ACOUSTIC ATTRACTION AND REPULSION.

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Much of our knowledge of wave motion is based upon the study of acoustics. A sound wave is an easily demonstrable vibration of a well known elastic medium, air. Hence, in acoustic attraction and repulsion, the properties of both the vibrating medium and the vibration are well known.

Guyot, Guthrie and Shellbach observed independently that a sounding body in a state of vibration attracts or repels objects near it. It was concluded from experiments of this kind that "the vibrations of an elastic medium attract bodies which are specifically heavier than itself and repel those that are specifically lighter."

For example, if a strip of paper is suspended at one end and a vibrating tuning fork is brought near it, the paper moves toward the fork. Air is the vibrating medium and the vibrations are composed of alternate compressions and rarefactions. Guthrie found that the air about the prong of a vibrating tuning fork is expanded. Hence, the paper is attracted to the fork owing to the difference of pressure on its two faces; the lesser pressure being on the side nearest the fork. Therefore, we may conclude that vibrations in an elastic medium cause expansion of the medium and that attraction, in some instances at least, is a function of pressure differences.

On the other hand, we read in "Ganot's Physics," Ed. 17, page 282, that a balloon of gold-beaters skin filled with hydrogen and tied down by a thread is repelled by a resonance box on which a tuning fork is vibrating. This may also be explained on the basis of pressure difference. In Figure 1, L is the hydrogen lens, with the walls A and B of thin membranous material. A sound wave, S, impinging on L is refracted outward, owing

to the relatively small density of hydrogen; L behaving like a conclave lens. The wave S exerts pressure on A. Since the wave is bent outward at B, the force due to the wave pressure may be resolved into two components, one parallel to B, and one perpendicular to it.

In other words, the force normal to the surface at B is less than at A, these unbalanced pressures resulting in movement toward X. Hence, we may have repulsion resulting from a difference in pressure. Therefore, it would seem to follow that a freely moving body in an elastic medium, different portions of which are, for some reason or other, at different densities, will always tend to move toward the region of least pressure.

This is true in the case of bodies floating on the surface of a liquid. Two bodies, both of which are, or are not, wet by the liquid, mutually attract each other, owing to the lessened pressure between them. If the liquid wets one and does not wet the other, the pressure between them is increased and repulsion results. Again we find attraction and repulsion to be functions of pressure differences.

Procure a strip of paper about two inches wide and three feet long, also a small piece of board; the top of a cigar box will do nicely. Fasten the strip at one end to some convenient support, so that it hangs freely. Then take the board and cause it to move up and down as rapidly as possible near the paper, as shown in Figure 2. The paper will move toward the board. The air has been set in motion and pressure differences have been created, resulting in the attraction of the strip. The bending of the paper away from the board at E shows that an air current traveling in that direction is producing increased pressure and hence repelling the strip.

The production of currents by an object vibrating in a fluid may be shown as follows: Fill a rather large tray about two-thirds full of water and dust some lycopodium powder, or cork filings, over its surface. Procure a glass strip and hold it so that one edge is slightly below the surface of the water. Now move it rapidly to and fro through a short distance.

Observe the direction of the currents formed. They flow in at both ends of the strip and out at the center, Figure 3. Hence, we find that the strip of glass is attracting particles at A and B and repelling them at C and D, owing to the currents produced by vibrations. However, water is only slightly compressible. For this reason the phenomena of vibrations in air differ from those in the former fluid.

To illustrate. Cause the board of experiment one, Figure 2, to rapidly approach and recede from the paper band. The band approaches the board, as before, Figure 4. The curious thing here is that the rapid movement of the board toward the paper causes the latter to approach the former in turn.

What takes place as the board nears the strip? Let us illustrate by another experiment. Cause the board to rapidly approach the rather tall flame (luminous) of a Bunsen burner. The flame darts toward the board, Figure 5, A. Now cause the board to rapidly recede. The flame follows the board, Figure 5, B. Attraction results in each case. Now strike at the flame with the board, suddenly arresting its progress just as it almost touches the flame. For an instant only, the middle portion of the flame bends away from the board, Figure 5, D.

Fig. 5.

Figure 5, C, shows what has probably taken place. Upon moving B rapidly through the air in the direction shown, the air nearest the board piles up on its surface and is slightly compressed. Hence, it is this pyramid of relatively denser air that bends the flame outward at D, Figure 5. The air further away from the center of the board spills over its edges and produces a region of lessened pressure at X. The movement of the board away from Y produces lessened pressure in this region. The air flows from X, tending to restore normal pressure at Y. Thus the movement of the flame toward the board, whether the latter is receding or approaching, is due to pressure differences caused by this motion.

A vibrating tuning fork will attract a strip of paper in its

vicinity; not only if the face of a vibrating prong be brought near the paper, but also, although to a less marked degree, if the ends are approached to it. This may be illustrated by rapidly vibrating an ordinary foot rule between the thumb and fingers, and holding one end near a strip of paper, Figure 6. The paper is attracted as before. The air forced off the end of the rule toward S does not balance the decreased pressure due to the movement of R through the air.

If, as in Figure 6, we take a tube and blow a current of air through it, the paper can be made to follow the current, upon changing the direction of the latter. Hence, these experiments to indicate that attraction and repulsion in the known elastic medium, air, are functions of differences of air pressure. Moreover, they suggest that a vibrating body in an elastic medium produce those differences of pressure which result in the phenomena of attraction and repulsion.

BOYLE'S LAW APPARATUS.

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DESCRIPTION OF APPARATUS.

The U tube is an unequal arm glass tube. The longer arm is about 18 inches and the shorter arm is 12 inches long. In the short arm is a short glass tube about 12 inches long. This short glass tube fits snugly into the short arm of the U tube by means of appropriate packing, and is fitted with a stop cock at one end.

USE OF APPARATUS.

Mercury is used in the U tube. The confined gas in the glass tube is compressed or expanded by pushing it as a piston into the short arm of the U tube.

ADVANTAGES.

1. Small amount of mercury required.
2. Ease of manipulation.
3. Compactness, simplicity and cheapness.
4. Accuracy of readings.