Here (Figure 8) is a very efficient instrument of this kind.

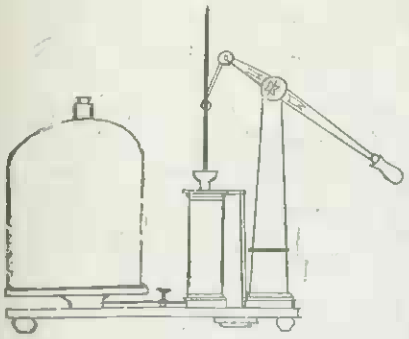

Fig. 8.

This form is known as a lever air pump. Its structure can best be understood from an examination of its parts (see figure 9)—is the barrel

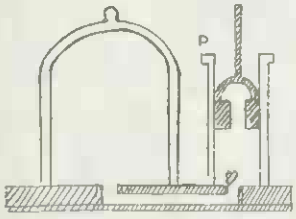

Fig. 9.

or cylinder in which works a tight piston—which is operated by means of a rod and lever. A valve—in the cylinder is made to open only in an upward direction, and a second valve—in the piston opens in the same direction. On the plate, from which a pipe passes to the cylinder a receiver is placed, and as the lever is operated, successive quantities of air are withdrawn from the receiver, so that a vacuum will be produced.

Let us test the power of this instrument. Here is a small cylinder of glass, open at both ends, except that over one, a piece of bladder has been tightly tied. As you see, I place the uncovered end on the plate of the air pump, and then the gentleman who is assisting me, exhausts the air from the cylinder. The pressure of the external air, being now unbalanced by any pressure from within, presses on the bladder covering, forces it inward, until—ah, there you heard it burst with a report like that of a gun. Now we will tie a piece of sheet rubber over the cylinder in place of the bladder, and exhaust once more. As you observe, the rubber is forced inward till it completely lines the inside of the cylinder.

Let us vary the operation once again. Instead of the bladder or the rubber, I will ask this gentleman to lend me his hand. He consents. I adjust his hand (Figure 10) over the glass, and now we will exhaust the air from within.

Fig. 10.

I see the gentlemen's hand drawn forcibly into the cylinder, and at every stroke I notice a faint cloud of perspiration filling the cylinder. The gentleman is unable to lift his hand from the glass till we admit the air.

But an illustration even more striking still is this. I take now a paid of iron half globes, made to fit accuately together at their edges, and provided with convenient handles (Figure 11). You observe

Fig. 11.

however that it is a very simple process to separate them. Now I attach the hemispheres to the pump, and the air is withdrawn. I will request some of the gentlemen to pull them apart. [Here a number of men tried to separate the hemispheres, and caused considerable merriment by their lusty and hearty efforts. Though the globe was only five inches in diameter, it required eight men to separate its parts.]

The Doctor resumed:

These pieces of apparatus are called the Magdeburg Hemispheres in remembrance of the little Saxon town at which the trial was first made. Here is another device of interest; (Figure 12), it is called the "Weight Lifter," and consists as you see of a cylinder (C) in which operates a piston (P) to which a weight of thirty pounds is attached. A tube leads from the top of the cylinder to the pump, and now observe as the air is exhausted, from within the cylinder, the pressure on the lower surface of the piston forces it upward raising the heavy weight also. These "lifters" have been constructed of such a size that two men could be raised by the atmospheric pressure alone.

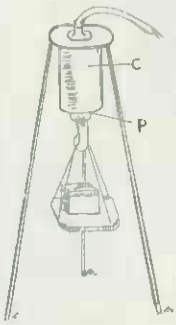

Fig. 12.

Another illustration of atmospheric pressure. Here is a conveniently shaped tube of glass, so arranged that it may be attached to the pump, and the enclosed air exhausted. This is now done.

Now I place the lower end under water, and open the passage, the result is a heavy and forcible rush of the liquid into the glass vessel forming a beautiful fountain.

An impressive illustration may be performed with the apparatus here shown (Figure 13). It consists of a stout funnel, through the bottom of which passes a plug of oak, nearly three inches long. This is placed

Fig. 13.

on the upper end of a small receiver and partly filled with mercury. The receiver is then exhausted by means of the air pump; and the pressure of the outer air on the surface of the mercury in the funnel, drives this heavy liquid through the pores of the oaken plug, so that it falls as a beautiful shower into the vessel placed for its reception within the receiver.

Here is a long glass tube containing discs of paper and others of metal of the same size. By turning the tube on end, the paper and the metallic discs fall the entire length of the tube and, as you observe, the bits of metal reach the bottom first while the paper pieces come fluttering down long afterward. It is a common but an erroneous belief that heavy weights of necessity fall more rapidly than lighter bodies. In practice this may be so because the light bodies encounter much more air in proportion to their weight than the other, and consequently their fall is retarded. Let us investigate by attaching this large tube to the pump. Now we have removed the air, and on turning the tube on end, the metallic and the paper discs fall in exactly the same time, for now there is no air to oppose the fall. The paper pieces fall as swiftly as the heavy ones. We usually do not think of the great effect produced by the air in retarding the motion of falling bodies. Here is an exhausted tube of glass containing some little water. The tube is sealed, and it is known as the water-hammer. The reason for giving such a name will be understood by all who will very quietly listen for a minute. As I turn the tube on end, you hear the contained water fall with a loud click on the glass. The fall is un-