The Siphon (M. C. Nokes, Harrow School)

The action of the siphon seems to be imperfectly understood by the authors of some elementary text-books. Perhaps the following considerations will serve to give a clearer picture of the physical principles upon which it works.

(1) A siphon works quite readily in a "vacuum".

(2) The height of the uptake tube above the reservoir is not limited by the barometric height.

These two statements can be substantiated in the following way:

(1) A tube system of the form shown in Fig. 1 is constructed and is filled with any liquid to the extent shown. If Pyrex glass is employed the liquid can safely be boiled to remove dissolved gas. In any case the apparatus should be carefully cleaned before use and, after filling, should be exhausted so that it contains only the liquid and its vapour. Good-quality vacuum taps should be used. The apparatus is turned until the siphon tube is full and its reservoir is nearly full. On turning the apparatus into a vertical position the siphon will empty the

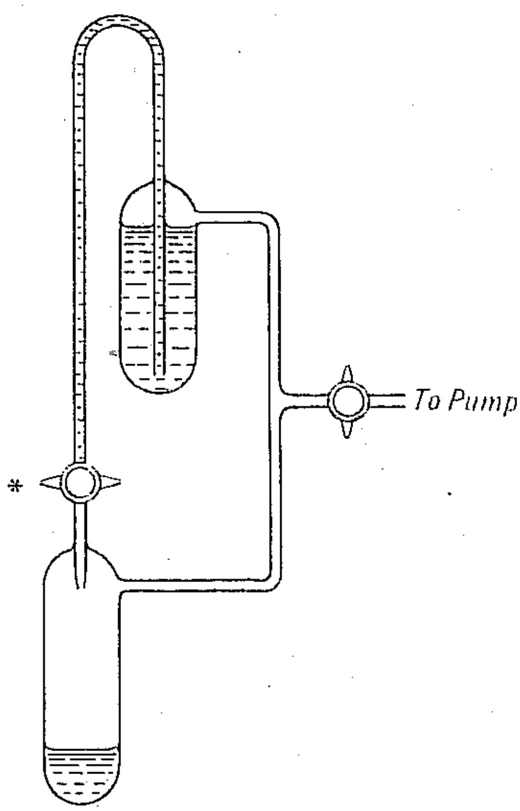

FIG. 1.

* The inclusion of this tap is optional. It is convenient for demonstration purposes. If used, it must be of good quality.

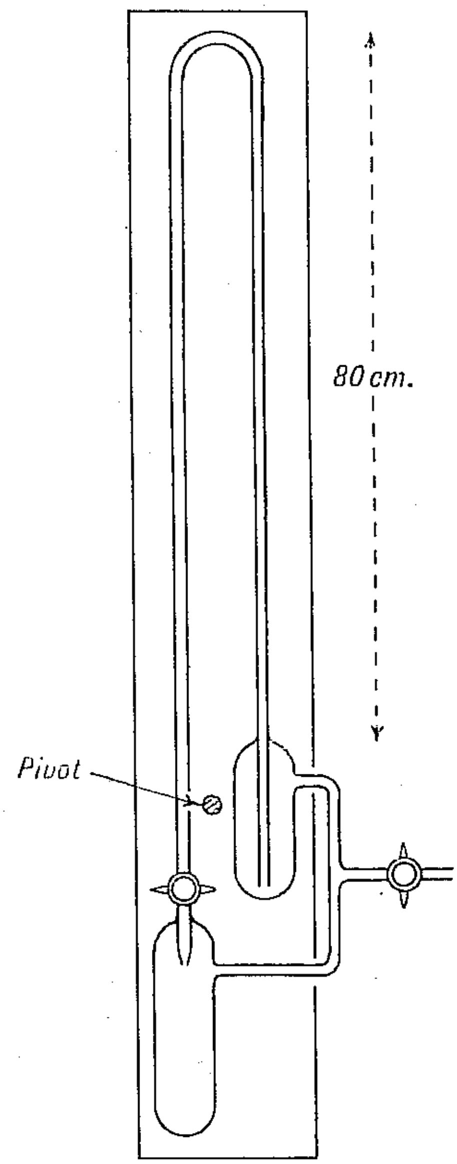

FIG. 2.

Ordinary quality taps will do; or no tap.

reservoir. The author has used water, dibutyl phthalate and mercury in these "vacuum" siphons, as being representative of liquids with somewhat different physical properties. For demonstration purposes the siphon may be continuously pumped while it is working, with a manometer between it and the pump. (The water-filled siphon, which works extremely well, should be without taps: it should be sealed off while the water is boiling.)

2. A similar tube system is constructed, but with an uptake tube 80 cm. long

between the top of the reservoir and the bend. One or both taps may be omitted. The apparatus is partly filled with redistilled mercury and partly with air at atmospheric pressure. The glass-work is carefully fixed to a wooden board which has some kind of pivot at the level of the reservoir, so that it can be brought slowly into a vertical position without shock. It is important in constructing the tube system to keep the diameter of the delivery tube as nearly uniform as possible throughout its length, especially where it is sealed through the reservoir. If no tap is included on the downtake side, a fine jet must be provided to decrease the rate of flow of the mercury. The siphon tube is filled as before by tilting and on carefully bringing the apparatus to the vertical a mercury siphon with an uptake length of 80 to 84 cm. can be made to flow (see Fig. 2).

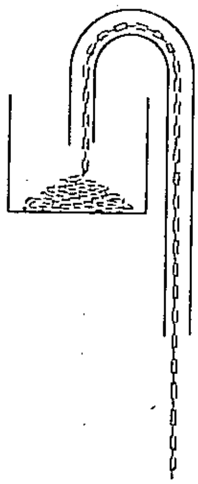

FIG. 3.

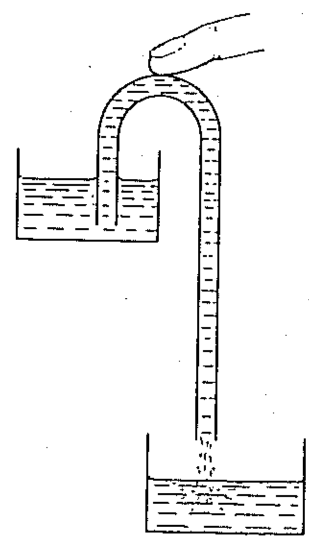

FIG. 4.

The explanation of the action of siphons now becomes plain. The gravitational force on the column of liquid in the downtake tube less the gravitational force on the liquid in the uptake tube causes the movement of the liquid. The liquid is therefore in tension and sustains a longitudinal strain which, in the absence of disturbing factors, is insufficient to break the column of liquid. The chief disturbing factors which tend to break the column in an evacuated apparatus are:

(1) gas dissolved in the liquid;
(2) adherent gas on the walls of the tube;
(3) mechanical shock; and
(4) turbulent flow of the liquid (caused by irregularities of the inner surface of the tube, or by too rapid a rate of flow, or by both).

The reason why siphons of small uptake height work so readily at atmospheric pressure is because the tension of the liquid column is neutralized and *reversed* by the compressive effect of the atmosphere on opposite ends of the liquid column.

Two further simple experiments may be used in illustration:

(1) The action of a siphon can be imitated with a chain as shown in Fig. 3.

(2) When the compressive effect of the atmosphere is removed by uncovering a small opening at the top of a siphon tube, air immediately enters and ruptures the column of liquid (see Fig. 4).

Compare also the effect of a constriction in the clinical thermometer and the tension that must exist in the horizontal alcohol column of Rutherford's minimum thermometer. For information about the tensile strength of liquids see *Properties of Matter*, by Poynting and Thomson, p. 122.

The Specific Heat of Air at Constant Pressure (B. K. Harris, Oundle School)

The object of this method is to enable a Sixth Form boy in the course of a two-