then tie the neck of it up tight; this done, connect the stem of an ordinary clay pipe to the neck of the bladder, or bag, and then make a solution of good soap and soft water (H_2O).

Now dip the mouth of the pipe in the soap solution, cut the thread from the neck of the bladder, or gas bag, and then press on it, and a bubble will be formed, as shown

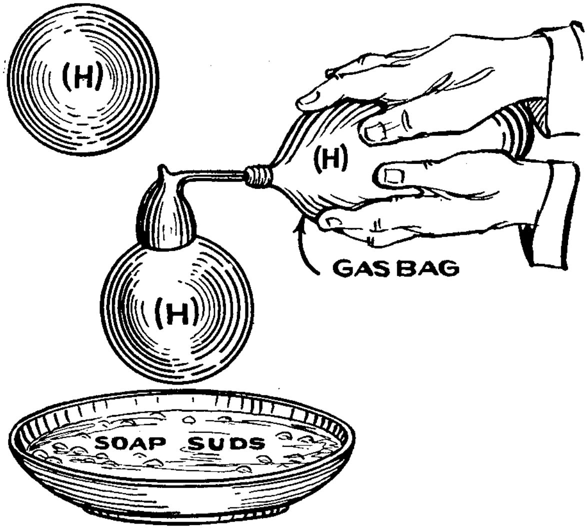

FIG. 85.—Blowing Hydrogen Soap Bubbles.

in Fig. 85. As hydrogen (H) is so much lighter than the air, the bubble will go up like a balloon, which it really is, and break when it strikes the ceiling. If, however, you hold a lighted match to it as it ascends, it will burst with a faint yellow flash and explode with a slight noise.

How to Blow Hydrogen Cauliflower Soap Bubbles. Fill a bladder, or a gas bag, with hydrogen (H) as before, but instead of the clay pipe fasten a glass tube in the neck of it; this done, half fill a wash-basin with the soap solution, then put the end of the tube into it and press on the bladder, or gas bag, and the basin will be filled to overflowing with small hydrogen (*H*) bubbles, as shown in Fig. 86. Now tie a match to a long stick, then light it and bring it into contact with the bubbles, and they will explode like a bunch of giant fire-crackers going off.

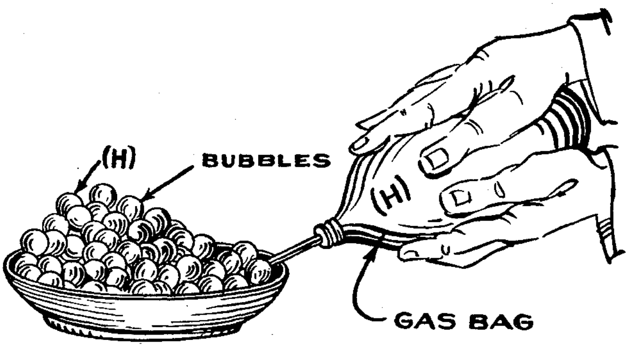

FIG. 86.—How to Blow Hydrogen Cauliflower Soap Bubbles.

How to Blow Resin Bubbles. Procure 1 ounce of pure linseed oil and 8 ounces of resin and put them in your porcelain evaporating-dish; place this dish in a pan partly filled with water. This arrangement, which is shown in cross-section in Fig. 87, is called a *water bath*. Now heat the pan with your alcohol lamp, or Bunsen burner, until the mixture is the right consistency and then blow bubbles with the clay pipe, either with air in the usual way or with the gas-bag apparatus which I have just described. If you blow resin bubbles with air, they will burst on coming in contact with the table or floor, but you can keep them for a long time by letting them fall on a sheet of paper on which you have sprinkled some lycopodium powder. Bub-

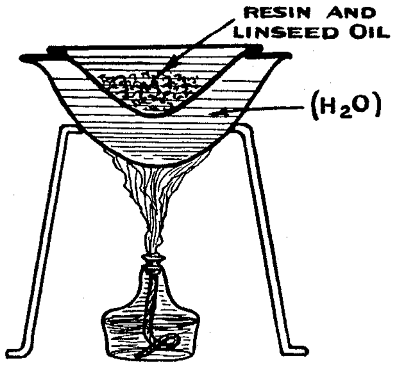

FIG. 87.—Melting the Resin and Linseed Oil Over a Water Bath.

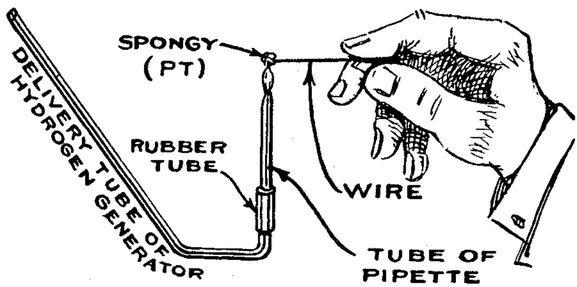

FIG. 88.—A Self-Lighting Gas Flame.

bles blown with the resin solution are exceedingly thin and, different from soap bubbles: they are perfectly gas-tight. They are very pretty when the sunlight is allowed to fall on them.

How to Make a Self-Lighting Flame. Make a hydrogen

(H) gas jet, as shown in Fig. 81, and hold a piece of spongy platinum (Pt) over it, as shown in Fig. 88, and it will soon get red-hot and then, in turn, it will light the gas. Spongy platinum (Pt) is a powdered form of platinum (Pt), and you can buy it ready to use. It is made by dissolving platinum (Pt) in *aqua regia*, which is a mixture of 1 part of nitric acid (HNO_3) and 3 parts of hydrochloric acid (HCl). Crystals of chloroplatinic acid (H_2PtCl_6) are thus formed; ammonium chloride (NH_4Cl) is then added, which precipitates the platinum (Pt) as ammonium chloroplatinate ($(NH_4)_2PtCl_6$), and on heating the compound it leaves the platinum (Pt) in a powdered form, and this is called *spongy platinum* (Pt).

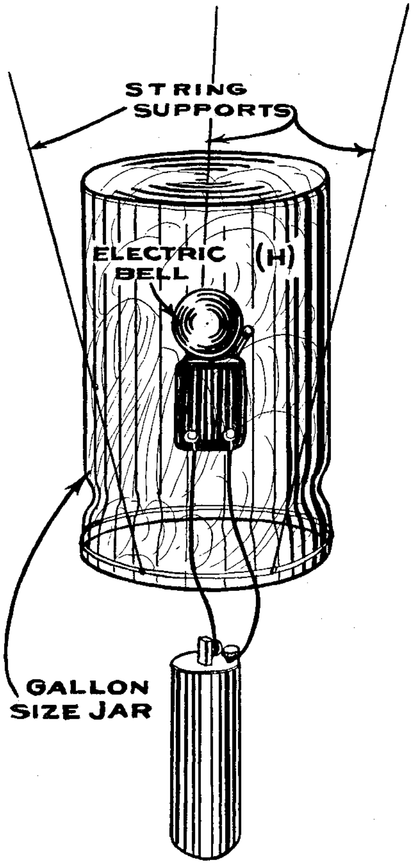

FIG. 89.—An Electric Bell in Hydrogen.

How Hydrogen Acts on Silver Nitrate. Dissolve as much silver nitrate ($AgNO_3$) as you can in a teaspoonful of pure water (H_2O), and with a toothpick write or draw upon a piece of silk; this done, moisten the latter with a damp sponge and then place the silk in a beaker of hydrogen (H), or you can direct a stream of the gas on it with the bladder or rubber-bag apparatus. The hydrogen (H) removes the oxygen (O) of the silver nitrate ($AgNO_3$) and leaves the pure metal on the silk.

FIG. 90.—A Squeaking Head in Hydrogen.

How Hydrogen Acts on Sound. For the following experiments take a gallon glass fruit jar, or a battery jar, fill it with hydrogen (H), and suspend it by means of strings; now connect a dry cell with an electric bell and hold the latter in the jar, as shown in Fig. 89, and it will give out quite a different sound from that which it does when it rings in air.

If you can get one of those squeaking toys that are sold at Christmas time, made in the form of a head, a duck, or a dog, and work it in a jar of hydrogen (H), as shown in Fig. 90, it will give forth a most ridiculous sound which is very funny. In fact any object which will make a sound in air and that can be worked in a jar of hydrogen (*H*) will set up a weird and curious noise.

While this experiment is not an easy one to make, still if you can do it you will cause no end of astonishment. Invert a tin, or copper, wash-boiler and suspend it by its handles. This done, fill it with hydrogen (*H*) and then play an accordion in it. After hearing the wonderful music

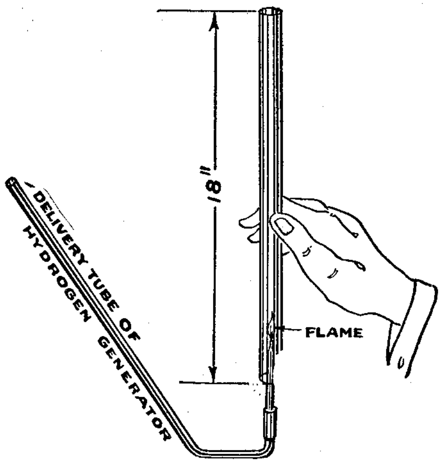

FIG. 91.—A Hydrogen Flame Organ Pipe.

it makes you will not need to stretch your imagination to conceive what a whole orchestra shut up in a room of hydrogen (*H*) would sound like.

Here is an experiment that has been made but which you are not advised to try. When perfectly pure hydrogen (*H*) is inhaled it is like nitrogen (*N*) in that it kills, not because it is a poison but because it will not support life. A most curious effect is produced on the voice by inhaling some of the gas and then speaking, or singing, while it is being exhaled, for it changes the deep voice of a man into a nasal, piping tone that is both curious and funny. In this experiment, two precautions must be taken, and these

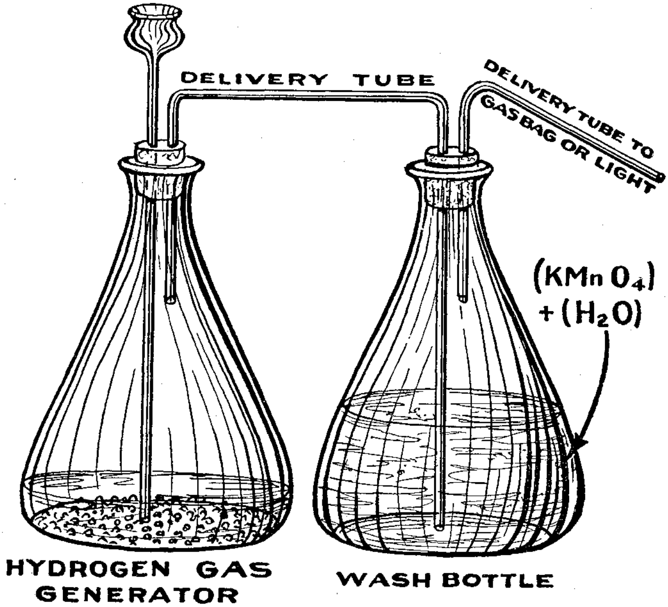

FIG. 92.—How to Purify Hydrogen and Other Gases.

are to use absolutely pure hydrogen (*H*), and to keep entirely away from a flame of any kind while inhaling the gas.

How to Make a Hydrogen-Flame Organ Pipe. For this experiment use the apparatus described under the caption of "How to Make a Hydrogen Flame" and hold a glass tube that has a bore of 1 or 1½ inches and a length of 18 or 20 inches and open at both ends, over a very small flame, as pictured in Fig. 91. Now raise and lower the tube a little at a time, and you will strike a point where it will give out a clear musical note, and then by moving it up or down, different tones will be produced.

How the Experiment Works. When 32 or more vibrations take place in a second, a musical sound is set up that

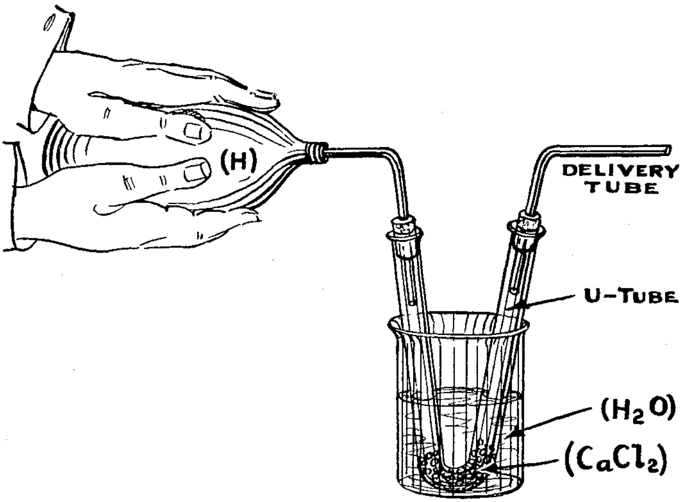

FIG. 93.—How to Dry Hydrogen and Other Gases.

the ear can hear. Now when the flame is made to burn in the tube there will be a large number of regular explosions of the hydrogen (*H*), and this sets up waves in the air, which in turn produce a musical sound.

How to Purify Hydrogen Gas. In making experiments with hydrogen (*H*), it is often necessary to have it free from all other substances. To purify it you need only to pass it through a solution made by dissolving 1 ounce of potassium permanganate ($KMnO_4$) in 4 or 5 ounces of water (H_2O). This solution is put in a wash-bottle, that is, a flask or any wide-mouth bottle with a tight-fitting cork in which there are two tubes; the longer one, which reaches below the surface of the solution, is connected with the delivery tube of the generating apparatus, and the purified hydrogen (H) is given off through the short tube, as shown in Fig. 92.

How to Dry Hydrogen. Likewise it is often desirable that the hydrogen (H) after it is purified should be perfectly dry. You can easily extract the moisture from it by first passing it from the wash-bottle connected with the generating apparatus into a bladder, or rubber bag; now connect the latter with one of the ends of a U-tube in which you have placed 1 ounce, or more, of calcium chloride ($CaCl_2$) and the other end with a delivery tube, as shown in Fig. 93. Calcium chloride ($CaCl_2$) is a substance that is very *deliquescent*, that is, it has the power of absorbing large quantities of water (H_2O) and, hence, it extracts whatever moisture there may be in a gas which is either passed through or over it.

CHAPTER VI

A PAIR OF SMELLY GASES

THERE are less than a dozen gases that are known to exist as elements, and the most important of these, namely oxygen (O), nitrogen (N), and hydrogen (H), I have told you about in the chapters that have gone before. There is, however, another gas called chlorine (Cl) that is an element, and as it is widely used I want you to know about it, too.

Now while chlorine (Cl) is not found free in nature, there is an enormous amount of it locked up in various compounds, as for instance in sodium chloride ($NaCl$), that is, *common salt*. As 3/5 by volume of sodium chloride ($NaCl$) is formed of chlorine (Cl) and there is enough salt in the oceans to make a range of mountains as large as the Alps, it will be seen that it is extremely plentiful and, moreover, it is easy to obtain. In turn, chlorine (Cl) forms a large number of useful compounds when mixed or combined with other elements.

Another interesting gas, though very strong-smelling, which I shall tell you of in this chapter, is ammonia (NH_3), but this is a compound and it is made up, as its formula shows of 1 atom of nitrogen (N) combined with 3 atoms of hydrogen (H). Now free hydrogen (H) is very scarce, and while water (H_2O) is made up of 2/3 by volume of this