There's glass in almost every phase of your life

WHAT GLASS can do for YOU

by E. W. Klimack

WHEN Samson pushed the pillars over in the film *Samson and Delilah* and the huge stone blocks of the prison house crashed down on the Philistine crowd, the thousands of casualties were only acting. Shooting of the scene left them unscathed, for the blocks were actually light, hollow shells. One reason why they were strong enough to withstand falling without being smashed was that a major ingredient was glass!

Speak of glass and almost everyone thinks of a transparent material that shatters if dropped on the floor. Yet glass in the fiber form—hardly a novelty today—is used as a reinforcement in such things as fishing rods, hammer handles, wall panels, chairs and even boats and automobiles.

One direction in which glass is headed is indicated by Pyroceram, the name Corning Glass Works has given to a new family of products which start out as non-crystalline glass but are processed

into crystalline materials. Tough, heat-resistant substances, they are said to be stronger than steel, lighter than aluminum and nine times as strong as plate glass.

In the laboratory very fine glass fibers have shown strength as high as 900,000 pounds per square inch, compared to 400,000 pounds per square inch reached by fine steel wire. However, industry admits that most of the glass of appreciable thickness that you see in windows and bottles has only about one percent of that measured strength. When a way is found to raise it to ten percent, and industry believes it will be done, glass will compete with steel, for example, as a structural material.

Glass can be formed in several ways. Besides being blown into bottles and jars, or spun and woven into fabrics, it can be cast like metal, drawn, pressed, made into foam and granulated. Pieces can be fused together, a trick the ancient Egyptians learned and did with great skill in decorating bowls and other objects with many colors.

A visit to the museum will demonstrate the difference between sheer Venetian glassware and the heavy modern crystal of Scandinavia. But the contrast is much greater. Glass fiber can be made about 1/300th of the thickness of human hair. On the other hand a radiation shielding window of glass has been made five feet thick weighing 17 tons.

As a non-conductor of electricity, glass finds wide use as electrical insulation, but it can also be so used for making such things as heating panels and aircraft de-icers.

Glass can be made comparatively hard or soft, depending on its purpose. Glass with a low melting point is used like solder to hold together two parts of color television tubes. The tube, which must be made in two separate parts, can later be taken apart again for repair without damage to the glass.

THE INERTNESS of glass is one of its most important characteristics, for it is surpassed only by some of the fine metals such as gold and platinum. Glass-lined tanks are used to hold corrosive chemicals and for drugs which would be contaminated by reaction with metal. Even pumps for handling such products are lined with glass, and complete protection is guaranteed by using glass pipe. The inertness of glass also explains its use in much laboratory apparatus.

The ability of glass bottles to protect their contents has often been demonstrated, but seldom so well as by a number of beer bottles found last year on the coast of Kent, England. Part of a cargo which was wrecked in 1703, some

of the bottles remained tightly corked and wired, protecting the beer for 250 years.

With all these attributes to make it popular, glass is fortunate in the abundance of its chief ingredient. Today 90 percent of all the commercial product is made primarily of silica (sand), soda ash and lime, with most other ingredients added in minute quantities. Since silica makes up about 60 percent of the earth's crust, scarcity is not a problem.

But here again is contrast. Even though commercial glass is all so much alike, every chemical element known today can be used in making glass. As a laboratory curiosity a black glass can be made containing all the elements in the percentage of their distribution in the earth. Because of this range of ingredients, there are more than 100,000 formulas for glass, and many more still to be developed.

The transparency of glass has long been a prime reason for its popularity. It transmits light because no matter how thick it is, it acts the same as a single molecule. When molten glass cools, it does not crystalize as do practically all salts, all metals and even water. Thus there are no internal surfaces to turn aside the light, and any reflection is on the outer surfaces only.

Glass formed by volcanic action has been found in all parts of the world, and primitive man, including the Indians of the Americas, fashioned tools and weapons with it.

In Yellowstone National Park there is a mountain of this natural glass, Obsidian Cliff. Jim Bridger, the famous trapper, saw the mountain about 1830 and later told of sighting an elk in the distance but failing to hit it with his gun because the transparent glass mountain happened to be in the way. He was right about the glass mountain but stretched the facts a little on transparency. Obsidian is dark and opaque.

WHERE MAN first learned to make glass is unknown. Legend has the method discovered by Phoenician sailors on the Mediterranean shore. As their fireplace of soda blocks from the ship's cargo melted on the sand, glass was formed.

The known record shows that the Egyptians had learned to glaze stone beads as early as 12,000 B.C. The oldest piece of pure glass, a molded amulet, is dated about 7,000 B.C. An early Egyptian bowl was made about 3,000 B.C., and glass of the same period has been found in the Mesopotamian region.

The Egyptians long considered glass equal to some natural gems. A collar found in the tomb of Tutankhamen has 255 gold plaques inlaid with jasper, lapis lazuli and turquoise glass.

All man-made glass was opaque at first, for the transparent variety was developed only after glass blowing was discovered, some time before 100 B.C. Syria, which has a long history of fine glassmaking, appears to have been the first to develop this technique, but it spread rapidly to Egypt and other countries.

During the Roman period glassmaking took on new importance, for the Romans admired the material. When Augustus added Egypt to the Roman Empire in 30 B.C., he demanded glass in tribute and later had Egyptian and Syrian craftsmen migrate to Rome and its other provinces.

Glass was only for the wealthy, and Pliny the Elder observed that fine transparent glass was replacing precious metals for drinking vessels. He also told of an elaborate piece of glass which Petronius, a favorite of Nero but also his critic, destroyed rather than let the Emperor have it.

The closing of window openings with glass, as taken for granted as anything we have in our modern lives, apparently originated with the Romans in the first century A.D. One piece of glass measuring 44 by 32 inches was found in Pompeii. The Romans cast these panes on large flat stones.

IN EUROPE, glassmaking declined with the Dark Ages, but it flourished in the Near East and Byzantium. In the sixth century A.D. Justinian ordered stained glass windows for the great church in Constantinople, the Hagia Sophia.

About 1200, toward the end of the Crusades and probably as an indirect result of them, a revival of fine glassmaking arose in Europe, beginning in Venice with craftsmen brought from Syria. So respected was the industry then that its leaders were made "noble gentlemen," eligible to intermarry with the families of aristocracy. This attitude toward the craft was later transferred to France, where members of nobility could work in glass plants without losing caste, and glass workers were exempt from taxation.

About 1300, so that the trade secrets could be guarded more easily, the glass furnaces of Venice were moved to the island of Murano a mile from the city. In time this island became a fabulous, immense factory, with furnaces lining a mile-long street. Workers and their families lived on the island, and eventually it had a population of 30,000.

Glass workers were forbidden to leave Venice on penalty of death, and for years the Venetians had the European trade to themselves. But all the precautions failed to prevent migration and loss of secrets, and in time other countries were making fine glass "in the Venetian manner."

Venetian glassmaking reached its height after 1450, following discovery of a new formulation for clear glass. The Venetians excelled in blowing elaborate and intricate shapes rather than molding or cutting. They blew this glass to surprising thinness. Too sheer to stand cutting with grinding wheels, it was decorated by gilding, enameling and diamond point engraving.

One of the specialties of the Venetian factories was making of mirrors, some of them highly prized. When the French minister Colbert died in 1683, his estate included these two items: a Raphael painting valued at 3,000 livres, and a Venetian mirror measuring 45 by 26 inches, with silver frame, valued at 8,016 livres.

In the American colonies, glassmaking was the first industry to make finished products, turned out by eight glass blowers from Holland and Poland. A factory was built a short distance from the town, and Captain John Smith was later to write in his *Historie of Virginia:* "We sent home ample proof of pitch, tar, glass . . ."

But after the captain's return to England the industry waned, and a second enterprise started in 1621 also failed after a few years.

Whether made in America or in Europe, glass beads and mirrors were among the chief articles in trade with the Indians.

The most famous of American colonial glass was that made by the flamboyant Henry William Stiegel, who strove for beauty as well as usefulness in the ware he produced. His expensive tastes, both in personal matters and in glassmaking, wrecked his business and landed him in debtors prison in 1774. But by that time he had produced many fine pieces which today are collectors items.

Another important colonial glassmaker, Caspar Wistar, opened his plant 24 years before Stiegel and survived him by a few more. Wistar was noted for his magnificently colored glass. Martha Washington owned a tiny Wistar scent bottle of yellow and turquoise and carried it tucked inside her glove, the fashion of the day.

Ever since the Egyptians learned how to make bottles—first by tediously winding glass strands around a core and then fusing them together or by dipping the core repeatedly in molten glass—it has always been a leading material for containers.

Bottles could be made much faster and better by blowing, and this method, with and without molds, was used until the twentieth century. By that time semi-automatic machines for making bottles were being used, but even so, the ware was on the expensive side.

In 1903 a big step was made

with the introduction of the first automatic bottle making machine, developed by Michael J. Owens. With the rise of mass production methods, bottles could be made cheaply enough for wide general use.

Glass containers are made in sizes ranging from the ampul for holding one cubic centimeter to the ten-gallon demijohn. For protection of its contents, the ampul used for injectible drugs is about as perfect a container as can be devised, for the opening is melted shut so that nothing but glass touches the product. To make the ampul easier to open, a ceramic band is fused around the opening area, creating tensions inside the glass so that it will break easily at that point.

Although glass can be molded and blown into almost any shape of container desired, there are practical limitations. A round bottle, for example, is stronger and easier to make than a square one. The spherical shape makes the strongest bottle of all.

Today glass containers are second only to folding cartons in the number used for packaging consumer products.

Last year more than 20 billion bottles and jars and other glass containers were made, although the number actually used by industry was much larger because milk, soft drinks and beer are sold in reusable bottles.

MANY FOODS on the supermarket shelves are sold in glass. For some products there is the dictate of tradition. Last year one major food company decided to do something about the catsup bottle, which has elicted complaints for years. This company put its product into a low, squat jar with a wide mouth. And what happened? In the market test, housewives bought the jar once, then lost interest. Perhaps designers will come up with the ideal catsup bottle eventually.

Although one method of preserving food is called canning, it started with glass containers. When Nicolas Appert proved to Napoleon that food could be put into a container, sealed, heated and kept indefinitely, glass jars were used in the experiments.

One of the oldest uses of the bottle is sea duty, carrying a message and letting the ocean currents take it where they will. This technique was used as long ago as 300 B.C. when Theophrastus, a Greek naturalist, used floating bottles to prove his theory that the Mediterranean gets most of its water from the Atlantic Ocean. Benjamin Franklin used bottles to learn some of the secrets of the Gulf Stream, and the method is still used today to study ocean currents.

Following the invention of the automatic bottlemaking machine, glassmaking developed rapidly so

that today nearly all of the industry output is by methods unknown before 1900.

The United States has contributed much to glassmaking and new forms of glass. A method was developed for continuous drawing of sheet glass for windows. A ribbon-glass machine for making light bulbs came next, eventually reaching speeds up to 2,000 a minute.

In 1915 heat resistant glass was introduced, and later high silica flame-resistant glass for top-of-stove use. Items of high silica glass can be heated until cherry-red and then plunged into ice water without breaking. Safety glass was introduced in 1928, followed several years later by a new method for making glass fiber, and then building blocks and foam glass.

One of the developments after World War II was photosensitive glass which can be used for making portrait photographs and mural decorations, although it finds wider application in the field of electronics. So fine is some of the work with photosensitive glass that a screen made of it can have as many as 250,000 holes per square inch.

THE THINGS made of glass for home and industry number in the hundreds, and new ones are constantly being developed. Only a few can be mentioned here.

One of the household appliance companies has designed an all-glass oven, a hood made of two glass domes, one inside the other so that the outer one will be kept cool by the air between. The burner plate is also made of glass, 19 inches in diameter, and able to withstand the heat of four burners placed one inch below the plate.

The home of tomorrow may have variable transmission windows which can be adjusted to raise or lower the amount of light and radiant heat that enters.

Lighting panels for home and office give a soft, low intensity light when the electricity is turned on.

Gathering energy from the sun makes use of mirrors to focus the rays for raising the intensity of the heat. Where mirrors are not used, a glass pane acts as a filter to allow radiant heat to enter the enclosure of the unit and to prevent the escape of gathered heat.

These things only suggest applications of glass for the home, to say nothing of industry and science. And they suggest mere forerunners of future applications, if the progress made by glass research of the past fifty years is any measure of what it will be in the next fifty.

Women, on the average, outlive men . . . another reason why husbands can rarely get in the last word. —HAL CHADWICK

This American university is providing education to servicemen stationed all over the world

MARYLAND HAS A MILLION MILE CAMPUS!

by Stanley J. Drazek

Associate Dean, University of Maryland

TODAY the University of Maryland's campus extends over six million square miles and provides educational opportunities to United States military personnel on four continents. Maryland courses are offered at American bases nestled in the fjords of Greenland, on the desert sands of North Africa, in the intense heat of Saudi Arabia, and on the 38th Parallel in Korea.

During the 1955-56 school year, over 20,000 military students enrolled in off-duty courses with the University of Maryland. Sixty of these military students completed their programs overseas and were awarded their degrees by the President of the University of Maryland in Heidelberg, Germany.

In 1947 the Board of Regents of the University of Maryland established the College of Special and Continuation Studies, and made it responsible for providing adult educational opportunities throughout Maryland. The College officials also recognized the existence of large numbers of military personnel stationed at nearby Fort George G. Meade, the Pentagon, The Aberdeen Proving Ground, Bolling and Andrews Air Force bases. Visits to these installations revealed that military personnel were eager to avail themselves of educational opportunities. It was also discovered that military leaders recognized the value of such programs, were enthusiastic and promised full cooperation.

Pilot programs were arranged