two right-angled bends about 1 inch apart at the center, smooth both ends, and your siphon is complete (Fig. 43).

Experiment 32. Magic.

Put one arm of the siphon in a tumbler of water and suck air out of the other end. Does the water start running and does it continue to run in a most magical way (Fig. 44) until the water us below the end of the siphon in the tumbler?

FIG. 44
A SIPHON

Fill the tumbler with water again, start the water running, put the outer arm of the siphon in an empty tumbler, and stand both bumblers on the table (Fig. 45). Does the water run up one arm of the siphon and down the other into the empty tumbler? Does it stop running when the levels are the same?

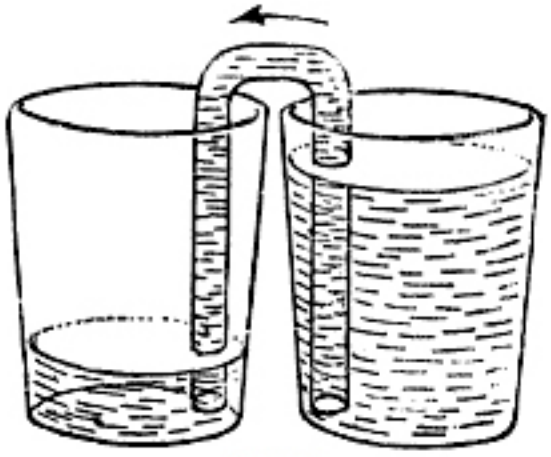

FIG. 45
FROM THE HIGH LEVEL TO THE LOW

Stand the first tumbler on a book. Does the water run again and stop when it levels are again the same (Fig. 46)?

Place the lower tumbler on the book and the upper tumbler on the table. Does the water now run in the opposite direction until the levels are again the same?

Raise one tumbler a foot or so above the table. Does the water run up over the edge and drop into the second? Now before the upper tumbler is empty, lower it in such a way that an arm of the siphon is in each tumbler, and raise the second tumbler. Does the water now run in the opposite direction?

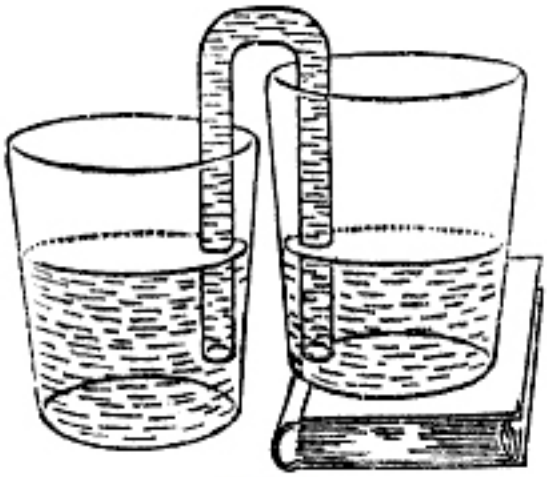

FIG. 46
THE WATER STOPS WHEN LEVELS ARE THE SAME

You boys who have the Gilbert set on "Hydraulic and Pneumatic Engineering" will know that it is the pressure of the atmosphere which causes the water to run up over the edge of the tumbler in this magical way.

Experiment 33. A long-armed siphon.

Attach a full length of No. 4 tube to each arm of the siphon, as in Fig. 47, and repeat the experiments described above.

Note: When you insert a glass tube into a rubber coupling or rubber stopper, wet the end of the glass tube and the inside of the coupling or stopper, grasp the tube near the end to be inserted, and insert with a twisting motion.

Experiment 34. To make a nozzle.

Attach a working handle to one end of a piece of No. 2 tube, heat the tube about one inch from the end in the lamp flame, turn constantly until soft, then remove from the flame, and draw it out about 3 inches. When cool, break off the thin tube, cut off the nozzle to a length of about 2½ inches, smooth the large end, and your nozzle (Fig. 48) is complete.

Experiment 35. To make a fountain.

Arrange the apparatus as in Fig. 49, and

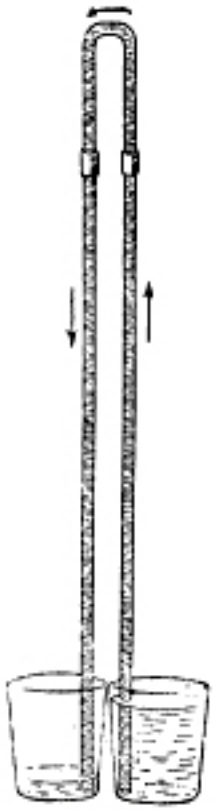

FIG. 47
SIPHONING WITH LONG TUBES

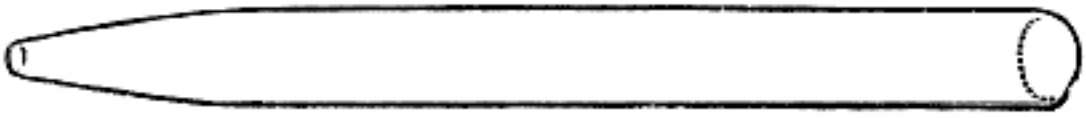

FIG. 48

A NOZZLE

suck air out of the nozzle. Have you made a beautiful fountain?

Experiment 36. Magic.

Make a nozzle 6 inches long out of No. 2 tube. Smooth the ends of the nozzle, and long tubes. Arrange the apparatus as in Fig. 50 and suck air out of the nozzle until the water runs in the siphon. Does the water squirt out of the nozzle in a magical manner?

Experiment 37. More magic.

Arrange the No. 2 apparatus as in Fig. 51, with the nozzle inside the bottle. Now to start the apparatus; Fill the bottle about quarter full of water, insert the tubes in the stopper as shown; insert the stopper into the mouth of the bottle; invert the bottle; then put the short tube in a tumbler full of water and the long tube

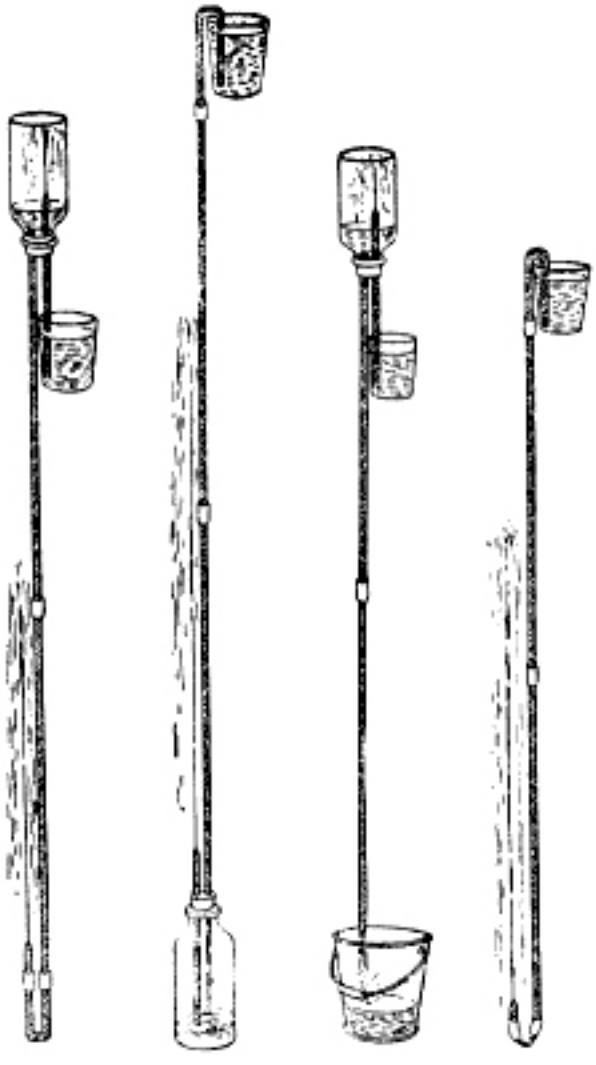

FIG. 49 FIG. 50 FIG. 51 FIG. 52

YOU MAKE A NUMBER OF MAGIC FOUNTAINS

in an empty pail or basin. Is there a magical fountain inside the bottle?

Repeat this with a taller bottle, if you can find one to fit your two-hole stopper. Do you get a higher fountain?

Experiment 38. Still more magic.

Make another nozzle and attach it to the apparatus used in the last experiment by means of the inverted siphon (Fig. 52). Start the experiment as described above. Do you get two fountains?

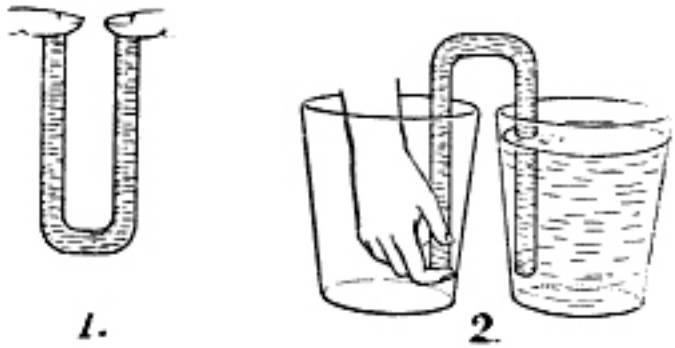

FIG. 53
STARTING A SIPHON

Experiment 38. To start a siphon.

You can start a siphon without sucking the air out of it as follows: Fill the siphon with water, put a finger over each end (1, Fig. 53), place one end in a tumbler full of water and remove the finger under water (2, Fig. 53), then remove the other finger. Does the siphon start?

In this case the water you pour into the siphon drives the air out, and this is the reason you do not need to suck the air out.

FIG. 54
SIPHONING SAND

Experiment 40. To siphon sand or mud.

Arrange a siphon (Fig. 54), start the water flowing, and then pour sand or mud into the upper tumbler. Is the sand or mud siphoned over into the lower tumbler?

Attach a long tube to the outer arm of the siphon and repeat the experiment. Is the sand or mud siphoned more rapidly and more thoroughly?

Experiment 41. To make a squirt bottle.

Make a nozzle at one end of a piece of No. 2 tubing, make a bend near the nozzle, cut off the other end at such a length that it will reach to within ¼ inch of the bottom of the bottle, smooth this end, allow it to cool, wet the tube and the two-hole stopper, insert an elbow in the other hole, and your squirt bottle is complete (Fig. 55). Fill the bottle with

FIG. 55
A SQUIRT BOTTLE

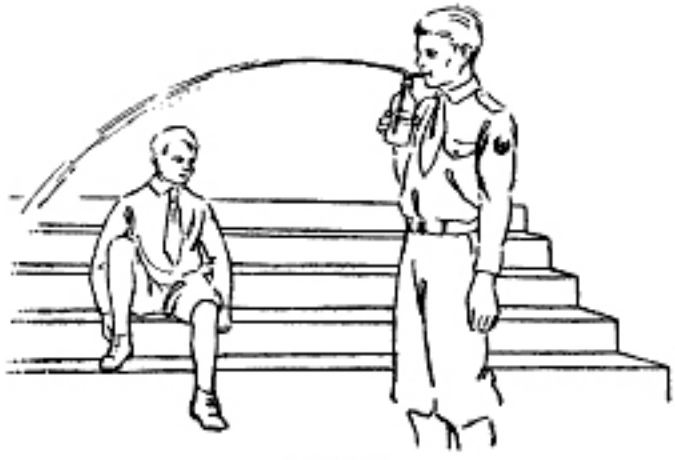

FIG. 56
SQUIRT BOTTLE IN ACTION

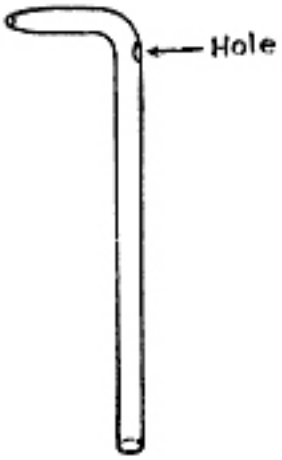

FIG. 57
TUBE FOR TRICK SQUIRT BOTTLE

water, and blow through the elbow. Do you get a fine long stream from the nozzle (Fig. 56)?

Experiment 42. To make a trick squirt bottle.

You can have any amount of fun with a trick squirt bottle. It is exactly the same as the squirt bottle described in Experiment 41 except that it has a hole just below the bend (Fig. 57).

To make the hole, make the long bent nozzle as in the last experiment, then heat the tube just below the bend in the blowpipe flame, touch a piece of glass tube to the red hot glass (1, Fig. 58), and pull it away (2, Fig. 58). Do you find that the hot glass is pulled out into a thin pointed tube? Break off the thin tube close to the large tube, heat in the blowpipe flame until the edges are smooth and at the same level as the sides of the large tube. Flare the edges of the hole, if necessary; it should be about 1/8 inch in diameter.

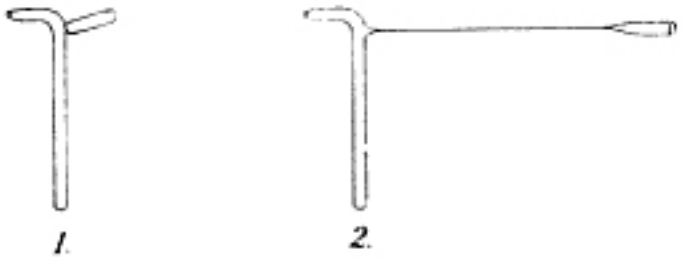

FIG. 58
MAKING A SMALL HOLE

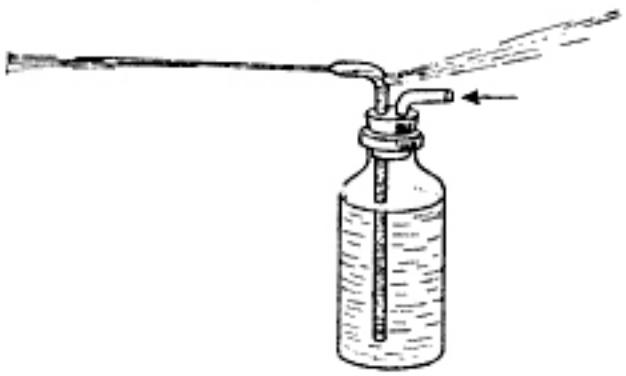

FIG. 59
TRICK SQUIRT BOTTLE

Now fill the bottle with water, and blow

hard (Fig. 59). Do you find that one stream of water is driven into your face and another out of the nozzle?

Experiment 43. Fun with a trick squirt bottle.

Now to have fun with your trick bottle, show it to one friend at a time. Do not ask him to try the bottle, just go where he can see you and squirt a long stream, but unknown to him have your finger over the hole below the bend.

FIG. 60
[illegible] IN ACTION

Your friend will just naturally want to have a try at it. So you say "All right, let's see who can squirt the longest stream." Tell him that all he has to do is to make a deep breath and blow as hard as he can. He will do so, with laughable results (Fig. 60).

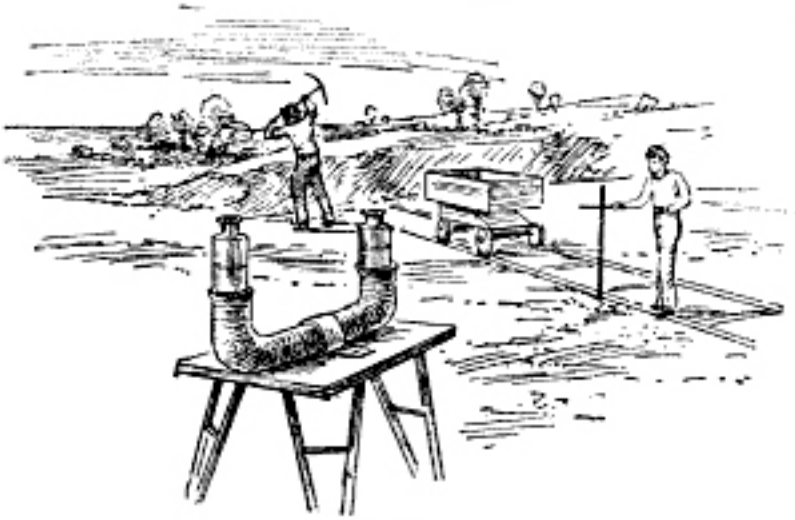

FIG. 61
A SIMPLE ENGINEER'S LEVEL
(From Aldous' Physics. Courtesy of the Macmillan Company)

Now together find another friend. Do not ask him to blow, but each of you blow as long a stream as you can, where

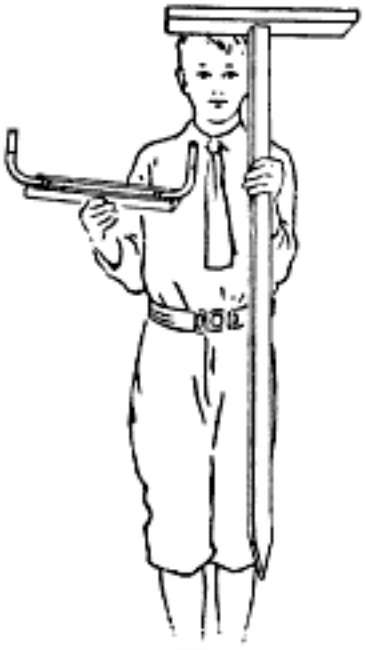

FIG. 62
ONE-LEGGED TABLE
AND LEVEL

he can see you. He will beg to be allowed to try, and finally you let him, with the same laughable results.

Repeat with other friends.

Experiment 44. To make an engineer's level.

You can make one form of engineer's level (Fig. 61) as follows: Take a full length of No. 6 tubing, bend it up 4 inches at each end, smooth the ends, attach it to a small board, rest the board on a one-legged table, and you have a serviceable level (Fig. 62).

Fill the tube with water, shove the pointed end of the leg into the ground and sight along the outside of the upright tubes at the level of the water surfaces. The line along which you sight is exactly horizontal, because the water surfaces are at exactly the same level.

Experiment 45. To use the engineer's level.

An engineer's level is used to find the difference in level of two or more points (Fig 63).

To practice using your level, find the difference in level of two points 100 feet apart on a road, sidewalk, or railroad.

To do this, you

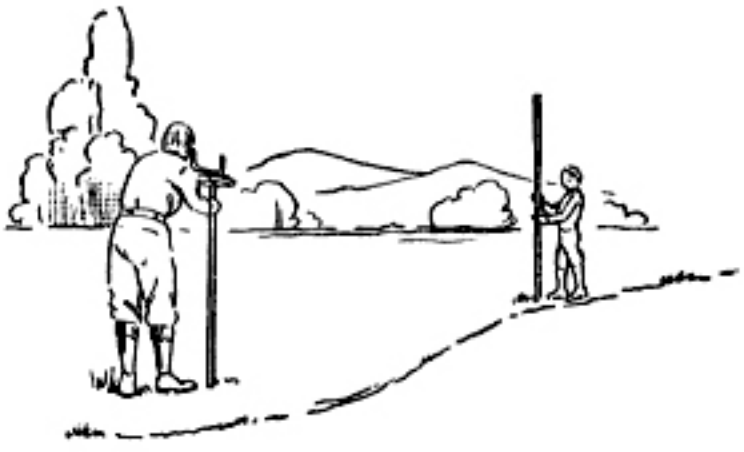

FIG. 63
HOMEMADE LEVEL IN USE

must first make what is called a **leveling rod**. Find a piece of wood about one or two inches square and six or more feet long, mark on it feet and inches, beginning at the bottom end, and your leveling rod is complete.

Now to find the difference in level of two points 100 feet apart, scratch a line or insert a small stake at one point, then pace off 100 feet and mark the second point. Now set up your level between the two points, ask a friend to hold the rod on the ground and upright, at the first point, sight along the water levels at the rod, and ask your friend to move his finger, or a white card, up and down until it is exactly in your line of sight. Now ask your friend to tell you exactly where his finger or card is and record the height. Let us suppose that it is 4 feet 6 inches above the ground. Now leave the level exactly where it is, ask your friend to hold the rod upright at the second point, and again sight along the water levels at the rod. Let us suppose that his finger or card is now exactly 3 feet above the ground.

The difference in level at the two points is 4 feet 6 inches minus 3 feet or 1 foot 6 inches. That is, the second point is 1½ feet above the first point or the grade is 1.5 in 100, or 1.5 per cent.

You can now mark a third point 100 feet beyond the second point, set up your level between the second point and third point, place the rod at the second point, then at the third point, and find their difference in level as above. If the third point is 1 foot above the second, the total rise in the 200 feet is 2½ feet; if, however, it is 1 foot below the second, the rise is 1½ minus 1 or ½ foot in the 200 feet.

You can repeat this with as many points as you please.

FIG. 64

A SPIRIT LEVEL

Experiment 46. To make a spirit level.

The spirit level (Fig. 64) is simply a curved glass tube filled with alcohol except for the bubble and closed at both ends. The curve of the tube is part of a circle.

Make a spirit level as follows: Take a piece of No. 4 tube about 7 inches long, heat a space about 3 inches long in the lamp flame, turn constantly, and when soft remove from the flame, hold both ends and allow the center to sink into a slight curve (1. Fig. 65).

Let the tube cool, mark the center of the curve with ink, and make marks 2 inches from the center on each side.

Hold the tube crosswise in the lamp flame, heat at one mark, draw down the tube and close it (2).

In a similar manner draw down the tube at the other mark but do not close it (3).

Let the tube cool and fill it with alcohol to the level shown in 4. To do this easily make the pipette (5), such alcohol into it within about 1 inch of the top, put your finger over the top, insert the lower end of the pipette to the bottom of 4, and remove your finger.

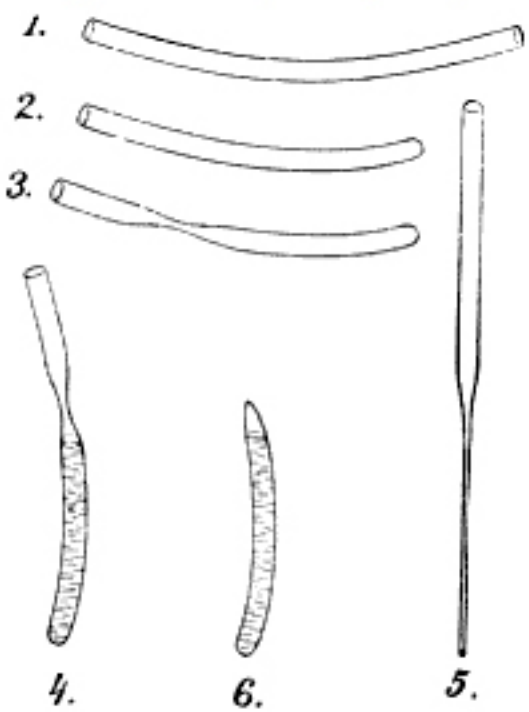

FIG. 65

MAKING A SPIRIT LEVEL