given. The weight of water being to that of mercury as 1 to 13·59, the height of a water column supported by the atmosphere would be about 34 feet.

The original mercurial column experiment of Torricelli was followed by an experiment by Pascal which proved conclusively that the support of the mercurial column was due to atmospheric pressure. It consisted in making simultaneous observations of two barometers, one situated at a high altitude, the other at a lower level. It was thus shown by the descent of the mercurial column, at a high elevation, that atmospheric pressure diminishes in proportion to the ascent.

AN INEXPENSIVE AIR PUMP.

The engraving illustrates an efficient air pump for both exhaustion and compression, which may be made from materials costing one dollar and fifty cents, and with the expenditure of not more than two or three hours' labor.

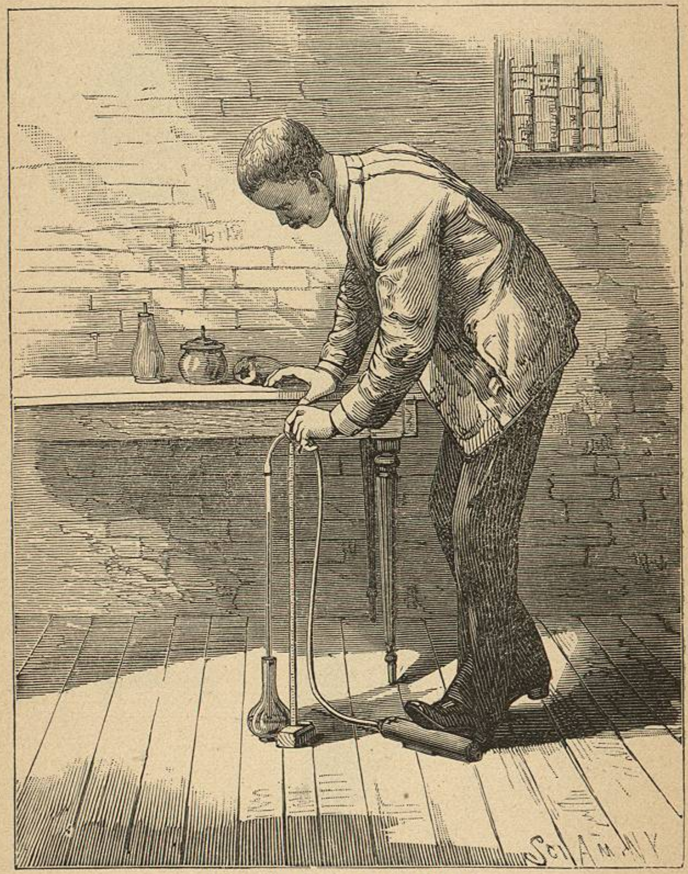
With this pump, the entire range of ordinary vacuum and plenum experiments may readily be performed by the aid of a few well known and inexpensive articles, such as lamp chimneys, fish globes, a tumbler or so, and pieces of sheet rubber, bladder, etc.

Fig. 88 illustrates the manner of using the pump. Figs. 89 to 92 inclusive are sectional views of the pump and its valves. Fig. 93 shows a form of valve for the compression pump, and Fig. 94 shows the application of a foot pedal to the pump. The materials required are as follows: A piece of so-called pure rubber tubing 1¾ inches external diameter, 1 inch internal diameter, and 9 inches long; a piece of pure rubber tubing 1 inch external diameter, ⅝ inch internal diameter, and 5 inches long; a piece of heavy pure rubber tubing ⅜ inch external diameter and 4 feet long; two wooden valve castings (shown in Fig. 90); a strip of the best oiled silk, ⅜ inch wide and 8 or 10 inches long; and some stout thread.

The piece of one inch rubber tube is cut diagonally at an angle of about 30°, so as to divide it into two similar pieces. The wooden valve casing is pierced longitudinally with a

one-sixteenth inch hole and transversely with a hole ½ inch square, and thoroughly shellacked or soaked in melted paraffine to render it impervious to air. The longitudinal hole is cleared out, and the walls of the square transverse hole are smoothed. One of the walls of the square hole into

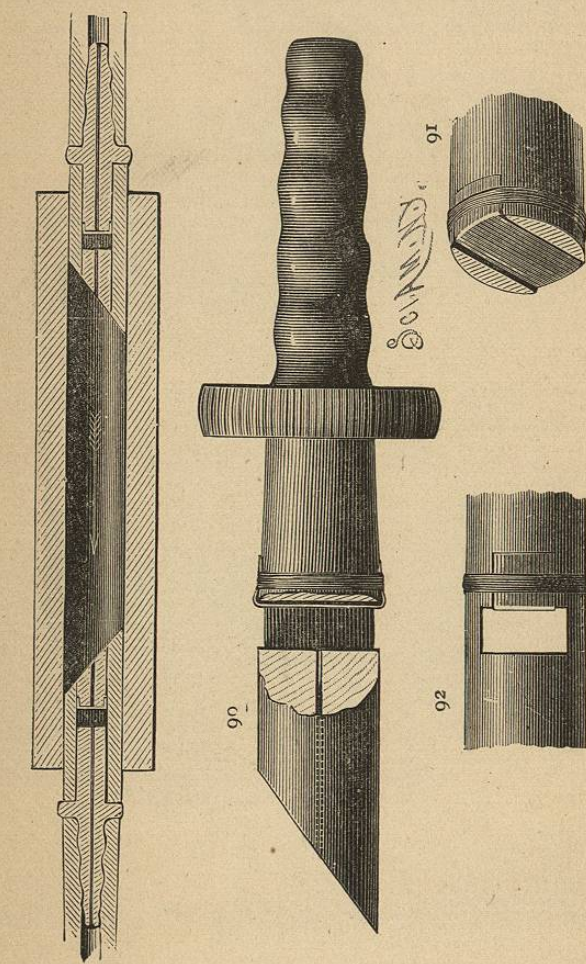
FIG. 88



Testing Simple Air Pump.

which the one-sixteenth hole enters forms one valve seat, and the other forms the other valve seat. The valves each consist of two thicknesses of the oiled silk strip stretched loosely over the valve seat, and secured by the thread wound around the wooden valve casing. It will, of course, be understood that when the valve casings are placed in the 1 inch rubber tubing, and the 1 inch tubes are placed in the ends of the larger tube, as shown in Fig. 89, the valves must both be capable of opening in the same direction, so

Fig 89.



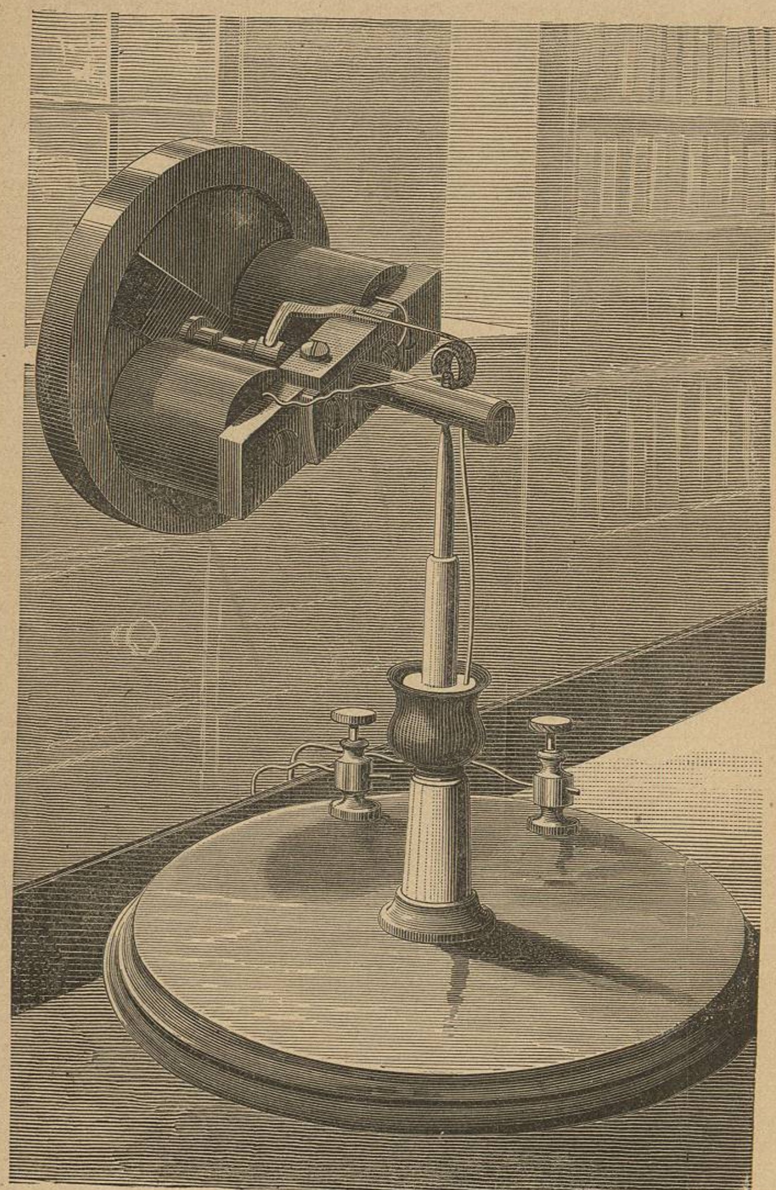
90 91 92

Fig. 89.—Longitudinal Section of Simple Air Pump. Fig. 90.—Valve Casing Partly in Section. Fig. 91.—Transverse Section showing Valve in Perspective. Fig. 92.—Plan View of Valve.

that the air may pass through the pump as indicated by the arrow, entering by one valve and escaping by the other.

The pieces of rubber tube inclose the valve casings, so that each valve has a little air-tight chamber of its own to

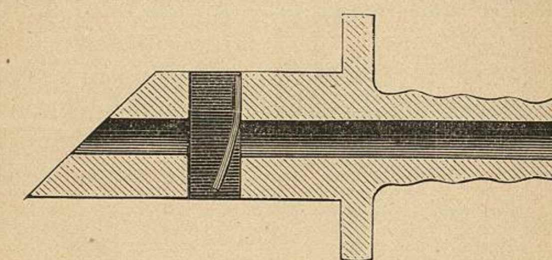
PLATE I.



An Electrical Gyroscope.

work in. The beveled ends of the rubber tube are arranged as shown in the engraving, and the inner ends of the wooden valve casings are beveled to correspond, so that when the large rubber tube is placed on the floor and

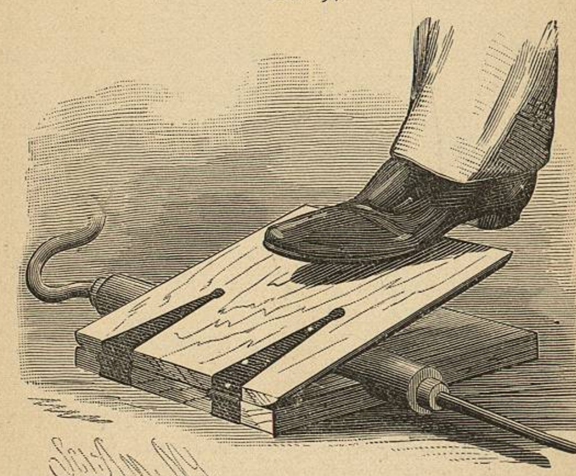
FIG. 93.



Valve for Compression Pump.

pressed by the foot, there will be very little air space left in the pump. The four-foot rubber tube is attached to one end of the pump for vacuum experiments, and to the opposite end for plenum experiments. To avoid any possibility

FIG. 94.



Treadle for Air Pump.

of the sticking of the valves, the valve seats are rubbed over with a very soft lead pencil, thus imparting to them a slight coating of plumbago, to which the oiled silk will not adhere. As an elastic rubber pump barrel of the kind described requires considerable pressure of the foot to insure the successful operation of the pump, it is advisable to construct a treadle like that shown in Fig. 94. It consists of two short boards hinged together, the lower one having a shallow groove for the reception of the middle part of the pump. The edges of the upper board are beveled at about the same angle as the ends of 1¼ inch rubber tube. The width of the hinged boards should be somewhat less than the length of the chamber in the pump. A mark is made on the side of the larger tube at one end to indicate the top, the proper position for the pump being that shown in Fig. 88.

The pressure of the foot on the side of the pump barrel expels the air through the discharge valve, and when the barrel is released, its own elasticity causes it to expand, and while regaining its normal shape it draws the air from any vessel communicating with the suction valve.

A vacuum sufficient for most of the ordinary experimental work may be produced by means of this pump in a short time. A gauge may be improvised by attaching the suction pipe to a piece of barometer tube about 30 inches long, and dipping the end of the tube in mercury, using a yard measure as a scale, as shown in Fig. 88. The pump will be found to compare favorably with piston pumps.

When it is desired to construct a pump of this kind for compressing air or for a low vacuum, the elastic tube forming the pump barrel may be larger and thinner, and the hole through the wooden valve casing may be made larger, as shown in Fig. 93, and the oiled silk valve may be replaced by a simple rubber flap valve, held in place by a single tack.

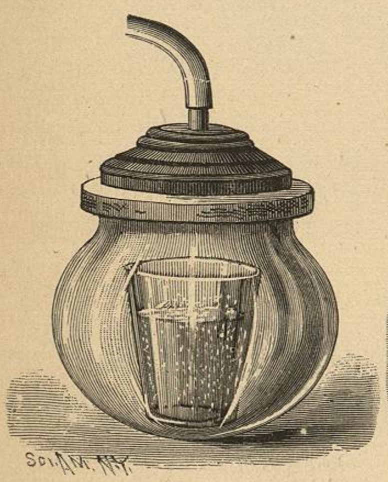
The fish globe forms the receiver of the air pump. It is closed by the soft rubber disk, which is supported by the wooden disk, the rubber being secured to the wood by four common screws passing through the rubber into the wood, about midway between the center and circumference of the rubber. Both the board and the rubber are apertured to receive a five-sixteenths brass tube, provided with a fixed collar at the top of the wood, and with a screw collar at the

inner end which is turned down upon the rubber, clamping it to the wood, and at the same time making an air-tight joint around the tube.

The suction tube of the pump is applied to the small brass tube, and the soft rubber disk is pressed down upon the mouth of the globe, when the operation of producing a vacuum is begun. After a few strokes of the pump, the cover will be retained on the globe by atmospheric pressure, and will need no further holding by the hand.

A great deal of experimental and practical work may be

Fig. 95



Water Boiling in Vacuo.

Fig. 96.

Bell in Vacuo.

done with the simple air pump described in the foregoing pages. The apparatus required for the vacuum experiments costs less than the pump. It consists of a fish globe 6 in. in diameter, a disk of thick, soft rubber large enough to cover the fish globe, a plain disk of wood as large as the rubber, two 3 in. pieces of five-sixteenths inch brass tubing, a lamp chimney with a flange on the lower end, a cork fitting the small end of the chimney, a thin piece of bladder, a thin piece of very elastic rubber, a small bell, a tumbler, a small rubber balloon, some sealing wax, some stout thread, and a piece of small wire.