soap into thin shavings, and dissolve it in rain-water, making a saturated solution. To two volumes of this solution add one volume of glycerine. Attach to the delivery-tube of the hydrogen flask, by a piece of rubber tubing, the stem of a tobacco pipe. Pour some of the soap-solution into a saucer, dip the bowl of the pipe into it, and let the gas blow a bubble. While the bubble is small, turn the mouth of the pipe upwards. The bubble, having attained a diameter of several inches, will break away, or else may be easily detached by a sudden movement of the pipe downwards. It will then rapidly rise.

75. *Explosive Mixture of Hydrogen and Air.*

Exp. 9.—Take a soda-water bottle and fit it to a perforated cork without a tube, or with only a quill, so that, if it flies to the ceiling and falls, it will do no harm. Place some granulated zinc in it, pour in some cold dilute sulphuric acid (about 1 of acid to 8 of water), and insert the cork, but not too tightly. Hold a lighted taper to the orifice, and in a short time a loud explosion will occur. Allow sufficient time to elapse so that the air may be expelled. No explosion occurs, but the gas burns quietly at the orifice.

Exp. 10.—Take a wide-mouthed bottle, and bend a glass tube in the form of a siphon, so that the shorter arm may be a little longer than the bottle. Support the bottle, mouth downwards, on one of the rings of the retort stand. Place the shorter arm in the bottle, the longer arm extending upwards and tied to the retort-stand. Cover the mouth of the bottle with a piece of brown paper gummed on to the glass, the siphon-tube passing through it. Connect the longer arm by rubber-tubing with the generating flask, and fill the bottle by upward displacement. Remove the rubber tubing, and the hydrogen being lighter than air, will be siphoned upwards, just as water is siphoned downwards. Apply a light to the end of the longer arm, and hydrogen is seen to burn with its usual, non-luminous flame. After a short time, however, this flame flickers, emits a musical note, at first shrill, but gradually deepens to a bass sound, until after a time distinct beats are heard, and at last, when the exact proportions between the hydrogen and the air, which enters through the pores of the paper, have been reached, the flame is seen to pass down the tube, enter the bottle, and the whole mass unites with a sudden and violent explosion, but quite harmless if the mouth of the bottle is sufficiently wide. Explosions are only dangerous when the gases are so confined that when expanded by heat they cannot easily get out. Hence bottles should be wide-mouthed, and thin glass vessels should not be used.

76. Precautions.

From the preceding experiments we see that no light should ever be brought in contact with the contents of the bottle in which hydrogen is generated, nor with any large quantity of the gas, until its non-explosive character has been demonstrated. This may be done by bringing the delivery-tube within the mouth of the test-tube. We have seen that hydrogen can be poured upwards, therefore, the tube will soon fill with the gas. After about ten seconds, remove it, *still holding it mouth* downwards, and apply a light to its mouth. If the hydrogen burns tranquilly at the mouth of the tube, the gas may be considered pure, but if it explodes with a whistling pop, further time must be allowed.

77. Cause of Explosions.

The explosion of the mixture of hydrogen and air is due to the sudden expansion caused by the heat generated in the combination of the hydrogen with the oxygen through the mixture. After the explosion of the mixture of hydrogen and air (oxygen and nitrogen), the substances present are steam and nitrogen, which are expanded by the heat developed in the combination to a volume far greater than the vessel can contain, so that a portion of the gas and vapor issues very suddenly into the air around, the collision with which produces the report.

78. Heat of Combustion.

Exp. 11.—Take a test-tube 6 in. by 1 in., fit it with a cork through which pass two tubes bent at right-angles, one of them reaching nearly to the bottom of the tube, the other just passing through the cork. Twist a short piece of copper-wire into a spiral and put it in the bottom of the tube, and nearly fill the tube with pumice stone, moistened with sulphuric acid, which readily absorbes moisture, and will thoroughly dry the gas. Attach the longer tube to the generating flask by means of a cork, and to the other tube attach a small glass tube, about 20 centimetres long, drawn out so as to form a rather fine jet, and supported in vertical position. If the hydrogen is not coming off with sufficient rapidity, add a little sulphuric acid, and before applying a light to the jet, ascertain that the hydrogen is not mixed with air, kindle the gas and note that the flame at first is of a pale bluish color, but soon becomes a bright golden, owing to the sodium in the glass. Twist a small piece of thin sheet tin into a funnel and place it over the jet; the flame becomes nearly colorless. Hold a fine platinium wire in it; the wire becomes nearly white hot and emits much light. Hold in it a small piece of caustic lime or chalk, with a fine point or edge; it soon produces a brilliant white light.

79. Product of Combustion.

Exp. 12.—Invert over the burning jet a large dry, wide-mouthed bottle, the inner surface is quickly bedewed with moisture, and presently drops of liquid trickle down the sides *and collect at the shoulder. When some drops of the liquid* have been collected, test it with blue and reddened litmus paper; it is neutral, that is, it has neither an acid nor an alkaline reaction. Throw a little bit of potassium upon it; the potassium bursts into flame. Water is the only neutral liquid on the surface of which potassium will burn. Now, since the drying-tube completely removes moisture from the unburnt gas, and the latter does not bedew a cold surface against which it may be allowed to impinge, the liquid we observe to be deposited from the flame must be a product of the combustion of hydrogen in air. It is from this property that hydrogen derives its name (Greek, *hudor*, water, and *gennao*, I gave rise to).

(To be Continued.)