The "why" of it

You boys who have the Gilbert set on "Hydraulic and Pneumatic Engineering" will know the "why" of the last three experiments. Any body floats in water if it is lighter than an equal volume of water. Water is practically incompressible but air is very compressible: thus when you press down on the stopper, you force water into the balloon and compress the air in it; when you release the stopper, the compressed air in the balloon expands and drives the water out. When the weight of the balloon and the weight of the water in it are together greater than the weight of water displaced by the balloon, the balloon sinks; when they are less, it rises.

FIG. 16

DRAWING A THIN TUBE

Experiment 10. Fun with thin tubes.

Hold a piece of No. 2 tubing in the lamp flame and turn it constantly. When it is red hot and soft, **take it out of the flame** and pull your hands apart until the tube is stretched ten or twelve inches (Fig. 16). is the tube in the shape shown in Fig. 17?

FIG. 17

A GLASS TUBE STRETCHED

Allow the tube to cool, break the large ends away from the thin tube, place one end of the thin tube in a glass of water, and blow into the other end to make air bubbles in the water (Fig. 18). If you can do so, it is a real tube.

Does the thin tube bend easily and does it spring back when released?

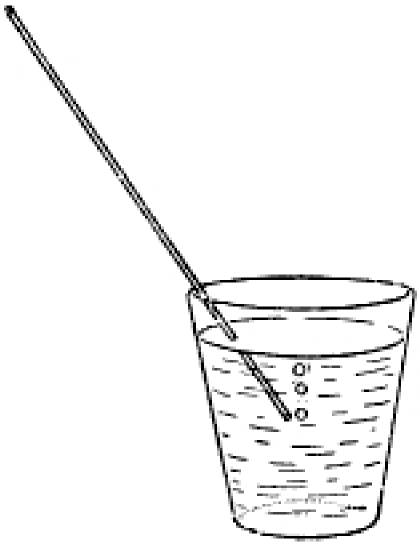

FIG. 18

AIR THROUGH TUBE

Repeat the experiment with another piece of No. 2 tubing, but make the thin tube as long as you can.

Can you blow air through the thin tube, and does it bend very easily indeed?

Repeat with a piece of No. 4 tubing.

These thin hairlike tubes are called "capillary" tubes, meaning a hair.

Experiment 11. Magic.

You have always heard that water runs downhill, but you will now see it run uphill and remain there in a most magic manner.

Cut off 5-inch lengths of No. 6, No. 4, and No. 2 tubing, stand them side by side in a glass full of water (Fig. 19), and move them up and down in the water to wet the inside of the tubes.

FIG. 19

WATER RUNS UPHILL

Now look at the water level in each of the tubes. Is it above the level of the water in the glass, and is it higher the smaller the inside diameter of the tube, that is, is it higher in the No. 2 than in the No. 4, and in the No. 4. than in the No. 6?

Now take the thin capillary tube which has the largest inside diameter, place one end in the glass of water, suck it full of water and blow it out. Now with one end in the glass of water notice quickly how the water rises inside the tube. Does it run **uphill** in a most magical manner (Fig. 20), and does it remain there?

Repeat this with your other capillary tubes. Does the water run uphill in each, and does it rise higher the smaller the inside diameter of the tube?

The "why" of this is explained in Gilbert's "Experimental Mechanics" under "Capillarity."

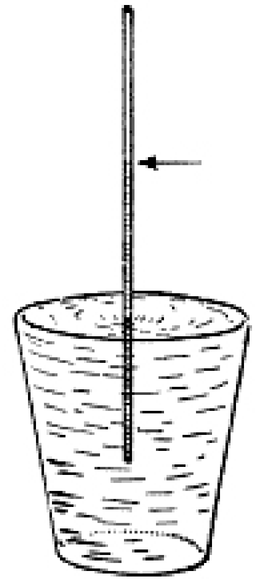

FIG. 20
WATER RUNS
UP TUBE

WHAT IS GLASS?

Common glass is made from three substances with which you are all more or less familiar; namely, sand, sodium carbonate (washing soda), and lime.

If sand and soda or potash are mixed and heated to a high temperature, they will melt together and produce a glass which dissolves in water. This is known as "water glass" and it is used in many ways: to preserve eggs, to cement fire bricks, to make fireproof cement, and so on. If, however, lime is added and the mixture is heated to a high temperature, a glass is produced which is not soluble in water. This is the glass you know.

The three more common kinds of glass are: Venetian glass, made from sand, soda, and lime; Bohemian glass, from sand,

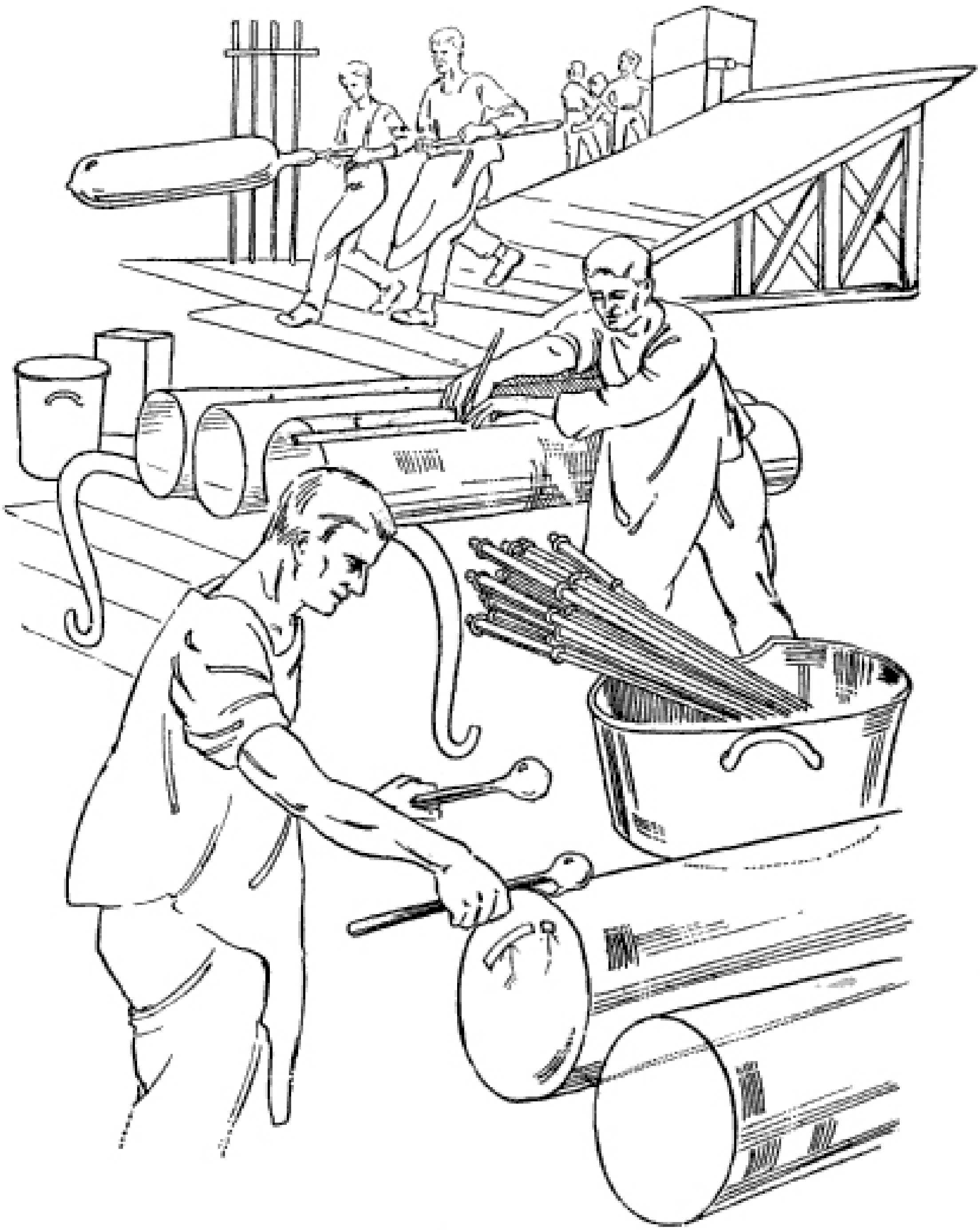

FIG. 21

SECOND STEP IN MAKING WINDOW PANES

potash, and lime; and crystal or flint glass, from sand, potash, and lead oxide.

FIG. 22

IRONING THE CYLINDERS FLAT

HOW ARE THINGS MADE OF GLASS?

The mixture is heated to a high temperature in fire clay pots or tanks in large ovens. The surface is skimmed from time to time and the heating is continued until all air bubbles have escaped from the mixture, usually about three days.

The glass is now quite fluid and it is allowed to cool somewhat until it is viscous; then the objects are made by blowing, pressing, or rolling, as described below.

The finished articles are finally "annealed," that is, they are placed while still hot in a second hot oven, which is then sealed and allowed to cool slowly, for four or five days or for as many weeks, according to the kind of glass.

If the glass objects cools quickly, it cools more rapidly on the surface than in the interior. This produces a condition of strain in the glass and the object may drop to pieces when jarred or scratched. This condition of strain is avoided by allowing the objects to cool very slowly, that is, by annealing.

WINDOW GLASS

Window glass is blown in exactly the same way as you have blown glass balloons; the process is illustrated in Fig. 1.

The glass mixture is heated for about three days in fire clay pots and is allowed to cool until it is viscous. The glass blower then attaches a lump of the viscous glass to the end of a straight iron blowpipe about five feet long and blows a bulb. He then reheats the glass and blows a larger pear-shaped bulb and in doing so rests the glass on a pear-shaped mold of charred wood (see center of Fig. 1). He again reheats the glass, holds the pear-shaped bulb over a pit, and blows a long cylinder (see left of Fig. 1).

The ends of the cylinder are now cut off and the edges are smeared with molten glass to prevent splitting (see right, Fig. 21). The cylinder is next cut lengthwise with a diamond (center, Fig. 21), and is placed in a second hot oven, where it is ironed out flat (Fig. 22).

The flat sheets are finally annealed in a third oven for a number of days and are then cut into panes, sorted, and packed.

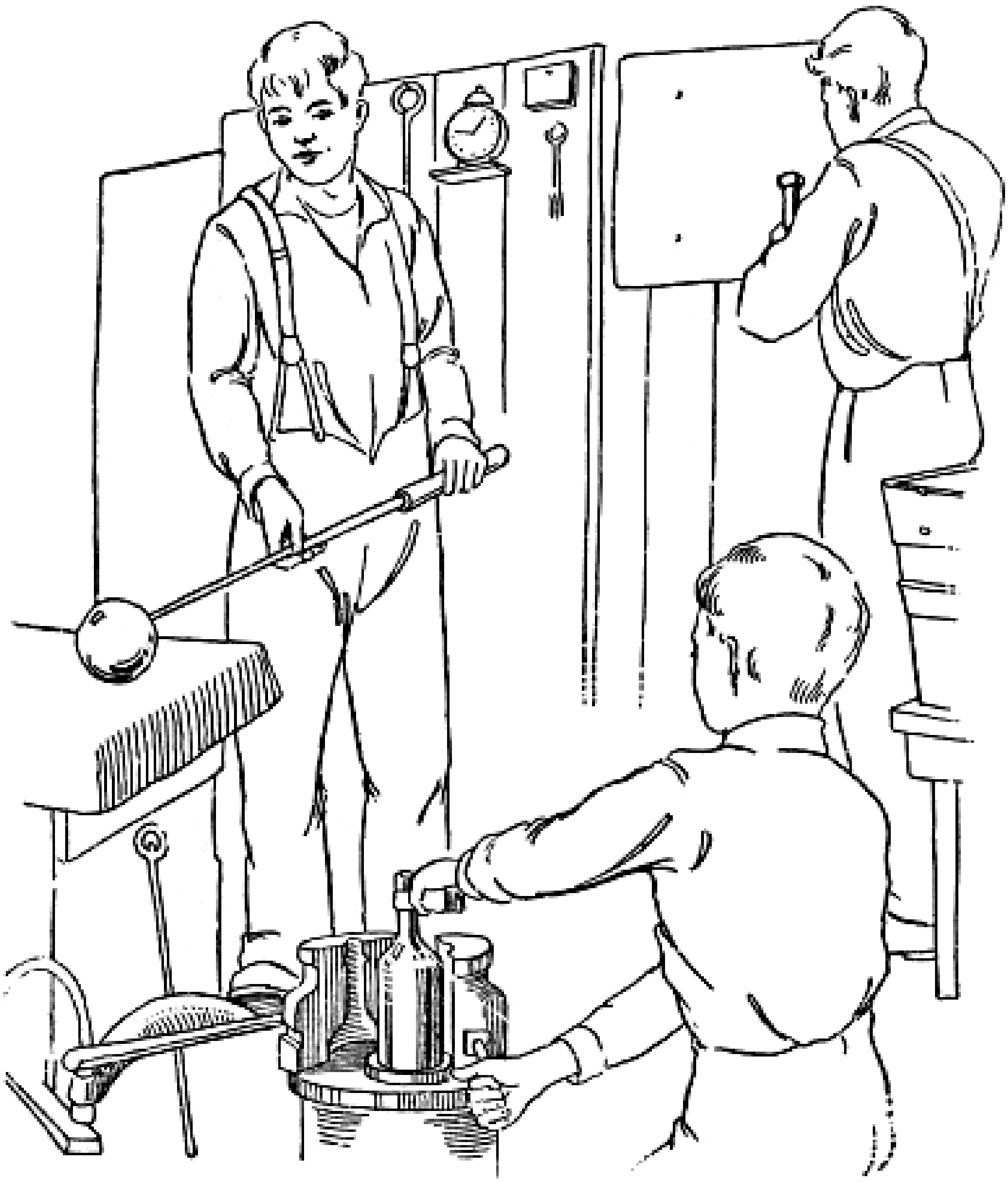

FIG. 23

BOTTLES BLOWN IN A MOLD

GLASS TUBES

The glass tubes with which you do the experiments in this book are made in the same way as window glass up to the stage of blowing the cylinder; then the blower's helper attaches an iron

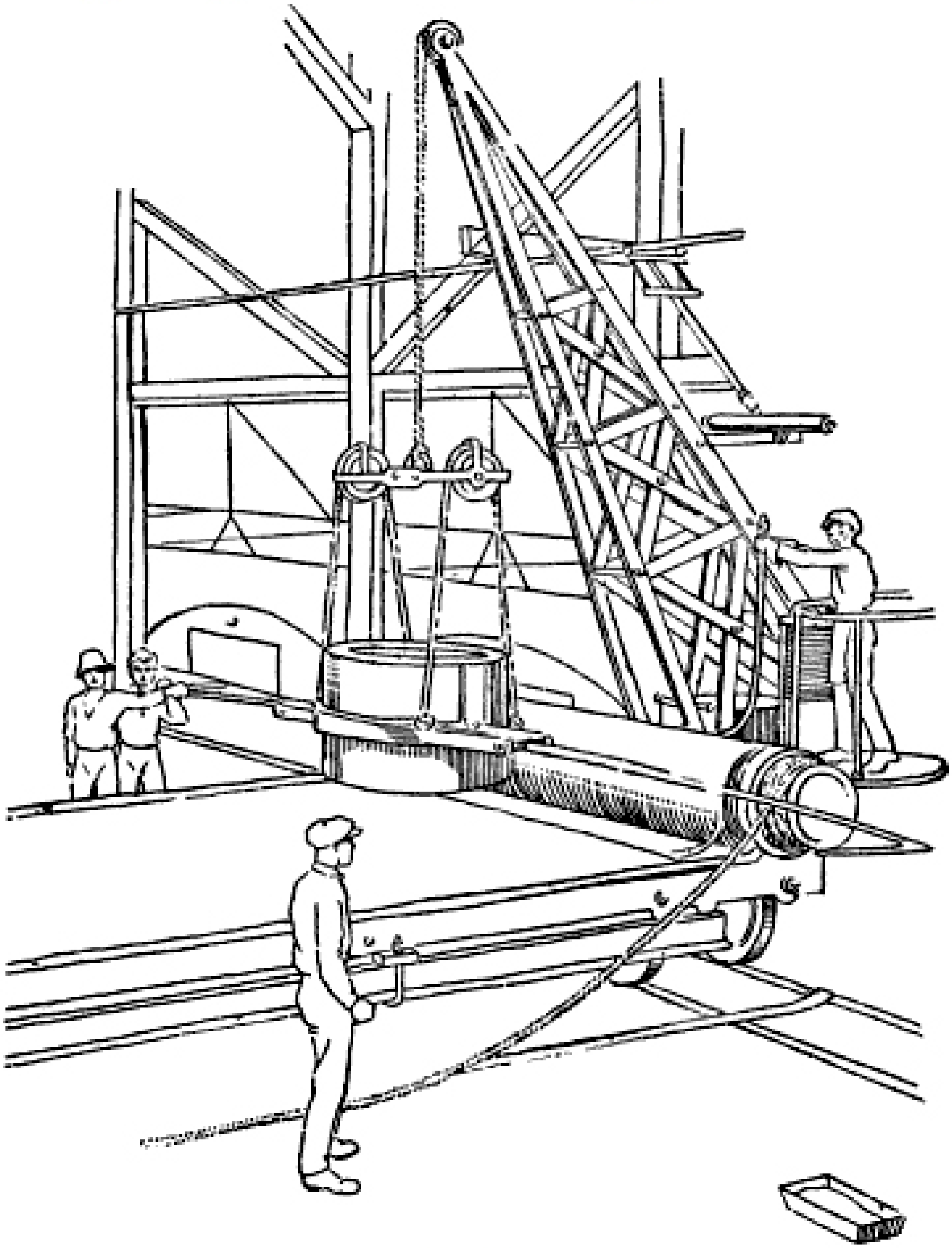

FIG. 24

ROLLING PLATE GLASS

rod to the opposite end of the cylinder (see right of Fig. 1), and the blower and helper walk backward away from each other to pull the cylinder into a tube. Of course, they use a small amount of glass to make small tubes, and larger amounts for large tubes.

MOLDED GLASS

Many articles of glass are made by blowing the glass into molds. Bottles are made in this way (Fig. 23), and large machines are now in use which mold many bottles at one time in this way.

PRESSED GLASS

Many articles are made by pressing glass into molds, that is, the molten glass is poured into molds and is pressed against the sides of the mold by means of a plunger. Imitation cut glass is pressed in this way.

PLATE GLASS

The large sheets of plate glass used in store windows are not blown, but rolled. The molten glass is poured from the fire clay pots upon a cast-iron table and is rolled flat by means of a large iron roller (Fig. 24). The glass is then in the shape of plate glass, but is rough on both sides. It is annealed for a number of days and then is ground smooth on both sides, first with coarse emery, then with finer and finer emery, and is finally polished with rouge. The result is the beautifully polished plate glass we see in large windows.

OPTICAL GLASS

The United States and Great Britain made great strides in the manufacture of optical glass during the war and there are now many kinds on the market. They are used in making the lenses, prisms, and mirrors for optical instruments.

Optical glass is made in much the same way as ordinary glass but great care is taken; first, to see that the materials are pure; second, to stir the glass constantly, as it cools from the molten to the viscous state, to make it as uniform as possible; and third, to cool it very slowly in the annealing process, to avoid strains.

QUARTZ GLASS

An entirely new glass has been placed on the market in quantities in recent years. It is made by melting very pure quartz sand at a temperature of 3000° F. and cooling it fairly rapidly. It has the very valuable property of expanding and contracting very, very slightly when heated and cooled. Thus there is practically no internal strain set up when it is heated or cooled quickly and it does not break. It can be heated red hot, for example, and then plunged into cold water without breaking. It is probably that this glass will be in universal use in a very few years.

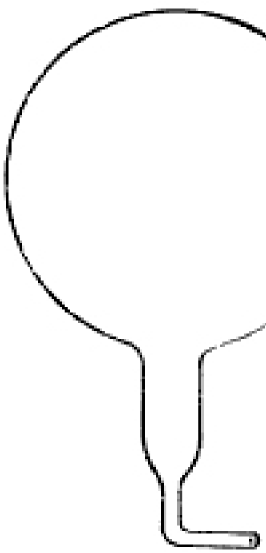

FIG. 25
A POLLYWOG

Experiment 12. To make an acrobatic pollywog.

Smooth one end of a piece of No. 2 tube to put in your mouth, close the other end in the blowpipe flame, take it out and blow a bulb about ½" inch in diameter.

Allow the bulb to cool, then heat the tube about ¼ inch from the bulb and draw it out into a thin tube. Now bend the thin tube at right angles near the bulb and break it off (Fig. 25).

Place the bulb in water. Does it float? If not, blow another with a larger bulb.