GLASS MANUFACTURE AND DECORATION

Raw materials

Following are the raw materials.

* 1. Sand: Forms acidic part of glass
* 2. Soda ash: Forms basic part of glass
* 3. Sodium nitrate: Accelerates melting
* 4. CaO: Forms the basic part of glass.
* 5. Silica: Forms acidic part of glass.
* 6. Barium sulphate: remove impurities in the form of scum.
* 7. Feldspar: Retards de-vitrification.
* 8. Potassium oxide: Used as a softening agent.
* 9. Borax: Increase hardness or refractive index.
* 10. Boric oxide: Improves chemical or corrosive resistivity.
* 11. Phosphoric oxide: To impart bright appearance.
* 12. Lead oxide: Increases insulation.
* 13. Selenimum: Used as decolorizer.

Manufacturing process

* **FOLLOWING ARE THE STEPS FOR THE MANUFACTURING OF GLASS:**
* 1. MELTING:
* 2. SHAPING AND FORMING:
* 3. ANNEALING:
* 4. FINISHING:

MELTING:

* Based on the type of the glass suitable glass manufacture materials are selected. Raw materials are reduced in size by crushing and grinding. Raw materials are now subjected to melting in furnace.

1. **POT FURNACE.**
2. **TANK FURNACE.**

1. **Pot furnace:**

* For special glasses like optical glass. Raw materials are melted in pot furnace made of ceramic material capacities varying from 1-2 tons and is used for small production batches.

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2. TANK FURNACE:

* Molten glass is obtained by melting the raw materials in 1350-1400 ton capacity regenerative tank furnace and can be used in continuous processes. During melting of raw materials various reactions occur at various temperatures.
* **Chemical reactions :**
* **$Na_2CO_3 + aSiO_2 \longrightarrow Na_2O.aSiO_2 + CO_2$**
* **$CaCO_3 + bSiO_2 \longrightarrow CaO.bSiO_2 + CO_2$**
* **$Na_2SO_4 + cSiO_2 + C \longrightarrow Na_2O.cSiO_2 + SO_2 + CO$**

Cont.

* **SHAPING OR FORMING**
* Glass may be shaped by either machine or hand molding. The outstanding factor to be considered in machine molding is that the design of the glass machine should be such that the article is completed in very few seconds. During this relatively short time the glass changes from a viscous liquid to a clear solid. The design problems like flow of heat, stability of metals, and clearance of bearings should be solved.
* **Fourcault process :- window glass**
* **• Colburn process :- window glass**
* **• Continuous automatic process :- plate glass**
* **• Float process :- float glass**
* **• Glass blowing :- bottles, light bulbs, tubing**

Cont.

ANNEALING:

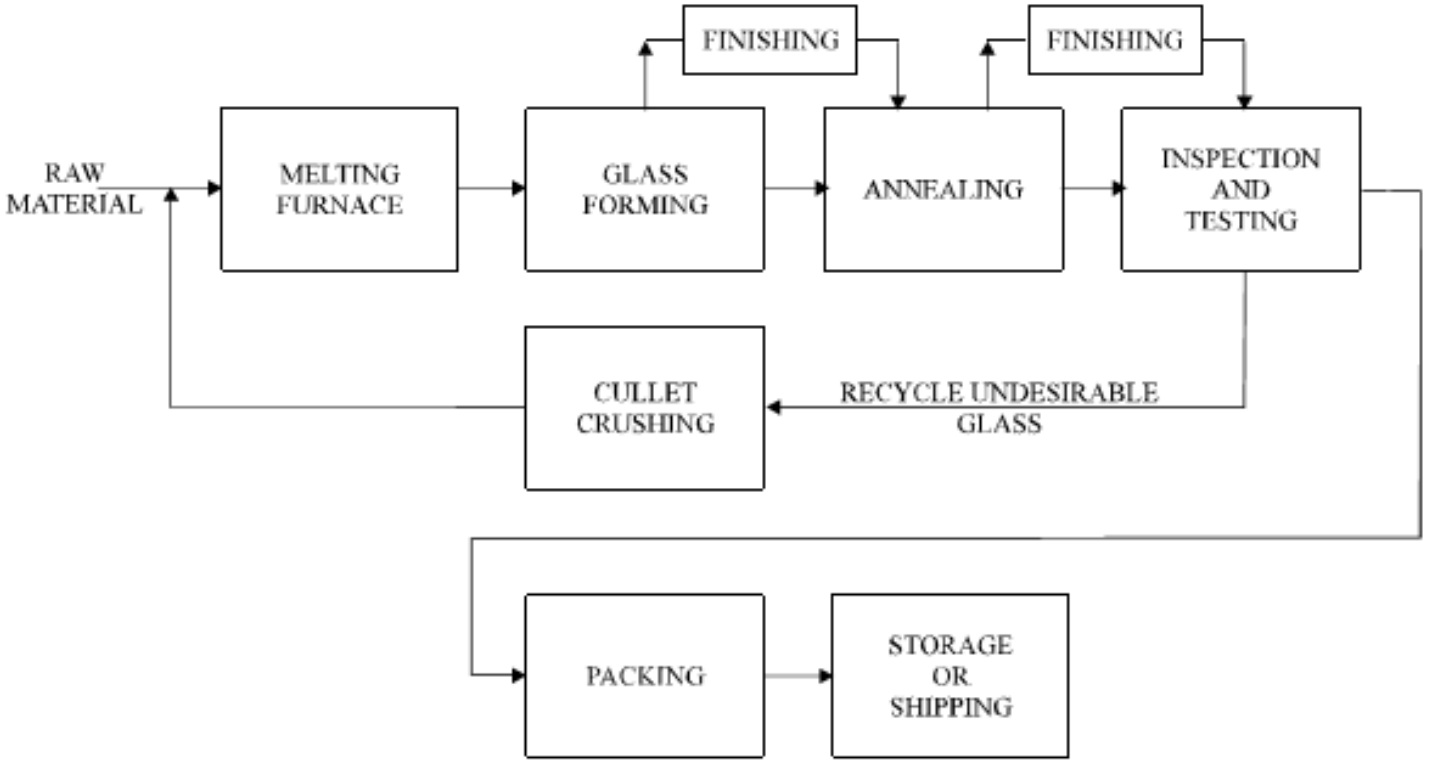
* When glass cools from the forming range to room temperature , thermal stresses develop that adversely affect strength properties.
* Annealing is done to eliminate this stress.
* Involves heating the glass to annealing range, holding it there for a period of time, and then cooling it slowly to room temperature.

Cont.

FINISHING:

* All types of annealed glass must undergo certain finishing operations, which are simple and important. These include:
* • Cleaning.
* • Grinding.
* • Polishing.
* • Cutting.
* • Sandblasting.
* • Grading etc.
* Although these are not required for every glass object, one or more is almost necessary.

Block diagram for glass producing



Fourcault process

* The **Fourcault process** is a method of manufacturing flat glass. First developed in Belgium by Émile Fourcault (1862–1919) during the early 1900s, the process was used globally. Fourcault is an example of a "vertical draw" process, in that the glass is drawn against gravity in an upward direction.[Gravity forces influence parts of the process.

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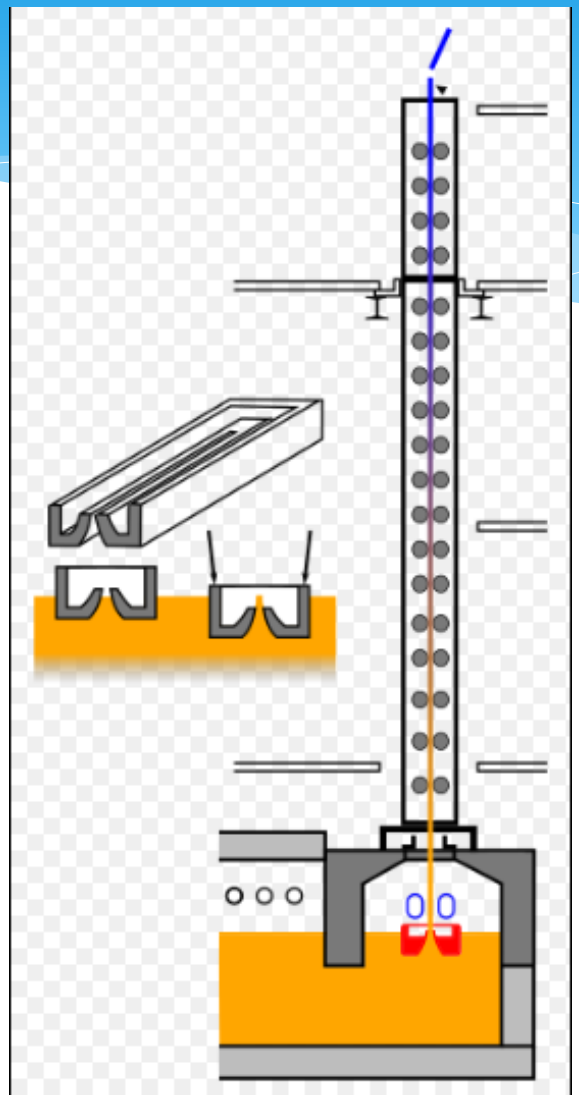

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* The Fourcault process requires a "pit" or drawing area and an assembly of machines to draw up the ribbon of glass while performing actions upon it that ensure desired quality and process yields. Today most glass manufacture has a "hot end" where the products are made. Fourcault is no exception.
* The action in Fourcault happens "at the draw", or area where the glass is taken from a liquid state into the start of the process needed to make it into flat glass.
* The Fourcault Process uses a ceramic die to shape fused (or molten) glass into a ribbon of rectangular cross section. The die, known as a Debiteuse, floats in the molten glass inside of the pit to a prescribed depth which slightly pushes a part of the molten glass slightly above the top surface of the die. A slot is cut through the center of the Debiteuse, which is shaped to produce the best quality of glass.

Colburn process

* In Colburn's process, the production of sheet glass using began with an iron rod as “bait” immersed lengthwise in a shallow tank of molten glass. This caused some glass to stick to the rod, where upon an electric motor pulled the rod, drawing a ribbon of glass horizontally over a set of rollers which roughly formed a flat sheet of glass as it continued to be drawn out of the molten reservoir. Its width was controlled by water-cooled side rollers as it approached a flattening table. In the next stage, the glass sheet passed through an annealing oven supported on a train of asbestos-surfaced rollers. The final step was to cut the work into plate glass sheets of the required size.
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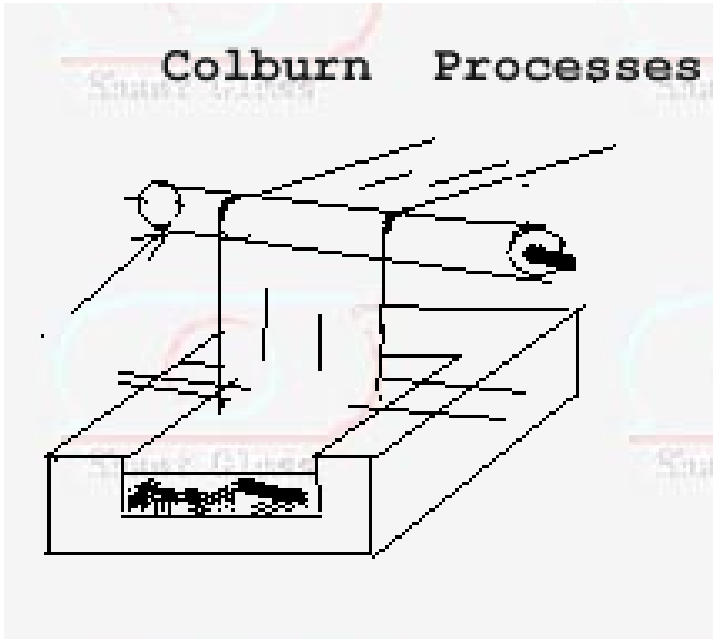

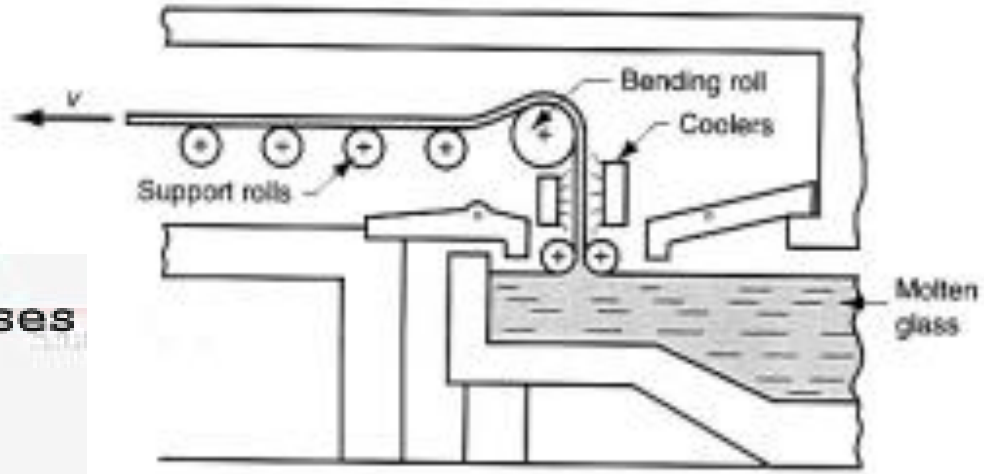

Colburn process

Float process

* The Float Glass Process is used to make high-quality, flat glass for the construction and automotive industry. Developed in 1959, this highly-technical manufacturing process involves .
* In the float glass process, a continuous strip of molten glass, heated to more than 1000 degrees Centigrade is poured from a furnace on to a large shallow bath of molten metal, usually tin.
* The glass floats and cools on the tin and spreads out to form a flat surface. The speed at which the controlling glass ribbon is drawn determines the thickness of the glass. The glass is now perfectly flat and parallel.
* Rollers are used across the top of the glass, pulling or stretching it out to achieve a thinner finished product.

Cont.

* As the glass continues through the process, it begins its cooling down phase. To complete this, the temperature is slowly cooled from 1100 degrees Fahrenheit to 200 degrees. This temperature change is accomplished in the length of approximately 800 feet.
* After the glass is cooled, it is trimmed down and any excess glass removed. These glass remains are re-used as glass cullet in later batches.

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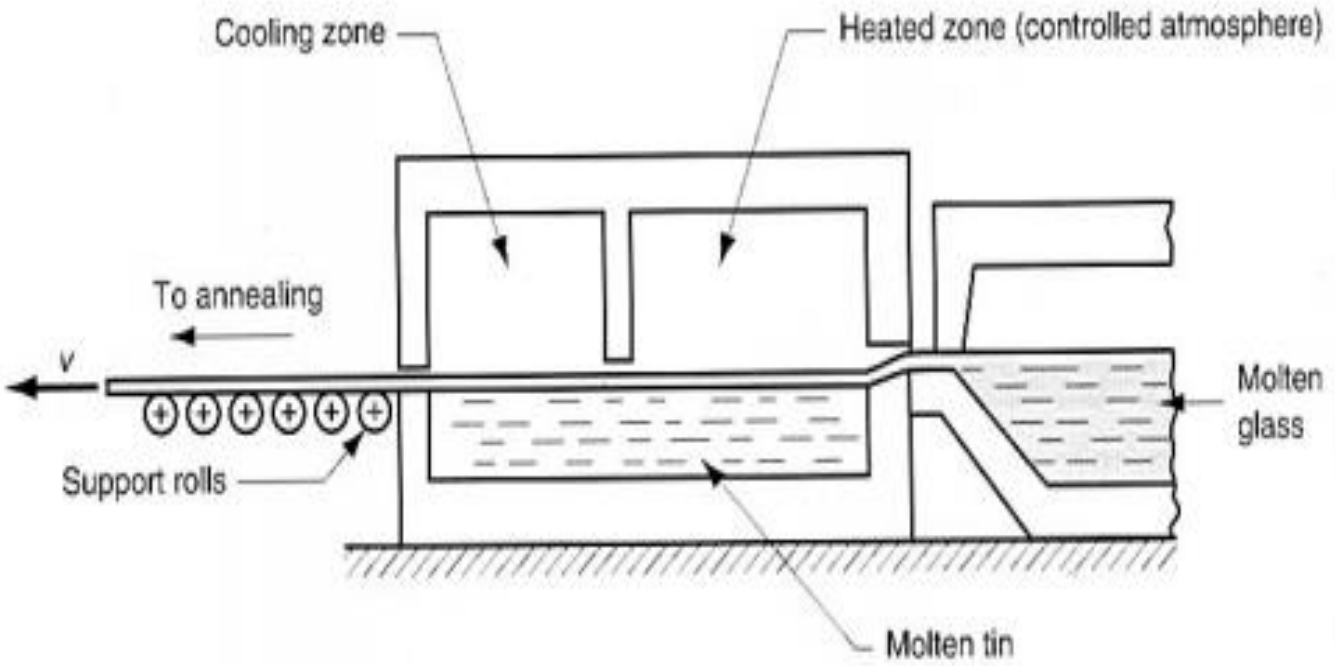

The float process for producing sheet glass

Glass blowing

* The blowing process is used to make thin-walled hollow glass items, such as bottles and glass containers.
* There are currently two primary methods of making glass containers: the *blow and blow* method for narrow-neck containers only, and the *press and blow* method used for jars and tapered narrow-neck containers.
* In both methods, a stream of molten glass at its plastic temperature (1,050–1,200 °C [1,920–2,190 °F]) is cut with a shearing blade to form a solid cylinder of glass, called a *gob*. The gob is of predetermined weight just sufficient to make a bottle. Both processes start with the gob falling, by gravity, and guided, through troughs and chutes, into the blank moulds, two halves of which are clamped shut and then sealed by the *baffle* from above.

Cont.

* In the *blow and blow* process, the glass is first blown through a valve in the baffle, forcing it down into the three-piece *ring mould* which is held in the *neckring arm* below the blanks, to form the *finish*. The term "finish" describes the details (such as cap sealing surface, screw threads, retaining rib for a tamper-proof cap, etc.) at the open end of the container. Then compressed air is blown through the glass, which results in a hollow and partly formed container. Compressed air is then blown again at the second stage to give final shape.

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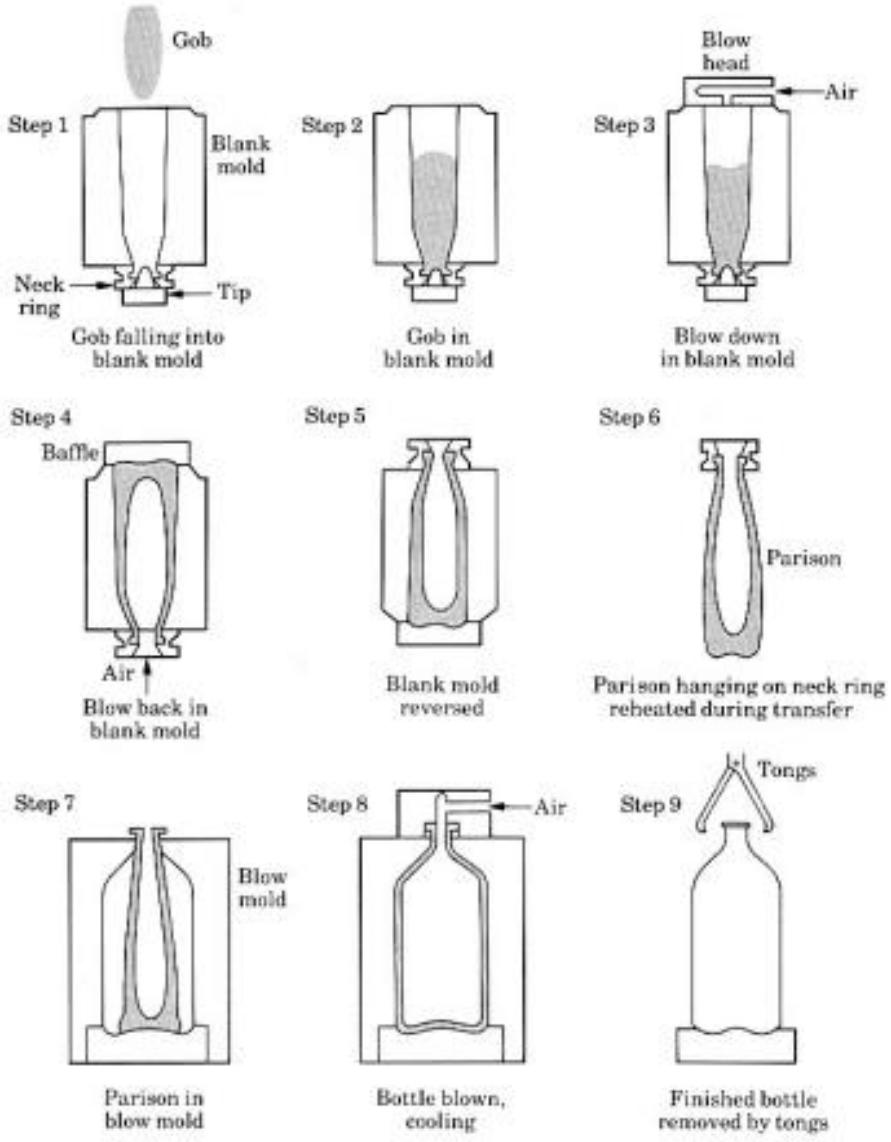
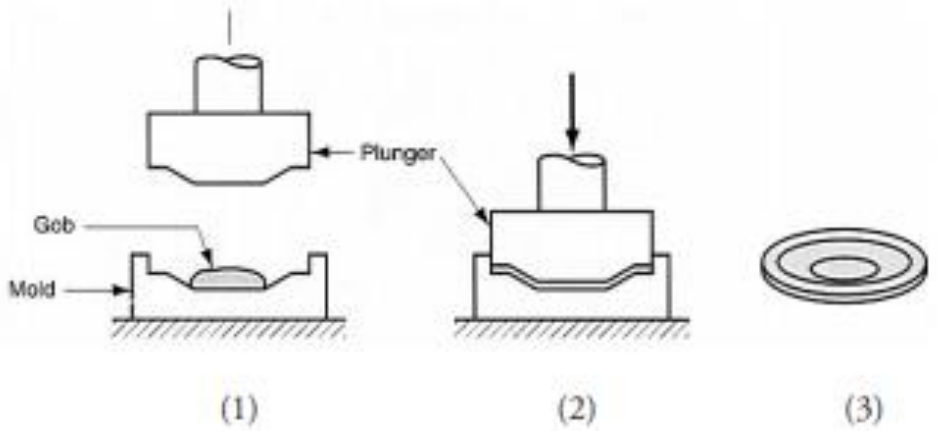


Stages in manufacturing an ordinary glass bottle

Pressing

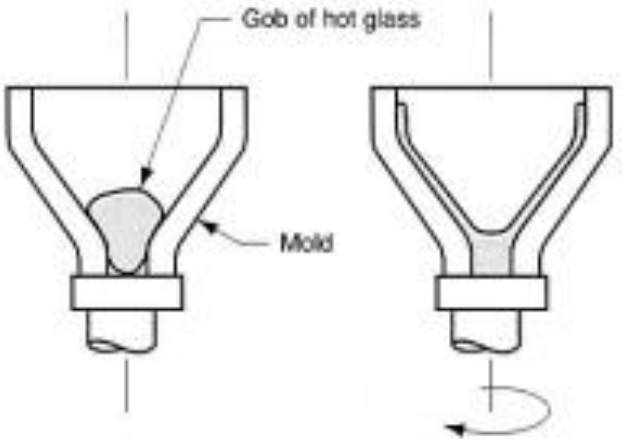
* Pressing is a process for mass production of relatively flat items, such as dishes, bake ware, lenses, TV tube faceplates (the faceplate is assembled to the funnel using a sealing glass of low melting point).



Pressing of a flat glass piece: (1) gob of glass fed into mold, and (2) pressing, and (3) finished product

Spinning

* Spinning is similar to centrifugal casting. It is used to produce funnel-shaped components such as tubes for televisions and computer monitors.



Spinning of funnel-shaped glass parts: (1) gob of glass dropped into mold, and (2) rotation of mold to cause spreading of molten glass on mold surface

Danner process

* This process is used for glass tubing.
* In the Danner process, the molten glass runs from the feeder as a belt onto an obliquely downwardly inclined, rotating ceramic hollow cylinder, the Danner pipe. Through the hollow pipe, compressed air is blown to prevent the glass tube from collapsing. At the tip of the pipe the so-called drawing onion is formed, from which the glass tube is drawn off in the free sag on a horizontal pulling line.
* If the drawing speed is kept constantly, an increase in the blow pressure causes larger diameters and smaller wall thicknesses; With this method, tube diameters between 2 and 60 mm can be made.

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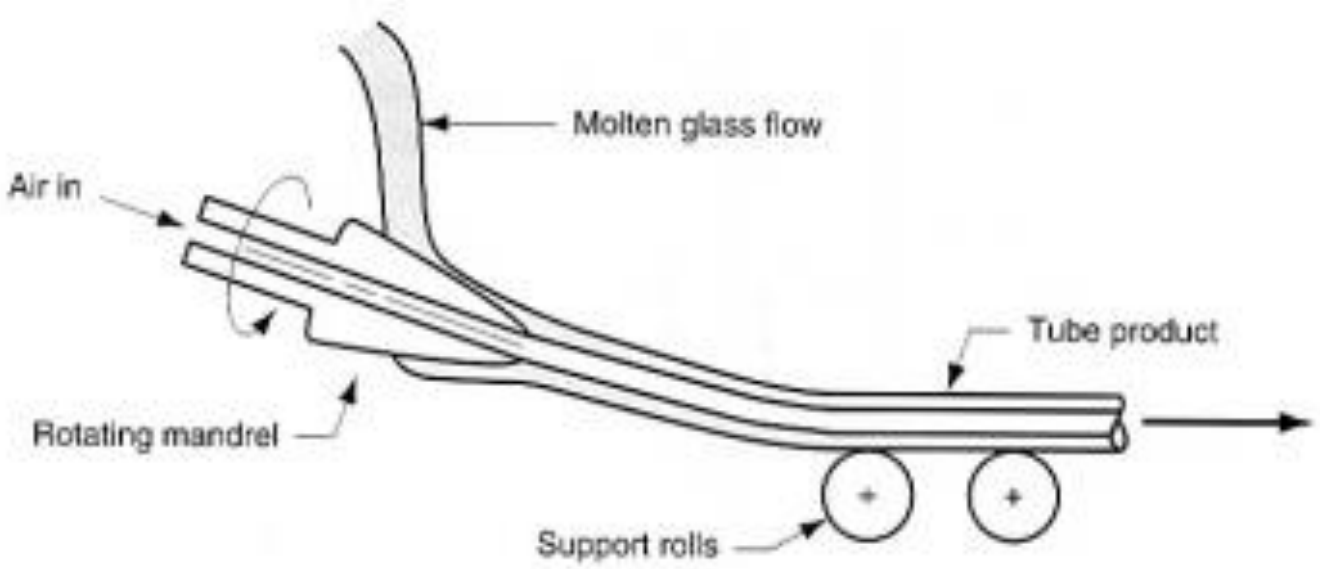

Drawing of glass tubes by the Danner process

Optical Glass Manufacturing

* **Crown glass** is a type of optical glass used in lense and other optical components. It has relatively low refractive index (≈1.52) and low dispersion. Crown glass is produced from alkali-lime silicates containing approximately 10% potassium oxide and is one of the earliest low dispersion glasses.
* Potassium and lead silicates are used in making optical glass. It is also called **flint glass**. The main use of **flint glass** is in the manufacture of **lenses**, prisms and other optical instruments.
* The melted **glass** is annealed and turned into various shapes, such as blocks, bars, and plates.
* **Glass** parts containing bubbles and stiare are removed from the **glasses**. Each **glass** block is checked by visual inspection. A high level of skill is required for the inspection to detect uniformity in **glass**.

Ophthalmic Glass

* The glass similar to optical glass but annealed in rolled sheets and used primarily for spectacle lens.
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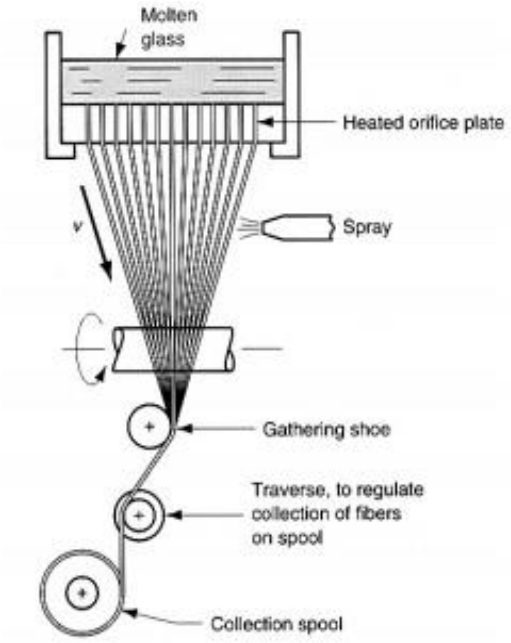
PRODUCING OF GLASS FIBERS

* This process is used to produce continuous glass fibers of high quality and small diameter used in fiber-optics communication lines.
* The fiberglass is suitable for insulation.



Drawing continuous glass fibers