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# THE STORY OF A BUSINESS 100 YEARS OLD

If you want to make glass, all you have to do is to mix four simple ingredients together—Sand, Soda Ash, Lime and Cullet (broken glass), heat them in a pot until they melt together, and then you have glass. Nice, glassy glass—that for any practical purpose would probably be utterly useless.

With all of your care in weighing and measuring the ingredients, with all of your precautions to have the heat just right, with all of your determination to produce a creditable batch of glass, you would of necessity miss the one all important element which makes all glass useful and some glass better than other glass. Unless you were trained over a long period of time in the intricacies of this highly specialized art, you just could not produce a batch of glass to meet the exacting standards of today's fabricating processes.

As in so many of the arts, skill in glass making comes only after years of practical experience and training. With the years comes more than a mere academic knowledge of the product—there is born that innate sense which marks the difference between the workman and the artisan, and creates instead of a process an art.

Glass manufacture is an art, practiced for nearly 2000 years—the pride of Rome, the glory of Venice. This booklet outlines briefly how it is practiced by the century-old firm of Whitall Tatum Co., in their automatically equipped plants at Millville, New Jersey.



Sand, soda ash, lime and cullet (broken glass) make glass for bottles. But do not let the simplicity of these ingredients fool you. There is a lot more to making glass as this booklet tells.

THIS booklet tells, in brief, about the manufacture of glass bottles, those objects of craftsmanship without which we could hardly live, yet which we so thoughtlessly use and cast aside when empty.

But before taking up the interesting modern automatic processes, it will bring about a better appreciation of what a wonderful thing a glass bottle is, if we quickly review the long and slow evolution of glass production from the first crude glass beads and bottles of the Egyptians, to the beautifully designed bottles of today.

If the Hebrew translations are to be trusted, then the first crude glass was made by Tubal-Cain, the eighth man after Adam. A different and more likely version of this first glass legend is the story of the Phoenician merchants who had landed on the coast of Palestine, near the point where the Belus River emptied into the Sea of Judea. These men had set up camp and were getting ready to prepare their evening meal when they found that there were no stones on which to place their cooking utensils. They had several cakes of nitre with them which they decided to use. When these cakes were placed over the fire, the action of the heat on the nitre with the sand from the beach and the potash from the ashes formed a transparent liquid which was glass. This was supposed to have taken place about 3500 B.C.

The Egyptians were the first to become real artists in glass making. So well developed was this trade



The early Egyptians knew the art of glass manufacture. There was but little change in their crude methods until almost the dawn of the twentieth century.

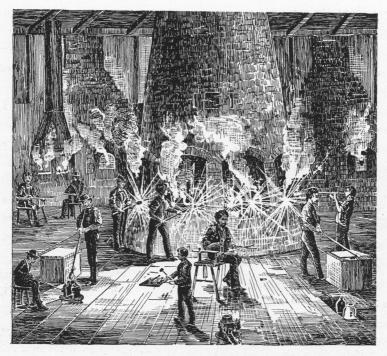
that when Augustus Caesar took the country in 26 B.C., he ordered that glass be a part of the tribute imposed upon them as a vanquished nation. The Roman people were so pleased with it that soon orders began pouring into Egypt for more and more glass objects. In 14 B.C., Egyptian glassworkers were lured to Rome. Quickly, the Roman artisans not only learned the trade, but improved upon it to such an extent that they soon became the leaders in the world in this industry. Glass goblets took the place of the gold and silver drinking cups which had been used for state dinners, glass imitations of gems and cameos were turned out in large numbers, and even glass replicas of foods were made.

With Middle Ages, the glass trade moved first to Constantinople, and from there back to Venice, Germany, Bohemia, France, Belgium, and England.

The first manufacturing enterprise in North America was the glass factory built in Jamestown, Virginia in 1608. This was a bottle factory built in the woods about a mile from the settlement. In 1683, another glass factory was mentioned in a letter from William Penn to the Free Society of Traders. Other factories were built along the Atlantic coast during the next two centuries, with the Middle West and West following as the territories were developed. In 1806, the first glass factory was erected in Millville, New Jersey. On this same site, one of the Whitall Tatum factories now stands.



In the early Eighties, the best freight route between Millville and New York or Philadelphia was via water. This drawing shows a Whitall Tatum schooner at the factory wharf, being loaded with glass products.



Reproduction of an early glass furnace from a Whitall Tatum catalogue of 1879.

T was not until 1900 that automatic machinery can be said to have made any appreciable effect on glass production. Until that time, the same basic methods as used by the ancient Egyptians were, in the main, still in use. In the past 35 years, more progress has been made than in all of the centuries preceding.

Up to about 1865, each glass blower worked alone, at the main furnace,

doing both blowing and finishing. The desired quantity of molten glass was gathered from the furnace on the end of a hollow rod called a "blow pipe." The skilled eye of the workman was the only guide to the quantity. The glass was then rolled back and forth on a flat metal plate or stone, to partially shape the glass for the making of the bottle. This was called "marveling." While this was being done,

air was blown through the pipe into the glass, making it ready for finishing.

The finishing was accomplished by placing the still molten glass in a clay mould, and blowing it to the size determined by the mould. The shoulder and neck depended upon the skill of the blower.

Now, the partly finished bottle, still adhering to the blow pipe, was withdrawn from the mould, and the end of a heated rod was stuck to the bottom of the bottle. The blow pipe was then detached, and the unfinished bottle was reheated to become plastic again. The excess glass was then sheared off, and hand tools were used to shape the neck and flare of the mouth.

In 1865, the so-called "glory hole" was introduced, and blowers began

to work in groups of three—two to blow and one to finish. The first glory-hole was a miniature furnace, and four or five gaffers or finishers worked around this glory hole. Additional boy help was required, including two snapping-up boys to each shop or group, the so-called "snapping-up" boys taking the bottles as they came from the moulds, and putting them in a form called a "snap" which was used to hold the bottle at the glory hole to heat the neck for finishing.

One or two gaffers or finishers worked at this improved glory hole, which reduced considerably the boy help required, and only one snapping-up boy to a shop was required. About 1880, the oil heated "glory hole" came into existence. This was one of the first steps toward automatic glass bottle manufacture.

If, as has been proved time and again, experience and skill make the best bottles, then the record of employment in the Whitall Tatum Company plants has a deep significance. To pick at random from a record of 100 years in the business of bottle making, in 1916, the Company had 32 men on the payroll who had served 44 years or more. They started at the average age of 11. Samuel Berry completed 72 years with the Company in 1934.

THE ideal glass would be made of pure sand. But as pure sand cannot be melted, other elements must be added. Soda ash will melt the sand, but forms a silicate which is soluble in water. Hence, additional ingredients must be used. Limestone and feldspar give the needed resistance to weathering and the action of water. Cullet, or waste glass, is added both to regain the waste and to improve the working qualities of the mixture, while borax reduces the coefficient of expansion and makes the finished product better able to stand temperature changes. Barytes cleans the glass and gets rid of all gases, while various decolorizers are used to neutralize anything which might keep the glass from being clear and white.

The ingredients of glass vary with the color desired. All glass contains sand, soda ash, cullet, feldspar, borax and barytes. In addition to this, flint glass contains burnt dolomite lime,



Sand is the principal ingredient in bottle manufacture. Many kinds of sand are used by different manufacturers because of necessity. But it is generally accepted that the very best deposit of bottle sand is only three miles from Millville, N. J., and is owned by Whitall Tatum Company. Above you see part of the pit, the sand being dredged out by hydraulic machinery and pumped to the cleaning and storage sheds. Operators watch for prehistoric bones buried here. Also for "lightning canes" made by lightning striking the sand and fusing it into a crude glass.

arsenic, and two decolorizers. When green glass is wanted, limestone is used. Both amber and emerald green glass consist of the same materials as the green batch, but to the amber, coke, charcoal, manganese, ferric oxide, sulphur and salt must be added, while the emerald green is completed with coke, sodium bichromate and cobalt.

Glass melts at a temperature of from 2500 to 2700 degrees Fahrenheit. During the melting and refining processes, constant watchfulness is required. One problem is to keep the coarser elements from separating from the finer ones in the batch. Another is that of the viscosity of the molten glass. This is kept at the proper point by keeping the temperature at approximately 2000 degrees with the aid of an optical pyrometer. At this temperature it is at the proper consistency to be fed from the feeder into the machines.



Here is one of the warehouses in which Whitall Tatum Company bottles are stored pending shipment. The storage capacity runs into millions of bottles, Dry storage is an unusual but necessary feature in bottle manufacture, for long ago, we discovered that glass subjected to the elements tends to deteriorate. Strangely enough, moisture is particularly to be avoided. Gasoline and electric tractors fly in and out of these long aisles, stocking fresh supplies or carting them away to the nearby rail siding.

A reproduction of a steel engraving of our plant during the Civil War days. The ageold methods of glass making was in vogue here. Mechanization of the processes did not start until the dawn of the present century.







N 1836, Andrew Jackson was the seventh President of the United States. The Alamo Massacre shocked the world, and "remember the Alamo" became the slogan of a war. At Millville, New Jersey, the firm of Scattergood, Booth & Co., from which Whitall Tatum Company sprung, started the production and fabrication of green glass. Wars and depressions have come and gone and been forgotten. The name Whitall Tatum Company has become impressed on the business world as a leader in its industry.

The illustrations on this page show the visible difference brought about by 100 years of vigorous business leadership. They do not show, however, the ten decades of accumulated knowledge of the intricate art of glass fabrication. From a hand operated plant burning wood for heat, it has become a modern mechanized one using gas for fuel.

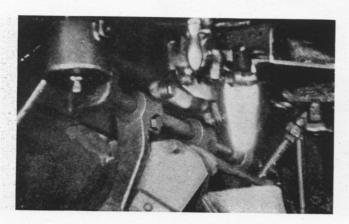


Air view of the two Whitall Tatum plants at Millville, N. J., as they appear today. In the picture on the left can be seen the immense under cover storage facilities.



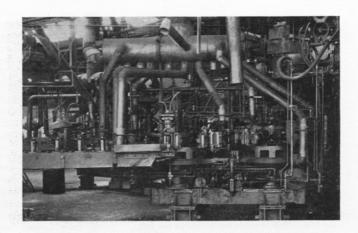
The sand, the soda ash and the other ingredients which go to make bottle glass are as carefully mixed as a housewife's cake. Only, of course, the measure is by the ton instead of by the ounce. Then it goes into the furnace, the mouth of which is shown here. It takes over 2500 degrees of heat to melt this mixture.

A COMPLETELY automatic bottle making machine works like a man. A mechanical feed which allows just the right amount of molten glass to enter the first mould might be likened to gathering glass on the end of a blow pipe in the old hand method. When pressed into rough shape in the first mould, it is automatically conveyed into the finishing mould, where compressed air, corresponding to the old fashioned lung power, blows it into finished form. Again, mechanical hands lift the bottle, now fully formed, on to a conveyor, whence it travels through the annealing process in what is known as a lehr, and becomes a finished product. Simple as this operation is to describe, it depends upon



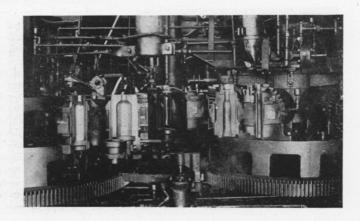
After the batch is thoroughly melted gobs of glass are automatically released and dropped into a funnel which leads to the rotating moulds on the bottle machine. Each mould as it passes the funnel is supplied with the right quantity of molten glass.

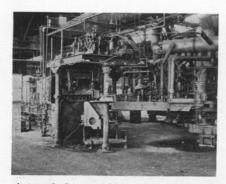
Here is one of the most amazing machines in modern industry. Entirely automatic in operation, it produces 72 finished bottles every minute. You can see them on the conveyor, leaving the machine and on their way to be annealed in the lehr.



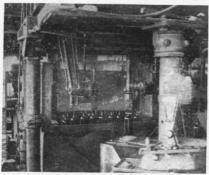
absolute timing to make it work. There are up to a dozen sets of moulds in the circumference of one of these machines. Each set of moulds has to receive its proper allotment of molten glass, press it and transfer it to the companion mould to be blown and discharged on to a conveyor. When it is realized that these machines make as high as seventy-two bottles a minute, it is easy to realize that precise timing is the essence of the operation. It should also be realized that with a machine of this intricate nature, once started it should be kept in constant operation for a considerable period of time. Hence the necessity for a continuous supply of molten glass and the continuous furnace.

This close-up of the above machine shows the transfer of a partially formed bottle from the blank mould to the blow mould on the left. This mould will immediately close over the bottle, compressed air will be applied, and the bottle blown into its final shape.

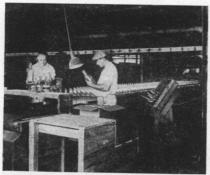




Automatic fingers pick the finished bottles off the conveyor and place them in exact positions in the lehr. The complicated overhead machinery accounts for the exact spacing in the lehr which streches away toward the left.



These steel fingers (close-up of above) space the bottles in the lehr. Accurate spacing means accurate cooling. Bottles pass through the lehr in about three hours.



Then as the bottles leave the lehr they are closely inspected and packed by experts. The bottle on the scale is to test the weight.

THE next time you are in the country, look at a telephone or electric power pole, and you will see a number of glass forms fastened to the arms and to which wires are attached. These are insulators, probably made by Whitall Tatum Company, for this company has been prominent in the development and production of these very useful and essential aids to wire transmission.

Insulators are made on completely automatic machines, except that they are pressed only and not pressed and blown, as with bottles. The operation calls for a set of moulds where a thread is pressed inside. Again, automatic hands remove the fully formed insulator and place it on a conveyor, whence it travels through the lehr, is annealed, cooled, and delivered to be packed and shipped.

The lehr performs a very important function in the manufacture of glass bottles. Bottles are put into the lehr at a temperature of from 1050 to 1075 degrees Fahrenheit, and before they have had time to set up strains from uneven cooling. In the lehr, they are cooled so gradually and evenly that no strains are present in the finished product, which is taken out at room temperature.

Before the mechanical lehr was invented box-like ovens of fire brick were used. When these were heated to the proper temperature, they were filled with bottles and sealed. They then cooled gradually and gave the proper annealing in three days, as compared with two or three hours now required.

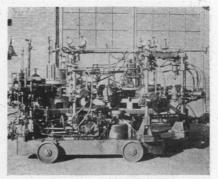
At the cold end of the lehr, each bottle is examined thoroughly for common defects such as marks, shrends (fine cracks), blisters, and splits. The sorter must weigh the bottles every so often to see that they are the proper weight, and he must make sure as well that each bottle is the right shape and is fully blown. Any of these faults would make the bottle unfit for commercial use. There is also a laboratory in which tests are made throughout twenty-four hours.

There is, in addition, a hot and cold water test for bottles which are specially processed, such as bottles for beers, beverages, and catsups. This test is applied until the bottle is broken, which usually takes place at seventy to ninety degrees Fahrenheit. There are few commercial bottles which can stand more than ninety degrees shock.

There is also a pressure test for all bottles, the pressure being applied until the bottle breaks. This usually occurs at seven hundred and fifty pounds per square inch, the normal pressure being from three hundred and fifty to four hundred pounds. Ring sections of the bottles are cut and examined under a microscope for strain and cord (hot and cold streaks in the glass), which can be seen in this way alone. The bottles are then graded for these defects, those falling under the classes A, B, and C being salable, while those with a D rating are unfit for use.

After the bottles have come from the lehr and have been sorted and tested. they are placed in four different types of packages. A few bottles are still packed in wooden crates, but most of the ware is shipped in some kind of carton. There are testboard corrugated cartons, fibre board cartons which are also testboard, and city delivery package which is the same type as the testboard material except that it is nontest. There is another type known as the crate substitute in which the bottles are placed with little or no packing, the principle being the same as the old wooden crates.

Once the bottles are placed in the cartons, they are run through a machine which seals them at either or both ends as the customer may specify. They are then taken to the warehouse and either shipped at once or stored. All ware at the Whitall Tatum factories is stored in modern warehouses, covering several acres, which protect the packages from the weather.



This is an automatic bottle machine, without the elaborate compressed air connections or the traveling belt which takes completed bottles to the lehr.



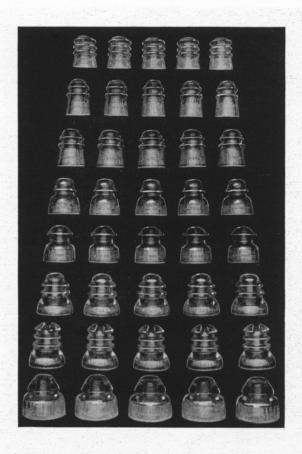
So many things can happen to a bottle in the process of manufacture that constant inspection is the only safeguard. This inspection is for strains and stresses which weaken the glass.



Bottles are first produced in wood. These models not only foretell how the glass bottle will look, but guarantee the exact content of the finished product.



Some of the recent bottles made by Whitall Tatum Company.





As you ride along in a train, watch the telephone and telegraph wires alongside of the road. You will notice that at every pole the wire is supported on a cross arm with glass insulators to bind the wire to. These insulators conserve current. They must be of an exceptionally durable glass to withstand the extremes of heat and cold to which they are subject. Whenever you see these glass insulators, glistening in the sun, think of Whitall Tatum Company, because for generators we have made them by the tens of thousands for use all over the country.



Whose Business is the Manufacture of Glass Containers and Insulators

