to the census, New Jersey produced bottles, jars, and vials, under the head of green glass, to the amount of \$1,681,015, the largest amount produced by any one State; window-glass to the amount of \$729,155; and glass-ware, under which head come flint-glass bottles, valued at \$400,000.

New York is now losing ground as a glass-producing State, but during the past one hundred years large quantities of glassware have been made, and some of the works have had a national reputation. In January, 1785, Leonard de Neufville and his associates, the proprietors of a glass factory located ten miles from Albany, at Dovesborough, in the midst of a well-wooded pine forest, applied to the legislature for aid in the undertaking, giving as a reason that £30,000 annually was sent abroad for glass. In 1793 the legislature of New York voted to loan them \$3000 for eight years without interest, and five years at five per cent., but by this time the works had passed out of the De Neufville family. The history of glass making in New York State shows that up to 1850 there had not been much headway made in establishing it on a permanently successful basis. Many factories were started, but ran for only a short time, and none of those in operation in 1850 are now in existence.

In 1820 some workmen left the New England Glass-Works at East Cambridge and built a factory in New York City, under the firm name of Fisher & Gilland; but in 1823 the partnership was dissolved, and Mr. Gilland removed to Brooklyn, where he established what were known as the South Ferry Flint-Glass Works. Mr. Gilland up to 1850 was evidently very successful. He had the reputation of making the finest flint-glass made in this country, and at the London Exhibition in 1851 took a medal for the best flint-glass on exhibition. He afterward failed, and the works are not now in existence. In the census of 1880 New York had nine window-glass works, producing glass to the value of \$1,157,571; nine

green-glass works, producing glass to the value of \$722,322. This record shows that the establishments were not very extensive, as they average only a little more than \$75,000 per factory.

From all the information obtainable, glass had been made up to this time in fifteen States in the Union. In Maine and Connecticut there is no glass made at the present time. It is impossible, owing to the imperfect state in which the census was taken, to get anything like an accurate account of the value of the product, or the number of people employed, previous to the census of 1870. Like other industries in the United States, the history of the glass business was, between 1850 and 1860, one of great depression. Fine glass was made in New England and in New York and in one or two factories in Pittsburg, but the bulk of the product was of poor quality, and the window-glass did not in any way measure up to the imported glass. During this period, however, a great impetus was given to the flint-glass business by the making of coal-oil from coal and the later discovery of petroleum. The demand for lamps and lamp-chimneys was very extensive. One of the first to make a specialty of glass for lighting purposes was Christopher Dorflinger, who started with a capital of \$1000 in 1852, in Concord Street, Brooklyn. The furnace held five small pots, and was afterward increased to hold seven, until in 1861 he was operating four furnaces. The first year his sales amounted to \$30,000, and he employed eighty-five people. When he left Brooklyn in 1865 his sales amounted to \$300,000. The factories increased in Brooklyn, from 1858 to 1865, from two to fifteen, mostly making the same class of ware, which was principally for lighting purposes—lamp-chimneys, gas-globes, and lamps. In 1865 Mr. Dorflinger moved to White Mills, and established what is now one of the best-known and largest of the manufactories of cut glass, while at the same time the reputation of the Dorflinger cut glass is second to none. Mr. Dorflinger has a record of forty-three years in the manufacture of flint-glass.

In 1860, from the best records we can get, the product of the glass factories did not exceed \$7,000,000. 1861 and 1862 were off years. The excitement incident to the commencement of the war produced great depression, but from 1862 until 1870 the increase in production was very great, and the census showed 154 establishments, with 15,367 employees, producing glass to the value of \$16,470,507, with a capital invested of \$13,826,142. It was during this decade that great improvements were made in the making of pressed glass. The modern dis-

covery of pressing glass was an American invention, and the credit is given to the Sandwich Glass Company, who, at the solicitation of a carpenter, in 1827 made a mold to press an article he wanted made. After that the mold increased rapidly in favor, but was used only for the commoner class of goods for many years, until the New England Glass Company, by a series of expensive molds, had produced some very fine effects in pressed glass. The triumphs of pressed glass in this country, however, came from Pittsburg. James B. Lyons & Company, of the O'Hara Glass-Works, Pittsburg, made for many years pressed glass only, and in 1867 made an exhibit at the Paris Exposition, and took the first prize for fine pressed glassware. Goblets and wine-glasses were made almost as fine and delicate as those made by the old mode of blowing and cutting. Prior to 1864 the pressed glass was either made of flint-glass, the ingredients of which were the best of sand, pearl-ash, refined saltpeter, and oxide of lead, and was a very good crystal glass, or from what was then known as German flint or lime glass, the ingredients of which were soda-ash, lime, nitrate of soda, and sand. This latter made a very inferior glass, apt to crack, and very poor in appearance. It was used principally in common tumblers and some lamp-chimneys.

In the winter of 1864, Mr. William Leighton, Sr., of the firm of Hobbs, Brockunier & Company, of Wheeling, made a series of experiments with bicarbonate of soda, with pure sand, lime, and refined nitrate of soda, and produced a very clear, brilliant glass, at a cost for the batch of not more than one third that of the lead-glass or flint batch. The result was a complete revolution in the pressed-glass business. It was impossible for the manufacturer making flint-glass to compete, and the result was that all had to adapt themselves to the change, and some were driven out of the business. Up to this time (1870) there had been very little change in the furnaces, which were mostly the old-fashioned type of round furnace, with the coal fired over the bench, or the Frisbie bucket-teaser, where the coal was pushed up from below. But the close competition and the desire for increased production led to the effort to get better results from the furnaces, and between 1870 and 1880 larger furnaces were built, into which, by a series of flues, hot air was introduced to the combustion-chamber, and much greater heat secured with much less fuel. Many of the furnaces also hold from thirteen to fifteen pots, and many of the pots each hold two tons of glass.

In 1880 the census reports show that the number

of establishments had increased to 211, employees to 24,177, production to \$21,154,571, and that the industry was divided among sixteen States. It was during this decade that the Centennial Exhibition held in Philadelphia gave a large impetus to so many industries. One of the great attractions was the glass-works operated by Gillinder & Sons, of Philadelphia. It was a complete establishment, showing the processes of melting, blowing, pressing, cutting, etching, and annealing. The furnace held six pots, and melted double the amount of glass made by the first flint-glass works operated in this country by Bakewell & Page, in 1808. This was the first time anything of this kind was attempted in an international exhibition. The product was sold as souvenirs, and realized \$96,000. Over \$14,000 was paid to the Centennial Board of Finance as commission on the sales.

At the close of 1880 the glass trade was in a very prosperous condition. Prices were good, and the outlook looked promising for the future; and it is from this period we must date the wonderful progress of plate-glass making in this country. In 1880 there were but four plate-glass works in this country, and only three in operation. They were located at New Albany, Ind., Jeffersonville, Ind., Crystal City, Mo., and Louisville, Ky., the latter plant being idle. The first attempt to make plate-glass was made in 1852, when Messrs. Tilton, Pepper & Scudder started a factory at Williamsburg, now part of Brooklyn, N. Y. The works were under the management of Cuthbert Dixon, a plate-glass worker from the Thames Plate-Glass Works, London, England. They produced a good quality of rough plate, but, owing to the ruinous competition of the English and German manufacturers, at the end of two years they were compelled to close. There is some dispute as to where the first plate-glass was made in the United States, but there are existing proofs that the Williamsburg works were the first, based upon the records found in an old diary of the late William S. Dixon, of Pittsburg, who was employed there as pot maker, his father being the manager.

Attempts were made to make plate-glass at Cheshire, Mass., Lenox Furnace, Mass., and at Greenpoint, L. I., previous to 1860. There are records of polished plate-glass being made at Lenox in 1865, but it was not continued. The successful founder of the plate-glass industry in this country is Mr. James B. Ford, of Pittsburg. In the year 1869 Mr. Ford conceived the idea of making polished plate-glass, and with this in view visited the works at Lenox, gathered what information he could from the work-



men who had been imported from abroad, and returned to New Albany with the determination to make plate-glass. Machinery for this purpose was imported, and the new plant was speedily successful so far as the production of plate-glass was concerned; but, like all new enterprises of the kind, it was not profitable, and in 1872 Mr. Ford withdrew. The factory was continued by William C. de Pauw until his death, and afterward by his heirs. To the indomitable will and perseverance of this gentleman this country is indebted for the early success of the industry, as he demonstrated, after a hard struggle, that polished plate-glass could be made here at a profit. Mr. Ford afterward built a factory at Louisville, Ky. It had two twelve-pot furnaces and was equipped with the old-style French machinery. He ran these works for two years and sold out, removing to Jeffersonville, Ind., where he built a plant that he operated until he moved to Creighton, Pa., in 1881.

Shortly after the building of the New Albany plant, Mr. E. B. Ward, of Detroit, and others, attracted by a very extensive deposit of sand of fine quality, originated the American Plate-Glass Company, with a capital stock of \$250,000, and began in 1872 the erection of works at Crystal City, Mo. The capitalization was increased in 1874 to \$500,000, and the works were operated until 1876, producing some glass of good quality; but, owing to lack of experience, the management failed to make a profit. In 1877 the works were reorganized, new capital was secured, Mr. A. E. Hitchcock, of St. Louis, president of the old company, continuing in charge. Mr. G. F. Neal, a practical plate-glass manager, took charge of the works, and a Siemens furnace was erected. The works have been largely increased, and plate-glass is made in Crystal City equal to any found in Europe. This was the condition of the plate-glass business when Mr. Ford built the Creighton Works in the midst of a rich gas-coal country. He built a factory with a capacity of 70,000 square feet per month. It was equipped with two sixteen-pot furnaces, eight grinding and sixteen polishing machines. This was really the first plate-glass works in this country that paid for the large investment required in its establishment.

While the success of these works was very largely helped by the experience that Mr. Ford had gained from his previous ventures, a new factor was introduced that had never been used in the making of plate-glass before. This was natural gas, which it was found could be used as a fuel. The Rochester Tumbler Works had used it in their leers, and par-

tially in their furnaces, as far back as 1875; but not having sufficient for the furnaces, it was not a success. At about the time Mr. Ford was starting at Creighton, wells had been drilled that promised inexhaustible quantities of the new fuel. For glass making it is impossible to conceive of a more perfect fuel—no labor required for firemen, no dirt, no ashes, and a uniform heat, or just what was required. Natural gas was a great factor in the success of these works, which were sold by Mr. Ford to the Pittsburg Plate-Glass Company, who enlarged them in 1883, and increased the output from 70,000 square feet to 110,000 square feet finished product. Having a great desire to own and operate his own works, Mr. Ford, in 1884, commenced the building of a plant at Tarentum, Pa., with a capacity of 150,000 square feet per month. Before it was completed the Pittsburg Plate-Glass Company made him an offer, which he accepted, and the Tarentum plant became part of the Pittsburg Plate-Glass Works. The success of their plants resulted in the building of plate-glass works at Butler, Pa., in 1886, and at Cochran Station, Pa., in 1889.

Natural gas had been discovered in Indiana. A large plant was built at Kokomo, Ind., under the name of the Diamond Plate-Glass Company. The gas being in abundance, this same company erected another large factory twenty miles away, at Elwood, in 1891; and the extensive works at Charleroi and at Irwin, Pa., were erected the same year. The Pittsburg Plate-Glass Company in 1887 commenced the erection of what are now the largest plate-glass works in the world. The company bought 480 acres of land, and a town was laid out, and named Ford City, in honor of Mr. J. B. Ford, who is one of the largest stockholders. Under his personal supervision the works were built, which have a monthly capacity of 400,000 square feet.

In 1891 the De Pauw Plate-Glass Company built a small plant at Alexandria, in the heart of the gas belt, in Indiana; but the panic of 1893 caused its suspension, and it has not been operated since.

The works mentioned have an aggregate monthly capacity of 1,785,000 square feet, or an annual maximum production of 21,420,000 square feet, while the consumption in this country has never exceeded 14,000,000 square feet; 3,075,491 square feet were imported in the fiscal year ending June 30, 1895. This great over-production, with a reduction in the tariff, has caused greatly reduced prices, in consequence of which several of the factories have remained idle and none has operated to its full capacity since 1893. In 1894 a movement was made by some

of the companies for self-preservation, which resulted in the outright purchase by the Pittsburg Plate-Glass Works of all the plate-glass works in the United States, with the exception of those at Butler and Irwin Station and the De Pauw plants of Indiana.

The total number of furnaces is forty-three of twenty pots each, and two of sixteen pots each. Of this number there are in operation at this time only twenty-three furnaces, containing 460 pots. Plates of glass are made containing 180 square feet, or, say, twelve by fifteen feet. The success of the plate-glass business, which really dates back only twenty years, is one of the wonders of our age. Much credit must be given to Mr. J. B. Ford, and especially when we consider that when the factory at Creighton was started he was over seventy years of age, and had to impress upon the capitalists his own faith that the business could be made to pay. So far as Pennsylvania was concerned it was an entirely new venture, the census of 1880 showing that no plate-glass was then made in Pennsylvania; while in this year (1895) Pennsylvania has capacity enough, including the 3,000,000 feet imported, to supply the whole country. The imports of 1894-95 are fifty per cent. more than the imports of 1893-94.

Mr. Ford is now trying to make us independent of other countries in soda-ash, and at eighty-four years of age is demonstrating that soda-ash can be produced in this country at a profit. He erected a factory at Wyandotte, Mich., for the production of fifty-eight per cent. alkali. After a very large expenditure of money and a loss of \$150,000 it proved a flat failure; but, not discouraged, he started again and almost entirely rebuilt the plant, and now has much better success, and is producing fifty tons per day of as good soda-ash as ever was imported. He is now adding to this plant, to increase his output to 100 tons per day. He has since purchased 143 acres of land to erect a factory to produce 150 tons more, and he says when this is done his ambition will be complete. It is to men of like ambition and character that this country is indebted for its commercial greatness.

From the year 1880 may be dated also the great success of window-glass making. Prior to this time, with few exceptions, the old furnaces and flattening-ovens that had been in use for fifty years were still prevailing. Fully twenty-five per cent. of the window-glass used in this country was imported. For many years the workmen have been organized into a union, which not only takes in the blowers, but the gatherers, flatteners, and cutters; these last two being practically unskilled labor, and paid as such in

European countries. Then, to mend matters and make the competition worse, the manufacturers of Belgium and England had adopted what is known as the tank-furnace; no pots were required, a more uniform quality of glass could be depended upon, and a much larger production. Mr. James Chambers, of Pittsburg, who had succeeded his father in the manufacture of window-glass, was in 1887 operating four furnaces, with thirty-six pots, using natural gas in his furnace and flattening-ovens. He had the improved flattening-ovens, but he came to the conclusion that something had to be done to put the window-glass business upon a better basis. He made a trip to Europe, obtained all the information possible, came back to Pittsburg and organized the Chambers & McKee Company, and, as president, planned, built, and operated the plant at a place on the Pennsylvania Railroad, twenty-seven miles east of Pittsburg, called Jeanette. The foundation of the tanks was laid in 1888, and in the spring of 1889 they commenced making glass. Glass workers and manufacturers all over the country, with few exceptions, had predicted that the tanks would be a failure, and that window-glass could not be made that way; but the tanks were a success from the first.

Mr. Chambers had associated with him in the building of these tanks Mr. George F. Moore, afterward general manager of the works; W. D. Hartupe, as engineer; and H. L. Dixon, a furnace builder, in charge of the construction of the tank-furnaces, leers, ovens, etc. Their furnaces at that time were the largest tank-furnaces in the world. Each furnace holds 800 tons, has a melting capacity of 30 tons for every twenty-four hours, and turns out 480 boxes of single and 250 boxes of double strength every twenty-four hours. There are three of these furnaces at Jeanette that are 20 feet wide and 120 feet long, inside measure. Owing to financial disagreement, Mr. Chambers withdrew from the Chambers & McKee Company, and in 1892 formed a company and erected a factory at New Kensington, nineteen miles from Pittsburg, on the Allegheny Valley Railroad, and built two continuous tanks that are said to be the largest in the world. They are 25 feet 6 inches wide, 130 feet long, inside measure; each furnace will hold 1000 tons of molten glass, and has a melting capacity of 35 tons, turning out 600 boxes of single and 300 boxes of double strength every twenty-four hours. This is said to be the largest and most complete establishment in the world for the manufacture of window-glass.

Although it has been only six years since the first window-glass tank-furnace was started in this coun-

try, other manufacturers, quick to see its advantages, have adopted the system, and now sixty per cent. of all the window-glass made in this country is made in tanks, and it needs no prophet to say that in the year 1900 there will be very little window-glass made in pots. The total capacity of the country is 1664 pots, of which Pennsylvania has 12 tank-furnaces, with capacity of 532 pots; Indiana, 7 furnaces, capacity 282 pots; New York, 1 furnace, capacity 36 pots; New Jersey, 1 furnace, capacity 48 pots; Ohio, 2 furnaces, capacity 54 pots; or a total of 952 pots made in tank-furnaces. Some idea of the size of these large furnaces at New Kensington can be obtained by considering that previous to 1880 the largest window-glass pots held but 1200 pounds, and a furnace of ten pots 12,000 pounds or six tons, and then comparing these figures with the tank-furnace at New Kensington, holding 1000 tons.

Mr. Weeks gives the value of the product of window-glass in 1893 as \$10,500,000. This was a calculation based on the works operating January 1, 1893, before the depression came. The imports of the year ending June 30, 1895, amounted to \$837,730, which is the smallest amount imported for many years, and is doubtless caused by the increased facilities and cheapening of the products of our tank-furnaces.

The discovery of natural gas, and its application to the glass-furnaces, has led to a very great increase in the building of flint and green-glass works, and the census of 1890 gives the relative value of the products of each branch of the industry:

	1880.	1890.
Plate-glass .....	\$868,305	\$4,869,494
Window-glass .....	5,047,313	9,058,802
Glassware .....	9,568,520	18,601,244
Green and black glass .....	5,670,433	8,521,464
Total.....	\$21,154,571	\$41,051,004

From these figures it will be seen that in this period the industry has almost doubled its production, the largest increase being in plate-glass and glassware. Glassware covers all the glass used for lighting purposes, such as lamp-chimneys, gas-globes, and shades, globes and bulbs for electric light, table-glass, both pressed and cut, flint-glass bottles—in fact, everything that is made in crystal or fancy colored glass. In this branch of the industry, in 1880, 73 establishments were reported, with a capital of \$6,907,278. In 1890, 125 establishments were reported, with a capital of \$15,448,196, an increase of 123.65 per cent. It is impossible to go into detail as to all the works, and I will confine myself to a few of the notable ones in the different lines.

Probably the largest flint-bottle works in the world are those of Messrs. Whittall, Tatum & Company, located at Millville, N. J. They have thirteen flint-furnaces, in addition to five green-glass furnaces and a green-glass tank, and employ from 1500 to 1900 employees, according to the demand for their goods. This business has been principally built up since 1860.

The Rochester Tumbler Company, at Rochester, Pa., was organized in 1872, and commenced making glass in July of the same year. They commenced with one ten-pot furnace and ninety employees, making a specialty of tumblers, and with a capacity of 12,000 dozen per week. At present they operate seven furnaces with eighty-eight pots, with a capacity of 75,000 dozen per week, or 150,000 tumblers each day. The melting capacity of the furnaces is 120 tons of sand per week. The pots are very large, and over 1000 hands are employed. When they first commenced they made only common tumblers, but now they make every kind of tumblers, with a cutting, engraving, and decorating department. The works cover over seven acres of ground. They make their own barrels, boxes, and machinery, and almost everything used for the manufacture of glass. All the fuel used is natural gas. They do some export trade,—probably more than any other concern in this country,—and without question have the largest plant in the world making a specialty of tumblers.

The discovery of natural gas was the means of largely stimulating the erection of flint-glass furnaces, and many small towns offered land and a bonus in money to have a glass-works established in their boundaries. By this means many works were started by parties who had little knowledge of the business, so that the business was largely overdone, and prices in 1891 were such that little or no profit could be made. Labor was high, and, in view of there being so much demand for it, was aggressive and unreasonable in its claims, being backed up by its labor organizations. A number of manufacturers met together and formed a stock company under the name of the United States Glass Company, which company bought up fifteen of the largest and most complete press manufacturers in the country, located in Pennsylvania, Ohio, and West Virginia. The fifteen establishments had a capacity of twenty-nine furnaces. The company afterward erected a plant at Gas City, Ind., with three fifteen-pot furnaces, to get the benefit of the natural-gas fuel. The capital stock of the company is \$4,158,100, \$640,000 of which is preferred and \$3,518,100 common stock.

The first year of its existence as a corporation the sales amounted to very nearly \$3,000,000. With a view of consolidating the plants the company bought 500 acres of land on the Monongahela River adjoining McKeesport, Pa., and have erected two fifteen-pot furnaces, and propose, as opportunity offers, to finally move all their plants to this one point. It is without question the largest flint-glass works in the world, and is almost able to supply this country with table-glass, if all the furnaces were in full operation. Quite a number of flint-glass works are operated in the making of glass for lighting purposes—arc-globes, gas-globes, and shades for electric lighting. There are six leading companies making these goods, four of them located in Philadelphia, Pa., one at Monaca, Pa., and one at Brooklyn, N. Y.

Gillinder & Sons, of Philadelphia, were the first of these works established, and operations were commenced in 1861 by William T. Gillinder, the father of the present owners. Their works have two furnaces, with twenty-three pots, and have a capacity of production to the amount of \$400,000 per annum. It is impossible to continue further to enumerate special plants, but I think I have established the fact that so far as glass making is concerned we are practically independent. We have sand in almost every State of the Union fit to make glass. The sand of Massachusetts, Pennsylvania, and Missouri is equal to, if not better than, any other sand in the known world. Soda-ash and other chemicals are being made, and when the beet-sugar industry is fully established we shall be able to get pearl-ash from the ashes of the beet, so that it will not be necessary to import our potash from Germany. We have fire-clay for furnaces, which is found in many States of the Union, notably in New Jersey, Ohio, Pennsylvania, and Missouri. The pot-clay found near St. Louis, Mo., has been used for more than forty years. It is a very superior clay, and for the making of glass-house pots is unsurpassed. It is capable of resisting a very high degree of heat, and will stand the changes of temperature much better than the most celebrated clays of Europe.

The census report of 1890 gives number of factories, 294; product, \$41,051,004. A carefully prepared statement by Mr. Weeks shows that in 1893 we produced:

## GLASS PRODUCTION IN 1893.

Plate-glass to the amount of .....	\$7,600,000
Window " " " .....	10,500,000
Flint " " " .....	20,000,000
Green and black glass to the amount of .....	9,500,000
A total of .....	\$47,600,000

Our imports for the year ending June 30, 1895, amounted to \$6,541,661. Owing to the environment of the glass-works abroad there will always be some glass imported, but the time will come when the amount brought over will be very much reduced. Our exports of glass have never been very large.

## EXPORTS FROM 1826 TO 1895.

YEAR.	EXPORTS.	YEAR.	EXPORTS.
1826.....	\$44,557	1870.....	\$530,654
1832.....	106,855	1880.....	749,866
1842.....	36,718	1890.....	882,677
1850.....	136,682	1895.....	946,381
1860.....	277,948		

We can get no data that will give the kinds of glass exported. Window-glass is credited with \$11,140; all others, \$935,241. This shows that we can export but little window-glass under existing conditions. The statistics from the Treasury Department show that in 1894 we exported to British America \$345,199, and to Mexico \$108,988, making a total for both of \$454,187. Thus it appears that these two, our near neighbors, took about one half of our exports. Cuba took \$82,931; France, \$18,267; England, \$44,076; and British Australia, \$54,973. The balance was distributed among forty-nine other countries, no one of which took more than \$26,576. Our principal export was pressed glass. There is no other glass we can sell cheaply enough to compete with the cheap-glass producers of Europe, and this demonstrates that the markets of the United States are worth more to us, fifty times over, than the markets of the whole world.

In the preparation of this article I have been aided very much in the early records by the "History of Glass Making in the United States," prepared by Mr. Joseph D. Weeks; and for information in regard to the various improvements in furnaces and leers, by H. L. Dixon, of Pittsburg, who for the past fifty years has been identified with the building of many of the improved furnaces that have taken the place of the old furnaces. What the future one hundred years will produce in the product of our furnaces none can tell. Had any one said one hundred years ago that the United States in 1895 would produce glass to the value of \$47,600,000, he would have been deemed insane; or that a furnace would be constructed that would hold 1000 tons of molten glass, and make 900 boxes of window-glass every twenty-four hours; or that a single plant would make 75,000 dozen tumblers per week; but such are the facts. The distribution of this product in the various States of the Union is shown in the subjoined table, taken from the census of 1890:

## GLASS PRODUCT BY STATES IN 1890.

Pennsylvania .....	\$17,179,137
Ohio .....	5,640,182
New Jersey .....	5,218,152
Indiana .....	2,995,409
New York .....	2,723,019
Illinois .....	2,373,011
Maryland .....	1,256,797
Missouri .....	1,215,529
West Virginia .....	945,234
Massachusetts .....	431,437
Kentucky	} ..... 1,065,397
Georgia	
Wisconsin	
California	
Colorado	
Delaware	
Michigan	
	\$41,051,004

The uses of this material in new ways have wonderfully increased during the past century. Dr. Muspratt says, that without speaking of the economical uses of this compound, and considering it only

with reference to its application in the study of natural phenomena, it is impossible to doubt the singular influence it has exerted on the progress of science. It is chiefly by its aid that astronomy has attained a perfection so wonderful. By it also naturalists have been enabled to study under the microscope a host of phenomena which have before escaped notice. But perhaps of greater importance is the use made by chemists in their experiments. It requires no profound chemical knowledge to recognize the fact that to glass is chiefly owing the present advanced state of the sciences so fruitful in marvelous applications.

With increased capital and the intense competition of the age there must be still greater improvement, and with her many advantages the United States in the future will be the great glass-producing country of the world.

*James G. Miller*

