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HISTORY of GLASS

By Darrel A. Diehn, I.E. 1

Glass, one of man's oldest known materials, steeped in centuries of romance, violence and thundering drama, today is one of man's most useful products, and, despite its antiquity, is in many ways as new as tomorrow's newspaper.

This magic material, its remarkable characteristics unmatched by any substance known to civilization, was discovered long before the time of Christ.

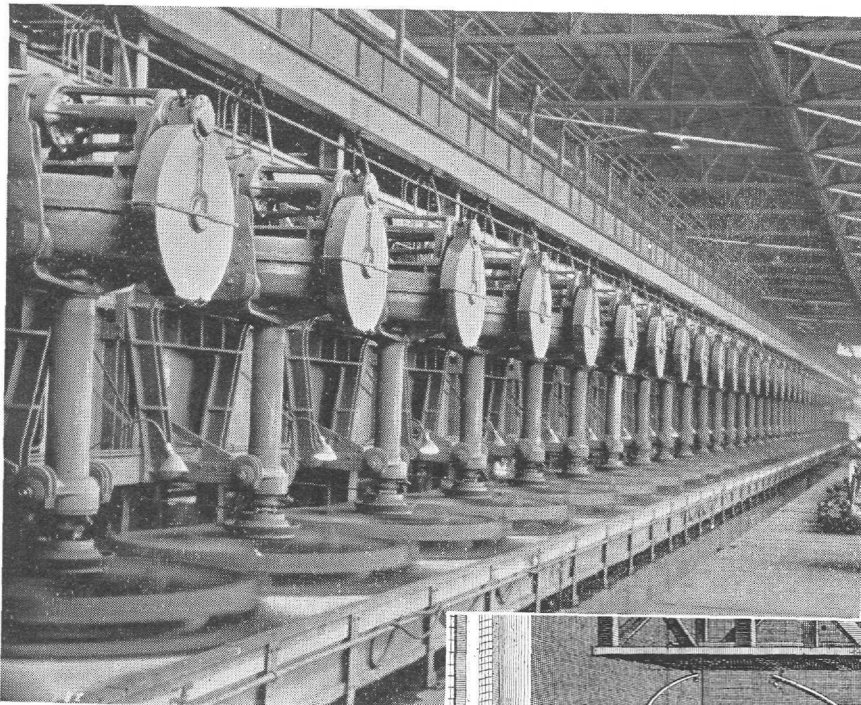
Its exact "birth" is a subject of scientific difference of opinion, but popular tradition, based on the writings of Pliny, Italian historian, dates it back to a day 5000 years ago when a party of Phoenician sailors debarked to prepare their noon-day meal on a sandy beach of the Mediterranean sea.

There being no rocks on the barren shore to construct a fireplace, the sailors brought cakes of nitrate (sodium nitrate) from their ships, and when the em-

bers of the fire had died down, the sailors beheld a strange new material, a glittering transparent mass never before seen by man, a crude form of glass formed by the fusing of the cakes of nitrate and beach sand.

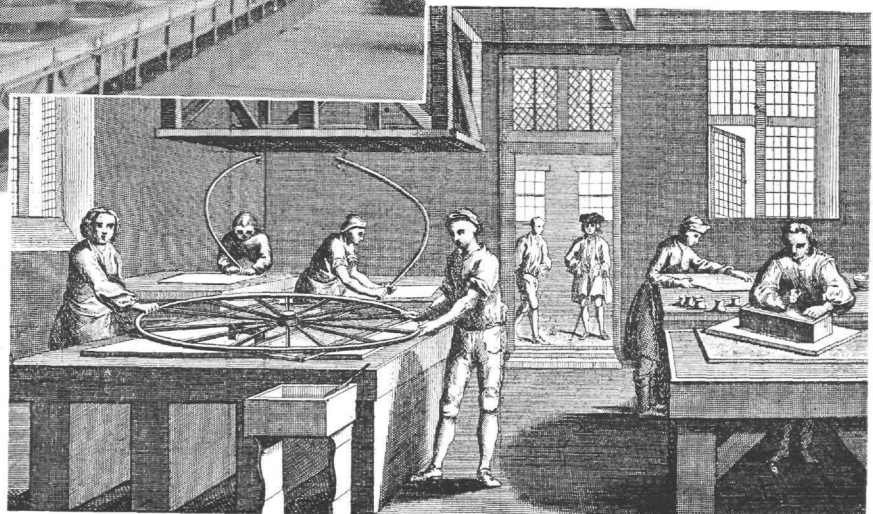
Modern glass men, well knowing that it requires a fierce heat of great furnaces generating temperatures of 2600-2850 degrees Fahrenheit to properly liquify sand, soda ash and lime (three of the most important ingredients of glass) are inclined to scoff, but the discovery is credited with being something more than a Phoenician fantasy.

The sailors examined the shimmering material with vast interest, but with no more than that displayed by a group of motion picture news weekly men quite recently when a three ton elephant stepped upon a platform with a floor consisting only of a one-half



A study in contrast; these pictures show the early and modern methods of grinding and polishing plate glass.

Courtesy—Pittsburgh Plate Glass Co.



inch pane of glass. The glass bent but did not break under its terrific live weight load and returned to its normal plane when the huge pachyderm stepped off.

Before discussing the fascinating modern magic of the glass technicians, however, it is well to consider a few things that developed after the discovery of glass, so that we may better understand the gigantic drama of American glass manufacture.

Although the production of glass as we know it today involves tremendous expenditures annually and a processing that has been reduced to an exact science, amazing in its detail, it can be said that fundamentally glass is the result of the fusing of sand, soda ash, lime and certain other ingredients.

Despite this apparent simplicity there is magic in its making, yet no black magic or mystery that characterized the art for about 5000 years, when even murder was invoked to protect the secret of manufacture.

Glass making then was conducted only by master craftsmen who worked behind locked doors, protected by secret guilds whose members were punished by death and their families thrown into prison for any slight attempt to divulge secrets of the craft.

From its accidental discovery by the Phoenicians, glass and its manufacture gradually spread among the Mediterranean peoples, Egyptians, Greeks, and Romans. To this day some of the most beautiful objects to be found in our museums are examples of ancient Egyptian bottles, vials, decanters in blue whose exquisite quality baffles the modern colorist to duplicate.

Glass manufacture reached its pre-American apex in the Middle-Ages when haughty Venice was at the height of its glory, its marvelous glass products the envy of European royalty.

On the tiny island of Murano, nestling among Venetian lagoons, furnaces were fired behind barred doors. Murano's glass workshops were prisons for the men who knew the secrets of blowing molten glass into shapes of gleaming beauty that were making Venice famed throughout the courts of Europe.

The outside world knew nothing of the operations, for a very good reason. Fortnightly the dreaded council of ten met in a palace room overlooking the island of Murano.

There the council members discussed the latest attempts to steal the secrets of the Venetian art of glass making. King Louis of France, was offering fabulous riches, titles of nobility, to any man who would escape from Murano and establish glass making in France.

The famed council acted quickly, swift death overtaking more than one hapless glass blower who tried to reach France; a few of them were stabbed almost within the shadows of the gates of Paris by trusted servants of the relentless council.

Despite all the murderous precautions, however, the secrets finally passed beyond the shores of Murano, into France, thence to Germany, England, and throughout Europe, yet withal the art remained a secret, handed down from one glass blowing family to another.

In 1607, eight Polish and German glass blowers, members of Captain John Smith's first colonizing group, sent out by English merchants, landed in the James River at what was later to be the site of Jamestown, Virginia. They constructed a crude glass furnace in the nearby woods; thus the manufacture of glass was the first industrial enterprise on American soil.

It failed, as did the works established later by Stiegel, the first great American glass maker, whose work today brings huge prices from museums and collectors. Glass plants of early America struggled on and upward, failing here, rebuilding there, but always the industry grew.

In 1900 the making of glass was not essentially different from what it had been in 1800 or 1700 or 1600—and at the turn of the century, when American business was about to launch one of the world's greatest industrial progressive parades in transportation and machinery, glass was still marking time.

Then there came, elbowing his way out of the hills of West Virginia, an aggressive young Irishman, himself a master glass blower, son of a coal miner, to precipitate the world's most interesting struggle between men and machines.

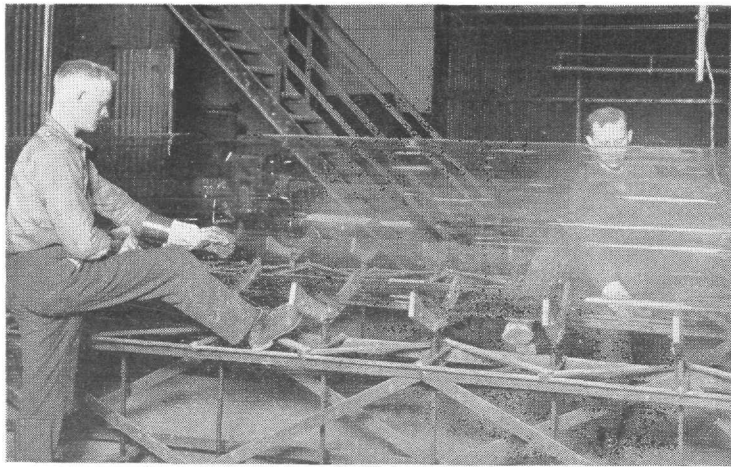
His invention of the world's first automatic bottle making machine in 1903 did more in fifteen years to revolutionize the art of glass making than anything had done for thousands of years previously.

As one views window glass coming out of one of our large glass factories, it is a little difficult to realize that this automatic progression is so new. Its birthday can be fixed to an exact date in 1916.

To comprehend the revolutionary character of the flat-drawing process requires a description of the older processes.

Window glass was obtained by blowing glass into spherical shapes, reheating, and rotating until it became a disk of glass marred by a bull's-eye in the center. America's center of production was Boston and "Boston Crown Glass" became a trade name in colonial America. After annealing, the disks were cut into small panes, those with the bull's-eye being used chiefly for transoms and door side lights.

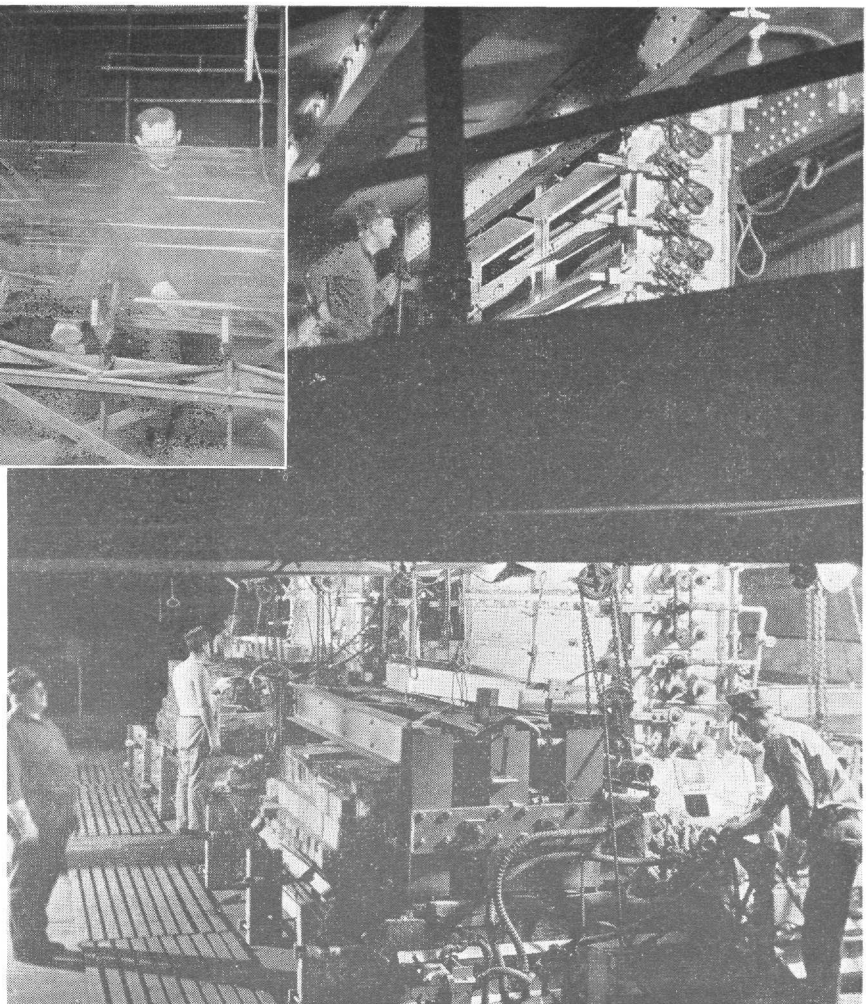
Larger panes resulted from another hand process involving exhausting physical labor and high skill; it came into general use early in the nineteenth century and continued to be the accepted method until 1903. By repeated gatherings, blowings and swingings of molten glass at the end of a heavy iron blowpipe, long cylinders were obtained up to dimensions of twenty



Above: Glass cylinders cut to length with red-hot iron.

Right: Modern machine for drawing molten glass into flat sheets.

Courtesy—Pittsburgh Plate Glass Co.



inches in diameter and seventy inches in length. They were then cut, reheated and flattened; but the most skillful operatives could not bring to absolute flatness glass originally blown into cylinders. For this reason old window glass is slightly bowed and given a considerable degree of distortion. Size and quality were limited sharply by human capacities under tremendous strain, and progress awaited a mechanical method for eliminating lung power and muscular fatigue.

The first step in that direction substituted compressed air in the blowpipe for the lung power of the glass blower. This made possible the fashioning of the large cylinders and sheets at less cost; but flattening the glass continued the same defect.

In the making of modern sheet glass preliminary operations are similar to those in other forms of glass manufacture, but they proceed on so vast a scale in those great plants that a visitor may be puzzled in correlating the simple "shop" glass making of olden days with the vast automatic manufacturing program.

From railway cars the raw materials are run up by cup elevators into huge circular concrete bins, like farm silos, but much larger. From these the ingredients of the "batch" are drawn by gravity—so much silica, so much ground limestone, so much soda ash and salt

cake. They are the chief ingredients which from time immortal have been used in glass making, but real progress has been made in controlling the mixture in both purity of materials, exactness in proportions and thoroughness in mixing.

After these materials have been thoroughly mixed in a power hopper, the batch travels along a broad band to the furnaces on a conveyor system. Unloading is accomplished at any desired furnace. There, with a certain amount of cullet, or broken glass, it is fed into furnaces to be melted under a heat of approximately 2700 degrees Fahrenheit. Cullet melting more quickly than the new materials, starts the liquefying of the mass and protects the sides of the tank from chemical action during the early stages. Even so, the tanks must be frequently rebuilt.

Eyes shielded against heat and glare, the visitor peers through an observation hole into a tank of molten glass. What he beholds is a lake of glass five feet deep and more than a hundred feet long, but the optical effect is one of vast distances and weird uncanny vistas. The colors of this lovely, ever-changing mirage are those not often seen on land or sea. Heat waves and convection currents explain the illusion of

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distance and the diffusion of light, but the layman will rest content with an unforgettable revelation of beauty.

This lake of glass in the great tank is ever being replenished at one end, and at the other end giving forth a broad carpet of white hot, even-flowing glass. The endless carpet passes first through a chamber which cools the glass slightly by a short, sudden drop in temperature to toughen it in preparation for a straight upward pull to bending rollers, thence horizontally over flattening rollers, and into the lehr for slow annealing.

The powdered batch and broken cullet have become fused into a solid transparent sheet; the white hot fluid of a few hours ago is now cool enough to be handled by cutters as it emerges from the lehr. The slow annealing possible under this flat-drawn process reduces internal strains and yields glass less brittle and hence more economically cut for glazing.

The past and the present of glass is strangely interwoven; one of the most fascinating stories of lost treasure ever told has to do with glass. A glass that was malleable, that would bend, that could be hammered like metal and dropped without breaking, was invented by one of the master craftsmen back in the days of the Caesars, when Liberius was master of the Roman world.

The inventor was brought to Caesar, the remarkable qualities of the glass demonstrated to him. He watched as the inventor flung the glass on the marble floor of the audience chamber, and as hammer blows were rained upon it. Here was one of the greatest discoveries of the ages, of untold value, the secret known to a single man, yet Caesar ordered him killed on the spot. He feared the marvelous glass would be worth more than gold and silver, and his own vast fortune was in those precious metals. Thus was lost on the bloody sword point of the Nubian slave body-guard a secret that kept the world waiting 2000 years to rediscover.

Today in one of the great glass plants of the country, technicians are working with the modern counterpart of that Caesarian glass. It can be twisted to a remarkable degree and is highly resistant to impact and severe thermal shock; it is a glass that is making possible the manufacture of all glass furniture. It enables glass to be utilized for applications heretofore ideally suited to glass but restricted to other materials because of the physical limitations of ordinary glass.

It is known as Tuf-flex or tempered plate glass. It is produced by heating ordinary plate glass until it is almost plastic and then cooling it suddenly by subjecting both surfaces to jets of air. Both outer surfaces, cooling more rapidly, are in a state of compression, while the inner portions of the glass are in tension or pressure in the opposite direction. In general one can say that with this discovery another ancient art has been accomplished.

Restricted in usage until comparatively recently, glass today is the symbol of all progress. It is the ever-present servant of man, and it can be said that we of today are dependent upon glass in one form or another every hour of the day and night from the moment we are born until the day we leave this earth.
