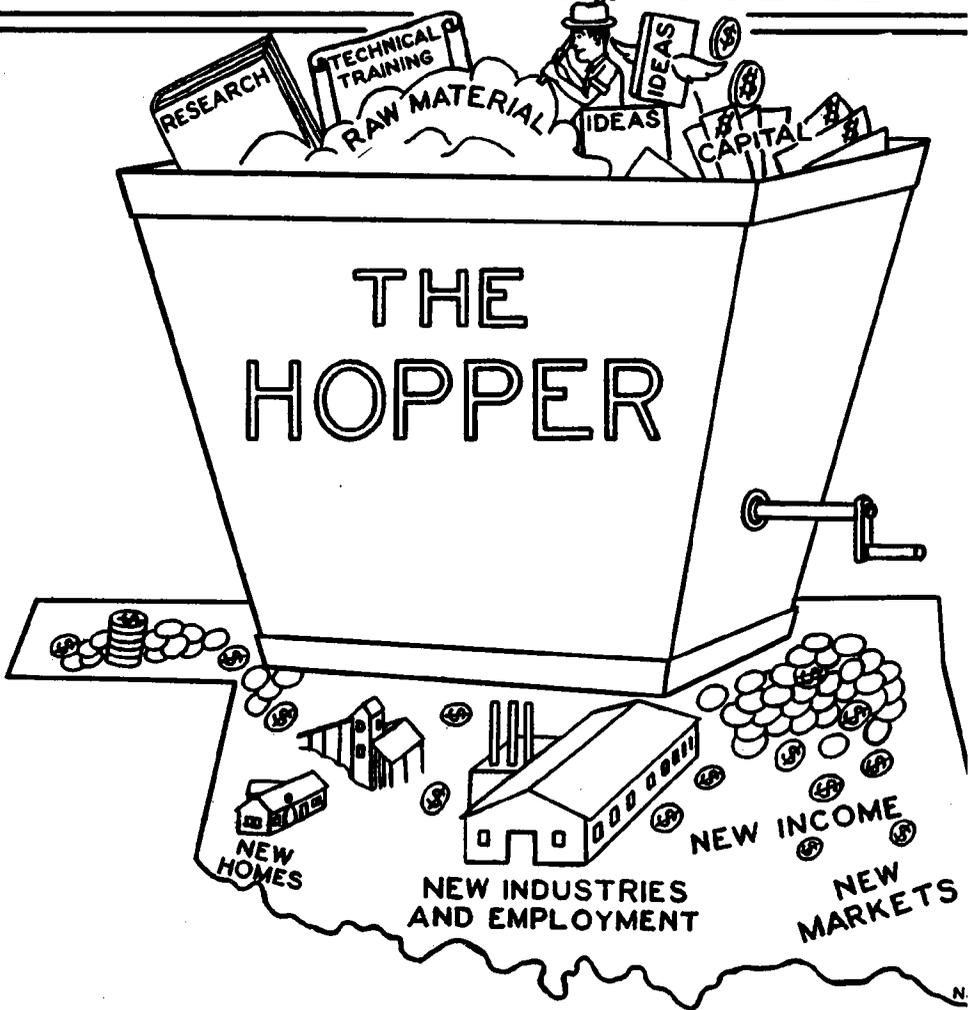


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THE GLASS INDUSTRY

by

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As a natural product, glass had its origin in the formative era. Long before primitive man made an appearance, bits of glass were scattered on the surface of the earth near regions of volcanic activity. The earliest written evidence of man's discovery of the secret of making glass dates from the first century A. D. Pliny, the great Roman naturalist, recorded the romantic story of the first glass being made by accident when a group of Phoenician sailors landed on the sandy Mediterranean shore to prepare a meal. One of the sailors brought soda blocks from the ship's cargo to support the cooking pot, and as the heat grew in intensity fusion of the sand and soda took place and from the fire flowed molten glass. The sailors took the glass with them to a port in Syria where they reported their discovery. The actual birthplace of glass making is in dispute. Archaeologists are able to present strong arguments for both Egypt and Syria. Certainly it is true that both made glass centuries before the Christian era. Actual glass blowing operations were depicted on the walls in the tombs at Memphis and Beni Hassen; glass artifacts from the Mesopotamian area are believed to be approximately seven thousand years old. It is not inconceivable that these two peoples could have independently discovered how to make glass at virtually the same time.

By 3500 B. C. glass containers were used by traders for their oils, honey, and perfumes. However, it remained for the Romans to expand this industry. They mastered most of the technical processes in glassmaking, produced pure crystalline glass which they ranked with the precious metals in value, perfected the difficult "cameo-glass", made spun glass, "millefiore" glass, and invented processes of applying gold leaf as ornament. They

developed the first glass windows. Excavations in Pompeii reveal that not only was the use of window glass comparatively widespread, but that glass, foreshadowing its future versatility, was used as paving stones! With the fall of the Roman Empire the center of the glass industry shifted to Constantinople, not to return to Europe as an important factor until some time in the tenth century. The art of glassmaking had not died but only waited a more favorable environment for further growth. By the eleventh century glassmaking had assumed large proportions in practically every country. Roger Bacon's "Opus Magnus" contains an account of the first practical magnifying glass used in the year 1266. This was a long step forward from the cut emerald used by the near-sighted Nero at the Circus Maximus.

The invention of the printing press in the fifteenth century was to give impetus to the development of glass for optical purposes. The artisans of northern Europe were experimenting with special glass for use in scientific fields. The first efficient mirrors and the beginning of modern glass were the great contributions of the artisans of the famous Venetian art colony on the Isle of Murano. Here, sometime in the late fifteenth century they produced the first absolutely colorless, transparent glass capable of being adapted to practical uses. This product, known as Venetian cristallo, was to make possible the development of the compound microscope in 1590, which was to be followed within the next two decades by the invention of the telescope, camera, and thermometer. These tools of the scientist which were to so greatly benefit mankind were made possible only by the advances made by the vitric artisan.

By the time Columbus had proved that the world was round glass had taken an important place in the lives of the people. It was used in containers, as it had been since the first bottle was blown before

the last pyramid was built, but its use for glazing found its greatest expression in the northern European regions where the climate demanded a material sufficiently transparent to see through, large enough to fit common window openings, and strong enough to withstand the winter blasts of wind.

The history of early glassmaking in America dates from the founding of the Jamestown Colony in Virginia when eight glass artisans were included in the original group of settlers. The first glass establishment was built in 1609 and some of its products were included in the first cargo exported from America. Except for the cargo record nothing more is known about this first attempt at glass making in the New World. The London Company in 1620 sent six Italian artisans to the colony to manufacture colored glass beads and similar articles for the Indian trade. This second attempt to found a glass industry is not recorded as being in operation after 1623. Many later attempts to establish the glass industry in the colonies were made. One of the first moderately successful glass factories was started in 1727 by Caspar Wistar, a German who imported skilled Belgian workers to staff his plant. The first glass works in which natively-trained glass workers constituted the major portion of the personnel was the Boston and Sandwich Glass Co., founded on Cape Cod, Massachusetts in 1825 almost exactly a century after the founding of the first financially successful plant by Wistar. The plant at Cape Cod flourished until 1887. The history of the American glass plants through almost the entire nineteenth century is one of individual failure due to factors beyond the control of the entrepreneur. Various colonies on many occasions taxed plants out of existence, but the chief factors in the struggle were the necessity of importing all skilled craftsmen and the relentless foreign competition in which at the time the success of an American undertaking seemed imminent the European manufactureres would reduce prices below

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cost in order to stifle competition. Glass manufacturing, the first industry of the colonist in the New World, was not to be a rewarding industry until almost three hundred years from the date of the founding of the first establishment at Jamestown Colony, Virginia.

In 1850 a group of American business men, realizing the value of the plate glass industry, formed a company, obtained certain European patents, and started a factory at Cheshire, Massachusetts. The location proved unfavorable and the factory was relocated at Brooklyn, New York. Although their products were apparently equal in quality to the foreign importations the company was unable to weather the competition and failed after five years of struggle. Others were to find their attempts ending in financial failure. In 1883 a struggling plant was reorganized under the name of the Pittsburgh Plate Glass Company. This was the beginning of the organization which was in later years to lead the world in development, manufacture, and distribution of plate glass products.

Until 1895 there had been practically no American research or developments undertaken in the American vitric industry. The American plants had used machinery imported from Europe or made from the foreign specifications. With the end of the nineteenth century the research engineers of American plants were working toward the development of newer and better plant machinery, methods of production, and different types of glass to answer the constantly growing demands of the machine age. The European method of production, which involved many steps, was not only costly in time and material but produced plate glass of variable quality. The American engineer met this problem by developing a satisfactory continuous process involving the fabrication and installation of a red Lehr. In a short time more Yankee ingenuity had devised a continuous roller Lehr which cut annealing time from

days to hours. It was not until 1922 that the complete mechanization of plate glass manufacturing was accomplished, resulting in the ability to produce large quantities of plate glass of uniform properties and characteristics.

The secret of financially successful plate glass production--mass production plus quick delivery--was to become the keystone of the foundation of many American industries. The automobile industry which was only in the trial and error stage at the beginning of the twentieth century was to become the plate glass industries' largest single customer in less than fifty years. The annual production of plate glass in the United States is approximately 225 million square feet, and of this at least 75 percent is used each year by the automobile industry.

In the seventh century the Syrians had developed the production of sheet glass using the "crown" method, and in the eighteenth century a Frenchman had developed a hand pump which was used to blow large cylinders of glass which were cut into sheets. Both these methods were slow and laborious, resulting in a high percentage of wasted time and materials and the production of an inferior type glass. From 1901 to 1904 engineers attempted to draw sheet glass directly from a tank without the necessity of subsequent flattening. In 1905 a process in which glass was drawn in cylindrical shape directly from a tank promised better results, but still it was necessary to flatten the glass by some mechanical method and reanneal the product. The glass produced by the method still did not meet the critical standards of perfection of the engineers--when foreign substances such as a rolls touched the glass imperfections were the result. It was not until 1927 that the engineers of the Pittsburgh research department evolved a new system, known as the Penn-Vernon process, which insured them of mass production of high quality window glass. In this

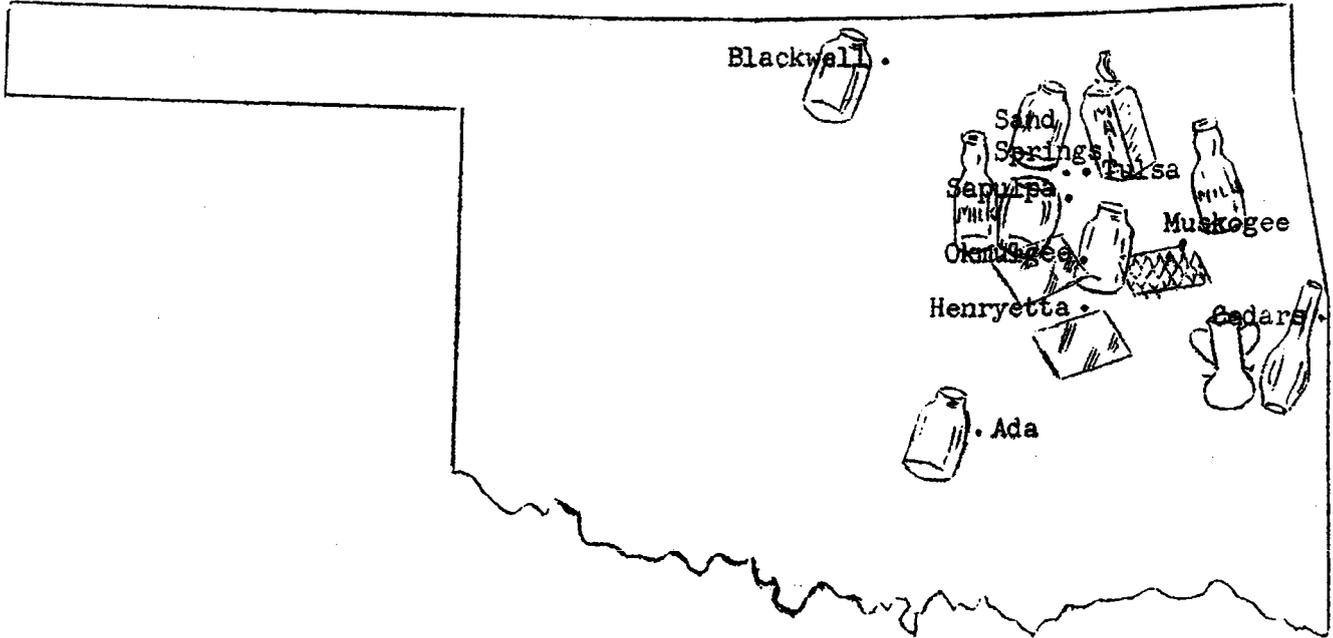
system the glass is drawn vertically from the molten state to the finished sheet. During the process no rolls or foreign substances touch the surface of the glass until it has cooled sufficiently to be beyond the marring state. When the magnitude of the sheet glass output of the United States is stated in round figures the vastness of the market can more easily be visualized. Over one billion square feet of sheet glass is produced in one year or roughly the equivalent of 36,000 square miles of sheet glass--enough to cover a township of land.

Simultaneously with the development of new and better ways of making both plate and sheet glass, American engineers were constantly working on new types of glass to be used for science and industry. Safety glass was one of these great new developments. Its true origin is not known but the legend in the glass industry is that a scientist noticed that a test tube which failed to shatter upon being dropped actually had the broken bits of the glass held in place by an inside coating of cellulose nitrate. Experiment after experiment was to follow the initial attempts to securely bond together two sheets of glass with a film of cellulose compound between. The products of these experiments have resulted in the perfection of safety glass for highly specialized uses, as Flexseal developed to serve the need of the aviation industry. As safety glass found more and more uses and vehicles became streamlined the need for bent laminated products became apparent. Again the research staffs proved themselves equal to the task and new processes for bonding various thicknesses of glass into shapes formerly thought impossible were perfected. Developments were speeded tremendously with the outbreak of the war for it has been accepted in the glass industry as axiomatic that as steel becomes short the demand for glass increases. Thousands of new items were developed to supply the war needs. These range from near-parallel bullet-resisting

windshield glass to super-flat airplane windows for high altitude reconnaissance photography. Highly specialized glass products were made for radar equipment. Now, as the curtail ailment of steel for various purposes is making itself felt the American glass manufacturers are to find newer and greater demands to meet in their production.

The earliest glass plants were located in the states of New York, New Jersey, Pennsylvania, and Massachusetts, to be near the source of fuel--wood--and to be near the centers of population. As our transportation system improved and the fuel used changed to natural gas it was possible for these plants to be profitably located elsewhere. The glass industry, ever alert of the necessity to produce the greatest amount and best quality possible in order to reduce prices to the consumer had located near the gas fields of Indiana. As these gas fields were rapidly exhausted, the industry looked for new locations where this important fuel was available. In 1902, attracted by the gas fields of Kansas, the first movement of the glass plants of the nation to the west had started. At the peak of this phase of the glass industry, around 1915, twenty glass plants were located in Kansas, but, due partially to the depletion of the known gas fields at that time, by 1929 only one plant was in operation in Kansas. The other adverse factor was the necessity to ship in from eastern Missouri the glass sand. The supply of sand was unpredictable due to the inability of the producer to promptly fill orders and of the railroads to move the sand at the most advantageous time for the manufacturer. Too, the freight rates brought the total cost of the sand to the glass manufacturer up four times the value of the sand at the quarry.

Around 1904 important natural gas discoveries were made in northeastern Oklahoma and a few Kansas plants migrated into Oklahoma partly to escape the



Blackwall .



Sand Springs .



Sapulpa .

Tulsa .

Muskogee .

Muskogee



Henryetta .



Cedars .



. Ada



keen competition in Kansas and partly to more easily supply the market of the new and growing state. By 1913 there were six plants in Oklahoma, two each at Tulsa and Okmulgee and one each at Bartlesville, and Avant. These plants were operating under the same handicap as those in Kansas in that all sand had to be supplied from eastern Missouri. A state institution, the Oklahoma Geological Survey, in pursuance of part of its duties--to make known to the general public the mineral resources of the state--realized the necessity of an investigation of sand deposits of the state which might be suitable for the glass manufacturer.

In January, 1913 the Survey published the report made by a young geologist, Frank Buttram. This report established the general high quality and suitability for glassmaking of sand deposits in three areas: Burgen sandstone of Ordovician age in northeastern Oklahoma, near Tahlequah; several different sand beds in the Simpson formation (Ordovician) in the Arbuckle Mountains in south-central Oklahoma; and the Trinity sandstone of Cretaceous age, which crops out in a broad band between the Arbuckle Mountains and Red River to the south, extending from a point near Ardmore eastward to the Oklahoma line. In the same year in which this report was made the first glass sand produced in the state was shipped from Roff by the Mid-Continent Glass Company. The sand from this deposit proved to be satisfactory and about 1918 two additional pits were opened in the Arbuckle Mountains, one near Hickory and another near Mill Creek. This marked the beginning of a new phase in the industry in the west. Here in one state were found the chief materials needed for the manufacturing of glass: vast deposits of sand suitable for the manufacture of all types (Optical glass excepted), a plentiful supply of natural gas, limestone, and dolomite. This, combined with the advantageous location of the state--almost the geographical center

of the nation--and the growing market of the southwest, was to lead to the development of the glass industry of Oklahoma to second place in the state's industries.

The number of glass plants increased steadily from 1913 to a peak of 16 establishments in 1919. Following the initial rapid development, decline in business resulted in nine plants in operation by 1937. Due to the expanding markets of the Mid-West, by 1951 a total of 13 glass plants were in operation in Oklahoma. There are two Hazel-Atlas glass plants, one at Ada and one at Blackwell; Scott Depot Glass Company at Cedars; Pittsburgh Plate Glass Company at Henryetta; Brockway Glass Company, Inc. and Corning Glass Works at Muskogee; American Window Glass Company, Ball Brothers Company, Inc. and Southwestern Sheet Glass Company at Okmulgee; Alexander H. Kerr & Company, Inc. at Sand Springs; Bartlett-Collins Company and Liberty Glass Company at Sapulpa; and Overmeyer-Perram Glass at Tulsa.

A resume of the production of the individual glass plants of the state, their place in the glass industry of the United States, and the future of the glass industry in Oklahoma will be presented in the following issue of the Hopper.

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