EXPERIMENTS IN PNEUMATICS WITH A STEAM VACUUM.

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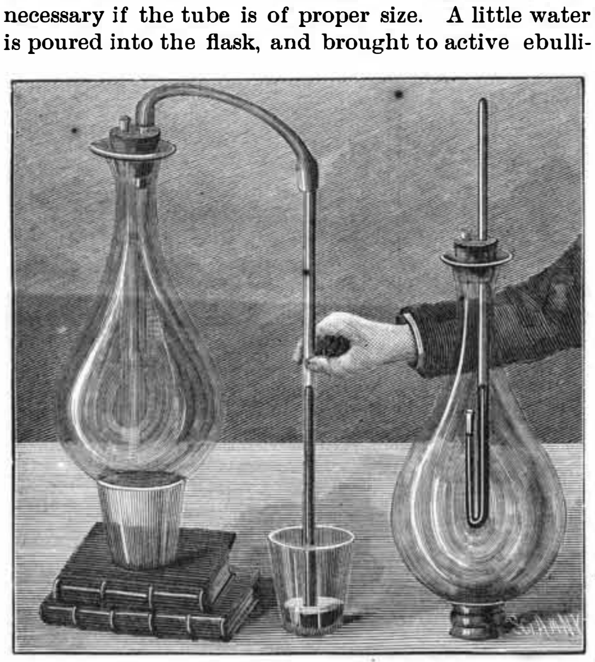
Some weeks ago, a description was given in the present series of articles of how a steam vacuum could be produced.* The experiment as detailed there was performed with Italian wine flasks, and is one that possesses a certain historical interest in connection with the early inventors of the steam engine. By developing this experiment a little, producing steam and condensing it, very interesting work may be done with steam vacua, many of the air pump experiments being thus simply reproducible. For the receiver or bell glass of the air pump, a round bottomed flask is substituted; the elastic force of steam represents the piston of the air pump as it lifts the atmosphere and expels it from the flask. Finally, the muscular force of the experimenter with the ordinary air pump is represented in the lamp by which the water is brought to boiling. The flask must be one in which water can be boiled without fear. Every piece of glassware will not stand this, and it is annoying to have to adopt special precautions in applying the heat. It must be strong and round bottomed, otherwise it will not stand the atmospheric pressure. Its neck should be as wide as possible. It should be provided with a doubly perforated India rubber cork. A few pieces of glass tubing, some closed at the end to answer for plugs, others open, some rubber tubing, and an alcohol lamp, complete in general the necessary apparatus.

To produce a vacuum, a little water, one or two wineglasses full, is poured into the flask, and brought to a rapid boil. This can be done by holding the flask with its bottom in the flame of the lamp. After two or three minutes' strong boiling, the cork, with both apertures plugged, is put in the neck, being held a little to one side. Eventually, it is pushed down, the flask at the same instant being removed from the lamp. On cooling, an almost perfect vacuum is produced. The cooling may be accelerated by blowing against the sides or by pouring cold water over them, when the water within the flask immediately begins to boil; and if cold water is used, the action is still stronger. This represents a well known paradox—a fluid boiling by cold; the effervescence being caused by the reduction of pressure due to the condensation of steam.

To refill the flask with air, one of the glass plugs must be withdrawn from the cork, when the noise of the entering air will be heard. Thus the flask and attachments represent an air pump.

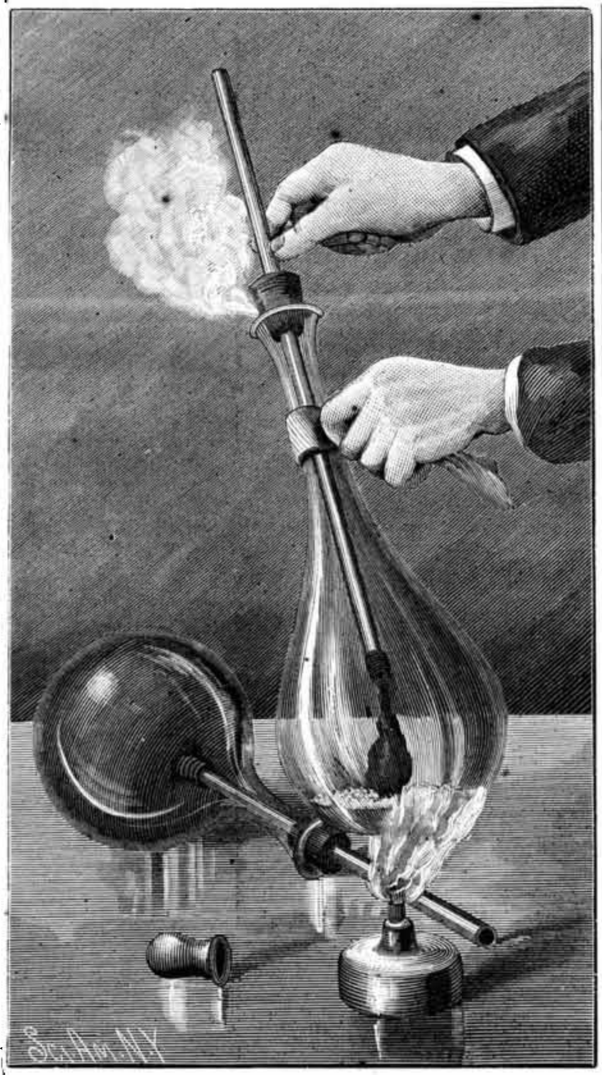
The experiments illustrated in this issue are designed to show the pressure of the atmosphere. For the first one, an India rubber balloon is required. These can be bought in toy stores, where they are sold attached to little pipes, forming a miniature bagpipe. One aperture in the cork is closed with a plug; through the other an open-ended tube is pushed; and over the end that is to go into the flask, the neck of the balloon is passed. It may, to secure it, be wound with a few turns of thread. This will not be necessary if the tube is of proper size. A little water is poured into the flask, and brought to active ebullition as before. Then the flask is taken from the flame, while the cork is introduced with the precautions just given. The steam begins to condense, and in an instant the balloon, under the effect of the atmospheric pressure, expands, and almost completely fills the vessel. The sudden swelling up of the balloon is quite impressive. Another way to conduct the work is to use the cork with its second aperture unplugged, to introduce it firmly while the flask is yet cold, and then boil the water. After condensed steam has appeared for some minutes escaping from the aperture, the latter is plugged as the flask is taken away from the lamp. After the balloon has expanded, it sometimes is so thin that it is semi-transparent.



BAROMETER AND MERCURY COLUMN.

This method of working with a plug, first securing the cork, is the better way in general, though it is not always convenient.

To show the pressure of the air, the barometer may be used. A tube twenty to thirty inches long is closed at one end, and bent into a siphon barometer.



EXPERIMENT WITH BALLOON.

This is filled with mercury, and passed tightly through one of the openings in the cork. The barometer may be easily made by any one accustomed to bending glass tubes. If it proves troublesome to fill a bended tube, enough mercury for the experiment may be poured into the straight tube, and then the bending may be done. A column of mercury fifteen inches high is sufficient.

While the flask is yet cold, the unplugged cork is tightly placed in the neck, with the barometer projecting as shown in the cut. The water is boiled, the cork plugged, all as before, and the flask allowed to cool.

As the vacuum becomes stronger, the mercury begins to fall in the outer sealed arm and to rise in the inner. Any excess that escapes falls into the water in the bottom of the flask. Eventually, the level of the mercury in both limbs becomes nearly the same. The apparatus may be laid aside for some hours, to see how long it will retain a vacuum. The mercury should remain as left for a long time. To open the flask, the plug is first removed.

This demonstration of the pressure of the air begins where the other ends, and is an indirect proof. The tube originally remained full of mercury because of the atmospheric pressure. The level fell as this was removed from the exposed surface of mercury in the open limb. A simple modification of this experiment is shown, where an open tube is used whose end dips into mercury contained in a vessel by the side of the flask. The vacuum draws mercury up into the tube.

The pressure of the air may be made to drive water into the flask. A piece of tubing is drawn down to a fine aperture, and passed through the cork with the small end downward, so as to come within the flask. The other end of the tube is bent at right angles, or has a short piece of India rubber tubing slipped over it. The cork is plugged and placed tightly in the flask, previously supplied with water. The water is boiled well until steam has issued from the tube for a minute or so. Care must be taken not to generate steam pressure enough to expel the cork. The flask is removed from the lamp, and the open end of the tube is immersed in cold water as quickly as possible, the flask being supported in a horizontal position. For a moment nothing is seen, but the cold water condensing the steam soon rises, and is driven into the flask, forming a horizontal and perfectly steady thread of fluid. This may be made a vertical fountain by holding the flask upright. As the water entering fills the flask the jet becomes submerged, and the entering water carries other water with it, producing a curious effect. A most interesting feature is the apparent immobility of the jet. It resembles a bright rod of glass reaching across the flask. This is a variation on the fountain *in vacuo* experiment.

From these experiments the fact will be deduced that steam is invisible, as in each one the flask is filled with steam, though nothing can be seen. Other air pump experiments that can thus be executed will be described later.

* See SCIENTIFIC AMERICAN of July 3, 1886.

Transparent Paper.

How to render paper transparent, especially paper photo negatives, is thus described by Mr. W. E. Woodbury. Using castor oil answers as well as any other method, the best recipe being the following: Take of castor oil 5 parts, and of ether 1 part; place the negative, face downward, upon a sheet of glass, and spread the solution thickly over it; well warm it till the oil has thoroughly soaked into the paper, and when cool remove the superfluous oil, and again warm; should any of the oil get on the surface, it can be immediately removed with a little ether.

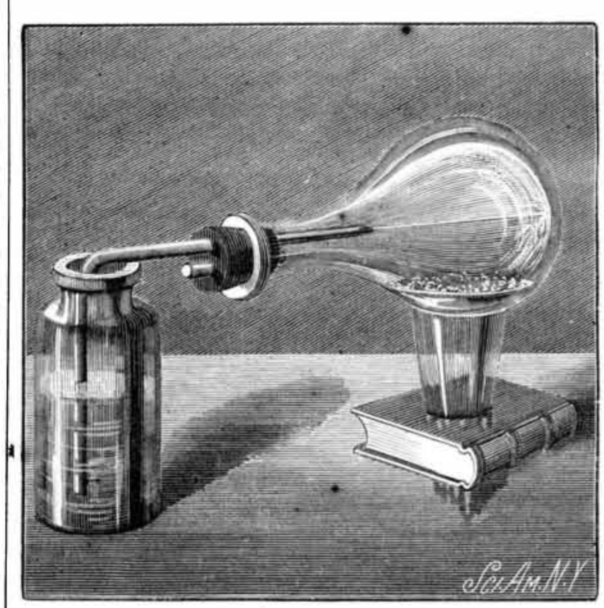
Another method adopted is by using Thomas' India rubber solution, 2 parts, dissolved with 2 parts Canada balsam in 3 parts pure benzole, and rubbing well into the back of the negative with a piece of cotton wool till thoroughly soaked and dry.

Passing through melted paraffine wax is also an excellent method. This must be effected at such a temperature as to enable it to thoroughly penetrate the paper. Better *not* to iron, as so often recommended, but simply to warm, and with a piece of soft cloth take off the superfluous wax. Paraffine cools instantaneously, and does not soil the albumenized paper; it renders the paper perfectly free from granularity, and prints very rapidly.

A process by no means easy, but which we have ourselves carried out with great success, is the following: gum dammar 20 parts, and gum elemi 5 parts, dissolved in 100 parts of benzole. Pour into a flat dish, and place the negatives in one after another, and allow them to remain for about five minutes; at the expiration of that period remove, and hang them up to dry. Benzole must be constantly added to the solution, in consequence of its speedy evaporation. The negatives will be found to be wonderfully transparent, and, of course, require no varnishing. If vaseline is employed, the negatives must be kept constantly between oiled sheets.

The Cunard Steamer Etruria.

The Etruria, plying between New York and Liverpool, commenced her career rather more than a year ago, having made her trial trip in March, 1885. She was built at the Fairfield yard, and is 520 ft. long, 57 ft. 3 in. broad, and 41 ft. deep. The displacement is 9,860 tons. She ran during a six hours' trial on the Clyde at the rate of 20·233 knots (about 23 miles) an hour, the revolutions being 67·5 per minute. The Etruria is arranged to accommodate 720 first-class passengers, and the saloon will seat 280 people. The engines are of the type usually fitted at Fairfield into large passenger vessels, having a high pressure cylinder in the center and two low pressure cylinders, one on each side. The former is 71 in., and the two latter 105 in. each in diameter. The stroke is 72 in. The boilers are nine in number, and the steam pressure is 110 lb. The heating surface is 38,817 square feet, and the bar surface 1,606 square feet. The engines are said to have given off "something close upon" 15,000 indicated horse power on one occasion. The consumption of coal is stated to be 315 tons a day. The moulded draught is 22 ft. 6 in., and the area of midship section 1,090 square feet. This ship has made the quickest run across the Atlantic, viz., 6 days 5 hours and 31 minutes. The Etruria is lighted throughout, even down to her shaft tunnel, by electricity.



FOUNTAIN IN VACUO.