The History of

GLASS CONTAINERS

OWENS-ILLINOIS

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OWENS-ILLINOIS
TOLEDO, OHIO

Glass, like sunshine, is such a basic part of everyday life that we never give it a thought. But without glass—as without sunshine—it would be a dark and barren world. There would be no windowpanes or electric light bulbs, no microscopes or thermometers, no mirrors or eyeglasses, no cameras, television sets, or hundreds of other things which contribute either to the preservation or enjoyment of life.

And without glass, there would, of course, be no glass jars or bottles. Made by the billion in America today, glass containers bring us an almost endless variety of foods, beverages, medicines, toiletries, and household products which we could not do without.

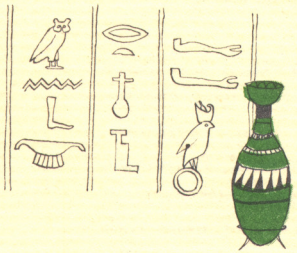
Produced in every shape and color, and ranging in size from the tiniest medicine bottle to giant demijohns holding many gallons, these durable, transparent and attractive bottles and jars have a rich and romantic history stretching back for thousands of years.

Glass itself has been made by nature from the beginning of time. Lightning, as it strikes sand, frequently forms a glass crust and—at other times—long glass rods which reach into sand like roots. The action of fiery volcanoes also makes a natural glass called obsidian from which cave men chipped sharp knives, arrowheads, and hatchets.

Just when and where the first "man-made" glass was produced has never been determined. One ancient legend credits a group of

Phoenician sailors with making the world's first glass. The story goes that the Phoenicians beached their boat on the sandy shores of a tidal river. Finding no rocks on which to rest their cooking pots, they used lumps of natron—a crude soda ash cleansing agent—from the ship's cargo. Fanned by sea breezes, their camp fire blazed hot. When it died, the sailors found in the ashes a shiny substance which became hard when it cooled. Since two of the basic ingredients of glass are sand and soda ash, this may have been how one of man's greatest gifts —glass—was accidentally discovered. Actually, nobody knows.

It is known, however, that many thousand years before the birth of Christ, the Egyptians, and possibly some of their neighbors, were producing glass which they used to glaze or coat small stones to make beads. Some experts place the date as early as 12000 B.C. The first experiments with molding glass into solid pieces—rather than using it as a glaze—occurred about 7000 B.C.



The world's first glass containers were made in Egypt some four thousand years ago by an extremely slow and laborious process. Using metal rods, Egyptian glassmakers pulled glass threads from a caldron of molten glass and painstakingly wound the strands around a mold formed of sand. After the glass had hardened, the sand was scraped away to leave a hollow container.

Another method was to dip a sand mold into molten glass again and again, tedi-

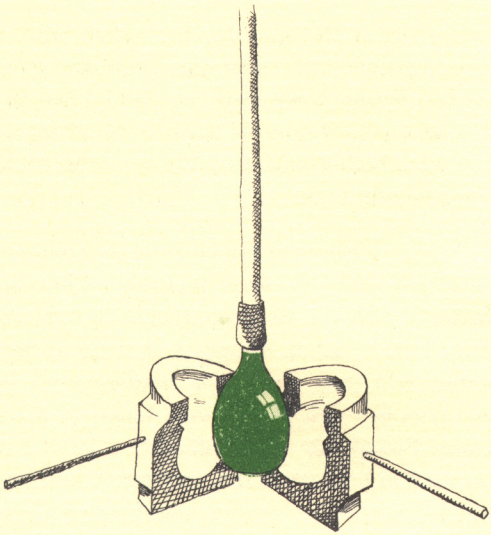
ously shaping the new layer of glass with a wooden paddle after each dip. These first glass jars and bottles were small and crude, and the glass was not, of course, transparent. Even so, they were highly prized by the few who could afford to own them.

Thanks to the intrinsic durability of glass itself and to the ancient custom of burying treasures with the dead, museums all over the world today contain examples of these ancient bottles and jars. Tiny tear bottles—used by mourners to catch tears—were found in many tombs. Found too were brilliantly colored bottles used to hold cosmetics, ointments, and perfumes. One early "double unguentarium"—or twin-bottle beauty kit—still contained flecks of crimson and black—probably rouge and kohl, a substance used to darken eyelids—similar to today's cosmetics.

Ancient craftsmen continued to make glass jars and bottles in this slow and tedious way for hundreds of years. Finally, however (and why it was so long in coming is another of the mysteries of glass), a nameless glassworker took a deep breath and blew the world's first glass bubble—thereby completely revolutionizing the ancient art of glassmaking.

One early method of glass blowing was to seal an end of a glass tube and reheat it. The blower then forced air from his lungs into the tube, causing the glass to expand into hollow, rounded containers.

The blowpipe—a long hollow metal tube with a bell-shaped end—was invented about 300 B.C. Blowers dipped the end of the blowpipe into a molten batch, gathered up a small gob of glowing glass, and formed it into



a rough shape on a marble slab. Then, blowpipe to lips, the glassmaker raised the pipe above his head, twirling the glass through the air in circles to create the shape he had in mind by centrifugal force. This free-blown method obviously required great skill—as well as time and lung power!

Molds were the next milestone in the long and slow evolution of glass containers. Instead of shaping jars and bottles by blowing and twirling them in the air, the blower took a few puffs and then lowered the red-hot glass bubble into a hollow mold. He continued to blow, but the bubble was shaped by the mold, not by his twirling skill and breath alone. This combination of blowpipe and mold made it possible to produce more uniform and more decorative bottles, jars, flasks, and other hollow ware in a fraction of the former time.

Egypt continued to produce glassware in increasing quantities, and her output

was taken by Phoenician traders to ports throughout the Mediterranean. Essential oils, wine, honey, and so on, once packed in pottery, were put into glass which was found infinitely more efficient. Chemically inert, then as now, the new glass containers added nothing to, and took nothing from, whatever was put into them.

These first glass-packed products not only withstood long sea voyages, but long periods of storage as well. And, as they could be used again and again, the original cost was soon justified. As other countries became familiar with the protective advantages of glass, they, too, tried their hand at producing it with the result that glassmaking soon spread throughout the Mediterranean.

Rome, among others, cast covetous eyes on Egypt's thriving glass industry. In 30 B.C., when Augustus added Egypt to his empire, he demanded glass in tribute. The supply failed to satisfy him, however, and he ordered Egyptian craftsmen to come to Rome to train others in their art. Because of Rome's patronage, the first four centuries of the Christian Era are known as the First Golden Age of Glass.

Glass bottles soon replaced leather bottles which, until then, had been used for many liquids. Even in those early days, it was a well-established epicurean custom to judge

the age and quality of wine by the seal on the cork and the label impressed on the glass. The first-century Roman satirist Petronius reported: "They brought glass bottles, carefully sealed. On the neck of each was a label marked thus: 'Opinan Falernian: one hundred years old.' "

Following the fall of the Roman Empire and the ensuing Dark Ages, Venice became the artistic and cultural capital of the world. Glassmaking was especially encouraged, and the Second Golden Age of Glass began in Venice about the thirteenth century and lasted for about four hundred years.

Like Rome in the First Golden Age, Venice had to import glassmakers at the outset. Artisans came from her colony in Syria, and were given royal treatment. But rich and respected as they were, these skilled glassmakers were also closely guarded and "protected," lest they—and their skills and trade secrets with them—be coaxed into other countries anxious to compete with Venice's glass industry.

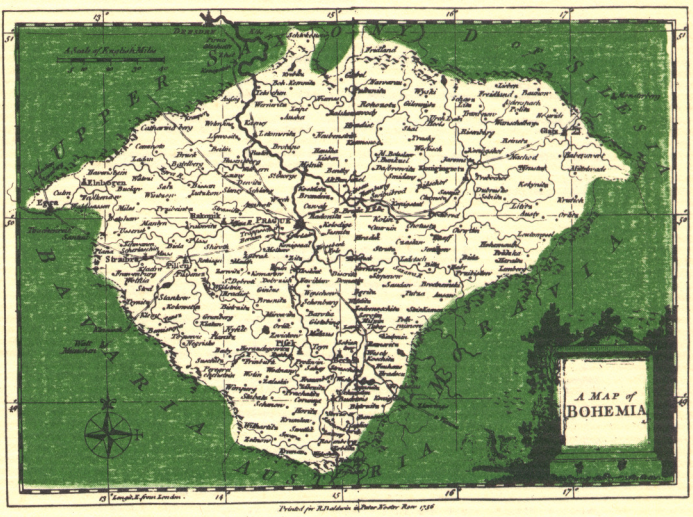
Venice's star began to dim, however, and by the beginning of the seventeenth century countries all over Europe were producing glassware which equaled that of Venice in her greatest days. Bohemia became famous for her magnificent ruby glass. Glass factories were founded in Antwerp in 1550, in Brussels in 1662. Others quickly sprang up in Germany and Holland, in Spain and France.

Glass factories were also blazing in England throughout the sixteenth century. They could not, however, satisfy ever-increasing demands, and England was forced to import much of her glass. Furthermore, coal had not yet come

into general use, and the hungry fires of England's glass plants were depleting English forests. Officials of the London Company of Virginia accordingly turned their eyes toward America with the hope of establishing – among many other things – new and profitable glass factories on the wooded shores of the new Continent.

Sent out by the London Company, a small and courageous band of colonists under the direction of Captain John Smith landed at Jamestown, Virginia, in 1607, to establish the first permanent English settlement in North America. A second group—which included eight glassmakers – arrived at Jamestown the following year, and, by the autumn of 1608, a glass factory was in operation in the nearby forest about a mile from the settlement.

Not only was the Jamestown glass plant America's first factory, and America's first industry—existing as it did a dozen years before



the arrival of the Pilgrims at Plymouth in 1620—but glass was part of the first cargo ever exported from these shores.

In his *Historie of Virginia,* Captain Smith wrote: "We sent home ample proof of pitch, tar, glass..." Fragments of glass found among the ruins indicate that bottles, vials, and drinking glasses were produced at the Jamestown plant and exported to England, and it is probable that glass beads given Indians in exchange for land were produced at America's first factory.

After Captain Smith left for London in the fall of 1609, sickness, hunger, and death struck the Jamestown colony in full force. Work at the glass plant first slowed down, and then stopped altogether. Twelve years later—in 1622—Captain William Norton arrived in Jamestown with six Italian glassmakers, and operations were resumed. The fires of the Jamestown plant died out permanently, however, in 1624.

In 1632, two Salem, Massachusetts, colonists started a plant to make glass bottles to transport New England rum and cider to the Carolinas and the West Indies. This venture was more successful than the original Jamestown plant, continuing until 1670. Glass plants were also operating in other states—notably New York and Pennsylvania—during the latter half of the seventeenth century.

One of the most successful of America's early glass factories was founded in 1739 in Salem County in southern New Jersey, by German-born Caspar Wistar, one of the great glassmakers of all time. At first, Wistar made bottles which he sold to traders who were smuggling West Indian molasses into the Colonies in violation of British regulations. Later, Wistar and his son also produced bowls, drinking glasses, preserve jars, and dishes.

The Wistars are credited with making America's first flint glass, the remarkably clear and brilliant glass which was perfected in England by George Ravenscroft in 1675. And they produced, as well, magnificent colored glass. Shades included beautiful greens ranging from aquamarine to deep emerald, and ambers from dark brown to yellow and honey. Martha Washington owned a tiny Wistar scent bottle of yellow and turquoise—and followed the current fashion of carrying it tucked inside her glove.

By the time the Wistar plant closed in 1780 after more than forty successful years, another great glassmaker—William Henry Stiegel—had come—and gone. Called "Baron" because of his flamboyant habits, Stiegel operated in Lancaster County west of Philadelphia. Stiegel's ambition was to prove that beautiful glassware could be produced here as well as in Europe, and prove it he did.

England had recently passed new tax laws. British glass—along with tea and other British products—now cost the colonists dearly in import duty. These duties, Stiegel concluded, were full reason for expanding and perfecting glassmaking in America. Hiring craftsmen from many foreign countries (a hundred men were employed at his Manheim furnace alone), Stiegel called upon them all to produce their best. Money—even if it had to be borrowed—was no object. The result was glassware highly prized today by museums and collectors everywhere.

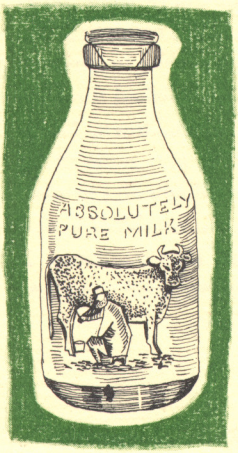
Stiegel's account books and advertisements mentioned bottles of many kinds: "smelling bottles," "pocket bottles," flasks from a gill to more than a quart in capacity, ink bottles, mustard jars, and so on. The flamboyant

"Baron's" enthusiasms were more than his deficit financing could support, however, and, in 1774, Stiegel landed in debtors' prison.

After the smoke settled from the American Revolution, a few new glasshouses bravely opened for business. There were, however, only nine or ten in the entire country at the time. John Frederick Amelung came to America from Germany in 1784 and established the New Bremen Glass Works at Fredericktown, Maryland. Amelung failed in 1796, and some of his workers migrated across the Alleghenies to western Pennsylvania and Ohio to establish a new industry. Glass plants were also operating in New Hampshire, Massachusetts, and Connecticut at the close of the century.

Early in the 1800's, American glassmakers began to manufacture the now famous "historical flasks" or "memorial bottles." Emblazoned with the likeness of American heroes, presidential candidates, and a smattering of those who were not celebrated but wished to be, these bottles soon flooded the country. The opening of a canal or a railroad, the launching of a steamer, were all fittingly commemorated in glass—as were slogans, emblems, and mottoes without number. Popular too, was the American eagle which appeared in numerous poses on countless bottles, all of which were quickly bought by an avid and patriotic public. Though they were originally made to hold cider or liquor, housewives treasured these bottles, refilling them again and again with other liquids.

Manufactured from the early 1800's until about as late as 1870, these historical flasks did much to bring bottles into more common use in America. As glass containers became more widely appreciated, they were put to an ever-increasing number of new uses. In 1841, the first nursing bottle was patented. In 1858 came the Mason jar, patented by John L. Mason of New York City, with its threaded cap. More and more medicines, requiring the protection which only glass can give, were glass-packed. And, in the middle 1880's, Dr. Harvey D. Thatcher perfected the first milk bottle.



Until then, inconceivable as it is to us today, milk was delivered into a pitcher or bucket put out on the doorstep by housewives. As milkmen stopped at each house, they dipped milk into the waiting pitcher from a large galvanized container which stood open in the back of a horse-drawn wagon. A far cry indeed from the sanitary and tightly sealed milk bottles which are now delivered to millions of American stores and homes every day!

Noteworthy, too, in the increasing use of glass-packaging for food products were experiments with the preserving of fresh foods conducted in France by Nicolas Appert early in the nineteenth century. His simple theory: If food were sufficiently heated and then sealed in a tight container, it would keep indefinitely. Appert accordingly filled glass jars with various

foods, sealed them with corks, and cooked them in boiling water. Samples of his preserved fruits and vegetables retained their wholesomeness—thereby establishing the foundation of today's science of food processing.

America's first preserving operations were started in 1819, one in Boston, the other in New York. In Boston, William Underwood packed fruits, pickles, and condiments in bottles. In New York, Thomas Kensett and Ezra Daggert packed the first salmon, lobsters, and oysters the same year.

In 1825, Kensett was granted the first American patent on the tin container. American bookkeepers began to abbreviate "canister" to "can," and a new word was born. The subsequent word "canning" came to mean the sterilizing and sealing of food in airtight containers whether the container was tin or glass, and whether the process was done commercially or at home.

Throughout the nineteenth century, an ever-increasing number of products were packed in glass, and an increasing number of glass jars and bottles were thus making their way into American homes. Important to note, however, is the fact that every single one of these bottles was made in the same way that glass bottles had been made for nearly two thousand years. Craftsmen gathered molten glass on the end of a blowpipe, lowered it into a mold, and blew into the pipe for the final shaping. At the end of a 12- to 14-hour day, the total output of a blower and four assistants rarely exceeded 18 dozen bottles.

Though mechanical processes had long been

in operation in other forms of glassmaking, no one had yet devised a way of shaping the neck and shoulders of a bottle automatically. Then, while various mechanical improvements had been introduced by 1900, no machine was entirely automatic. In 1903, the first fully automatic bottle machine was invented, and the glass container industry progressed further than it had at any time since the invention of the blowpipe some two thousand years earlier.

Overnight, metal arms revolving in endless succession around a vertical axis replaced the arms of glass blowers. Overnight, compressed air replaced lung power. Most important, this mechanical marvel soon delivered an endless succession of bottles to annealing ovens at the incredible rate of a million a week! Called the father of mechanized glass, Michael J. Owens was the inventor of the first entirely automatic bottlemaking machine. Though similar machines were to be patented later by others, Mr. Owens is credited with revolutionizing the glass container industry.

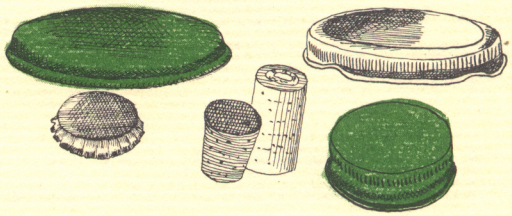
Mechanization wrought many changes in the glass container industry during the next half century. Original machines were perfected considerably through the decades. Research, on which millions of dollars were spent, led to improved production techniques and an improved product. Machine-made bottles, being uniform, made high-speed automatic capping and sealing machines possible.

The performance and usefulness of glass containers obviously depend upon their closures – jars and bottles being incomplete without caps—and the closure industry has kept

full pace with the remarkable progress of the glass container industry through the years.

Crown caps, screw caps, lug caps, friction-type and pry-off closures, cork stoppers and others, each with its special advantage, are all applied today by high-speed machines in a single operation.

In 1908, for example, the first so-called side-seal type metal closure, using a rubber gasket which gripped the side of the rim to effect an airtight or vacuum seal, was applied to glass containers by machines at speeds of 25 to 40 per minute. After refinements dating from 1926, the present greatly improved side-seal pry-off closures which have played such an im-



portant role in the growth of commercial food packing, are now applied to jars and bottles by fully automatic capping machines which vacuumize and seal up to one thousand containers a minute!

Though screw caps were in use at the turn of the century, today's counterpart is a far cry from those early models. Made of metal or plastic, today's popular screw caps are used to efficiently seal a multitude of products in bottles and jars of all sizes and styles.

During this same period, another type of twist-off closure, the lug cap, was developed and it too is to be found today in every American home guarding a wide variety of foods, drugs and cosmetics, and chemicals.

The familiar crown cap, which nearly everyone has removed so often from carbonated beverage bottles, was introduced in 1892. The low cost and high speed of application of crown closures, together with their ability to hold the pressures of carbonated drinks, unquestionably revolutionized the bottled beverage industry, replacing as they did an assortment of complicated wire sealing devices.

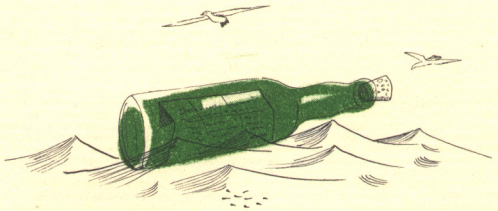
Regardless of the type of closure or the type of container, together, they make possible the almost infinite variety of glass-packed foods, beverages, drugs and cosmetics, and chemicals which are available today to American consumers.

Through the years, sturdy, easy-to-seal glass containers have served in another interesting and even important capacity. What they have done is to float—anywhere the winds and tides have happened to take them. The sea duty of tightly sealed glass containers has contributed much to mankind's scientific knowledge and maritime safety—as well as having brought good fortune, sad news, romance, or a fascinating hobby to people all over the world.

As early as 300 B.C., a Greek philosopher named Theophrastus used floating bottles to prove his contention that the Mediterranean gets most of its water from the Atlantic Ocean. Even the handmade glass containers of those ancient times withstood long sea trips—and

drifted in the proper direction to prove Theophrastus' point.

Several centuries later, Benjamin Franklin used the floating-bottle method to chart the little-known currents of the Gulf Stream. Sealed safe and dry inside each of Franklin's bottles was a piece of paper containing his name, address, and a request for whoever found the floating questionnaire to please let him know when and where it had appeared. Franklin's sea-borne data is still considered correct in almost every detail.



Today, the United States Navy scatters thousands of corked questionnaire-filled bottles in all the seven seas to gather information on tides and currents. In peaceful years, this oceanic knowledge saves shipping time and money. During wartime, it helps our ships avoid floating enemy mines. Sea-borne bottles have delivered forlorn messages from shipwrecked sailors and also good news—including negotiable checks, offers of marriage, and even a will leaving the finder fifty per cent of 12 million dollars.

In England last year, there were unexpected additions to the glass container fleet. Eighteen bottles of beer escaped from their watery grave inside a ship that had been sunk on the East Kent coast over two centuries ago.

The beer bottles—identified as the variety made by hand about 250 years ago—were all in excellent condition!

Further impressive proof that modern glass containers are durable is found in the Final Report of the Transportation and Packing Survey, sponsored by the Railroads of the U.S. and the Fibre Box Association. According to this unbiased report, the average freight claim on foods and beverages packed in glass amounted to only $10 per car—against $44 per car for fruits and vegetables in tin, and $55 per car for juices in tin!

Today's steadily increasing demand for glass containers keeps some 90 plants throughout the country in full production. Automatic machines, each consisting of over 10,000 parts, are producing glass containers at speeds as high as 250 a minute. Annual production in the United States is now in the neighborhood of 18 billion new glass containers—or about 110 for every man, woman, and child in the country.

Placed side by side, the almost 18 billion new glass containers produced in the United States in 1954 would stretch around the world at the equator more than 22 times. And yet, that is not the end of the story by any means. Many purchasers of new glass containers reuse the same bottle again and again. The average number of trips for milk bottles is 30; soft drink bottles, 23; and beer bottles, 18.

Based on closure statistics, it is possible to estimate reliably total sales of glass-packed units in the United States in 1954 at 73 billion—or an average of 454 per capita. This means that more glass containers "went to mar-

ket" in the United States in 1954 than did any other type of rigid container. Shipments of metal cans in 1954 totaled some 36 billion units. American consumers thus bought more than two glass-packed items in 1954 for every one packed in metal!

And, not only are today's modern glass container plants producing more glass containers than ever before, but they are producing them stronger and better every year.

The production process in today's modern plants begins with the delivery of the raw materials. All glassmaking starts with three basic ingredients: sand (largely silica), soda ash (sodium carbonate), limestone. Cullet, which is crushed glass, is added to hasten melting and to make the batch more workable. Several other materials are used, but quantities are extremely small in relation to the three basic ingredients. However, each of these minor ingredients contributes important properties to the finished glass container.

Raw materials are weighed on automatic scales and mixed in giant hoppers. Buckets, suspended from overhead rails or on endless belts, carry the batch to the continuous automatic batch feeder which introduces it into the furnace or "tank" where molten glass bubbles at temperatures of more than 2700 degrees F. These white-hot infernos must be kept in operation twenty-four hours a day, seven days a week, and furnaces literally burn themselves out in a few years and must be rebuilt.

From the melting end of the tank the molten glass progresses through a submerged throat into the refining chamber where it becomes purified before passing on to the forming machines.

In one type of operation, the molten "metal" (as the glass blower calls it) then flows into a huge, revolving bowl made of heat-resistant material. From there it is sucked up into the molds of a rapidly rotating forming machine.

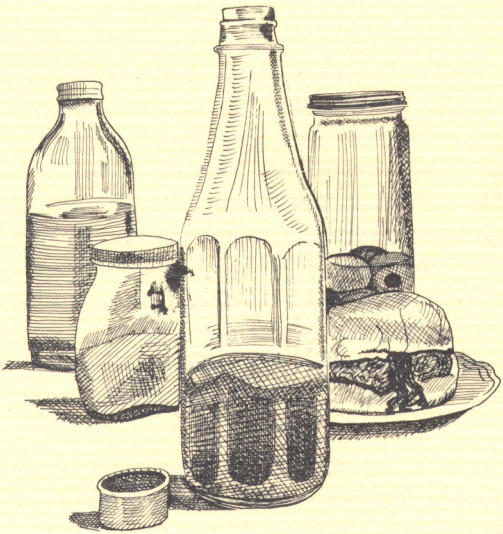
In another method, the tank is mounted on a raised platform, above the forming machines, where the molten glass flows into mechanical feeders which in turn exude red-hot gobs of a taffy consistency. Cut free, a gob of molten glass drops with the speed of a falling star into a waiting mold which presses or blows it into a rough approximation of the finished bottle. As this mold releases the embryo (called a parison), a finishing mold closes and captures it. In split seconds, compressed air blows the glass container into final shape. The mold's iron jaws swing open, and out comes a jar or bottle —every container uniform in size and shape.

To leave just the right temper in the glass for strength, finished containers are passed through an annealing lehr or cooling oven. In an endless parade on a moving belt, bottles and jars pass through these long, tunnel-like ovens. Heat which at first is approximately 1000 degrees is gradually reduced to room temperature. At the end of the lehr, containers are carefully inspected before packing. One minute flaw, all but invisible to the untrained eye, and the container is broken into cullet and returned to the beginning of the production line.

Some four thousand years ago, the world's first crude glass containers were priceless luxuries. Today's gleaming billions of bottles and jars are household necessities.

While literally thousands of different consumer products were packed in the almost 18 billion containers produced in 1954, all fall into one of the following four major end-use categories: food, beverage, drug and cosmetic, and chemical.

The 7.3 billion glass containers used to package food products in 1954 constituted about 42 per cent of all domestic shipments, comprising by far the industry's largest single end use. In addition, food packaging is the area in which glass containers have scored their largest gains, 1954 shipments to food processors having increased 190 per cent over 1939. Pickles and relishes, mayonnaise, catsup, chili sauce, preserves, jams, jellies, green olives, and many staples which no cook could do without are among the food products which are packed principally in glass.



Processed baby food also dramatically reflects increasing consumer preference for glass-packed products. In 1939, some 13 per cent of the total baby food pack was in glass. At the end of 1954, glass containers were carrying 70 per cent of all processed baby foods —to oldsters, dieters, live-aloners, and, of course, to America's steadily increasing crop of babies.

Soluble coffee offers another glass container success story. Instant coffee sales have quadrupled since 1946 and the greater part of the product is packaged in glass—for important reasons. Since instant coffee is seldom consumed at one time, quick and easy resealing in the original package is a vital consideration. The visibility factor, which lets the homemaker tell at a glance when supplies are running short, is another unique advantage.

Some 4.3 billion glass containers were used in bottling wines and liquors, beer and soft drinks in 1954. No other packaging material has yet proved feasible for wines and liquors and virtually all are glass-packed. Shipments of beer bottles in 1954 were four times their prewar level with approximately 70 per cent of all the beer packed in the United States last year going into glass, the remaining 30 per cent in metal. It is estimated that Americans consumed the astronomical total of 28,240,000,000 bottles of soft drinks in 1954, or 174.2 bottles per capita, about 98 per cent of which were glass-packed.

From the earliest days of the glass container industry, the use of jars and bottles for packaging drug and toiletries has been of major proportion. Bottles were the foundation of old-fashioned pharmacies. Today, countless products sold in drugstores and in the drug and cosmetic sections of the vast new supermarkets are also in jars and bottles. Over-all sales of drugs and cosmetics have scored marked gains in recent years, and sales of glass-packed products in this field have risen correspondingly.

In chemicals (for both household and industrial use)—an industry expanding

more rapidly than almost any in the country—1954 glass container sales exceeded those of 1939 by 238 per cent. Many products in this field are chemically incompatible with other containers. Frequently kept over a long period of time, chemicals also need the protective properties that only glass containers give.

Today's bottles and jars by the billions—clear, amber, blue, green, and opal—are the most versatile, time-tested, and indispensable form of packaging ever devised. Sanitary, durable, and easily handled they add nothing to or take nothing from the product packed in them.

The contribution of glass containers to the world's health, welfare, and comfort during the last four thousand years can be called incalculable. It is a contribution which has increased annually with the passing of over forty centuries since Egyptians made the world's first glass containers nearly 2,000 years before the birth of Christ.

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