COMPOSITION OF VIBRATIONS.

BY GEO. M. HOPKINS.

The optical method of studying sonorous vibrations has the advantage over other methods in being of interest, not only to the student of acoustics, but also to those who care only for beautiful effects, and have no regard for the lessons they teach.

As incidental to scientific work, the effect of beautiful experiments on the latter class may be worth a little consideration, as it not infrequently happens that the mere on-looker is lured into the paths of science by such means.

Among physical experiments, none are more attractive or instructive than those connected with the subject of sound. The experiments of M. Lissajous are particularly interesting, but when the figures are produced by the apparatus employed by Lissajous, a costly set of instruments will be required.

In the annexed engraving are shown two pieces of apparatus for producing these figures; that shown in Fig. 1 being quite inexpensive, that shown in Fig. 2 being a little more costly, and, at the same time, more efficient in its performance.

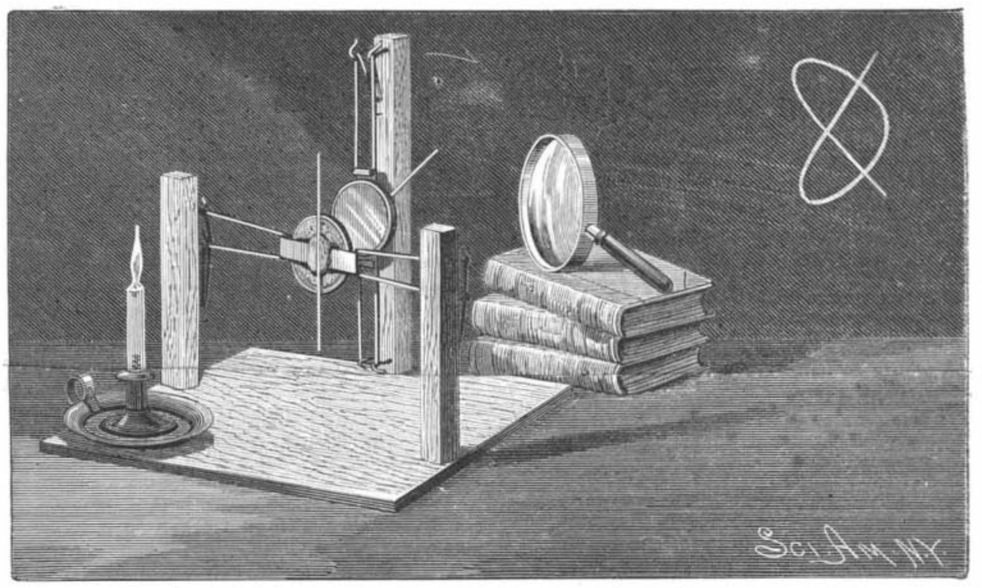

Fig. 1.—SIMPLE APPARATUS FOR PRODUCING LISSAJOUS' FIGURES.

The device shown in Fig. 1 consists essentially of two plane mirrors, supported by torsional bands of ribbon, one being supported so as to vibrate in a vertical plane, the other in a horizontal plane, the mirrors being arranged with respect to each other so that the light received by one mirror will be reflected upon the face of the other mirror, by which it will in turn be projected through the double convex hand glass, to be finally received on the wall or screen.

The mirrors employed in the construction of this instrument are the small, inexpensive circular pocket mirrors sold on the street corners. They are about 1½ inches in diameter. To adapt them for use, a strip of tin, having its ends curled up to form hooks, is secured to the back of each mirror by means of sealing wax.

A base board provided with three standards supports the mirrors in the position of use. In one of the posts near the top are inserted two ordinary wire hooks, and near the bottom are inserted two similar hooks. Rubber bands received in these hooks are inserted in the hooked ends of the strip of tin attached to the back of the mirror. Several wire nails are driven into the face of the standard, for convenience in increasing or diminishing the tension of the rubber bands, the bands being drawn forward between the hooks and slipped over one or the other of the nails to increase the tension.

The mirror thus mounted on the vertical rubber bands will, when struck lightly, vibrate in a horizontal plane. To change the rate of vibration, a weight is attached to the back of the mirror by means of beeswax. In the present case the weight consists of a piece of wire about 6 inches long. By varying position of the wire on the mirror, *i. e.*, by placing it at different angles with the rubber bands that support the mirror, the rate of vibration may be greatly varied.

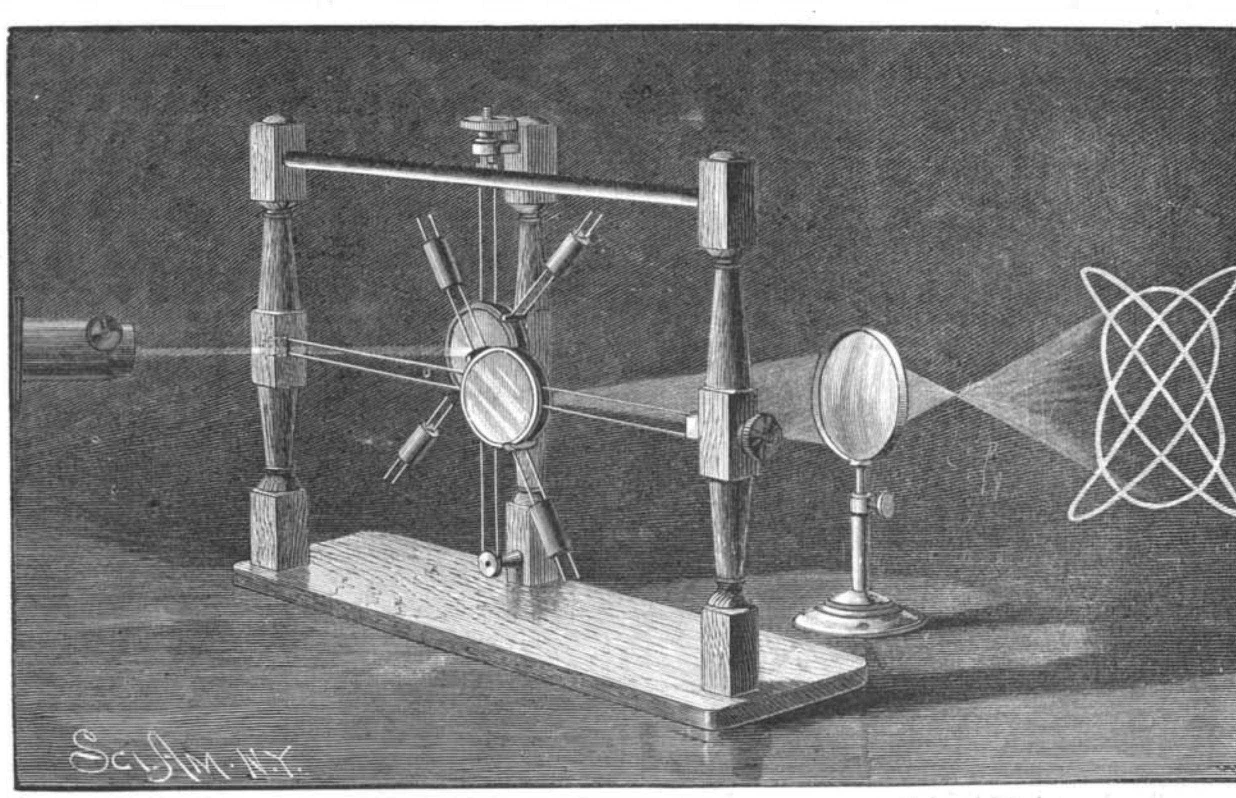

Fig. 2.—APPARATUS FOR COMPOUNDING RECTANGULAR VIBRATIONS.

The second mirror is mounted in substantially the same way, the only difference being that the rubber bands are arranged horizontally, and supported by two posts instead of one. This mirror vibrates in a vertical plane, and its rate of vibration is changed in the manner above described. A candle or other source of light is arranged so that the light from it will fall on one mirror and be reflected to the other mirror, which in turn will project it through the lens to the wall. When the mirrors are set in vibration, a figure of more or less complicated character will be produced upon the wall. If the two mirrors vibrate in unison, a straight line, or an ellipse, or a circle will be produced. If one mirror vibrates twice as fast as the other, the figure will have the form of figure 8. The figures may be varied to an almost unlimited extent by changing the tension of the rubber bands, and by shifting the wire weights. As the various figures which may be produced are illustrated in most works on physics and on sound, it will be unnecessary to illustrate them here.

The apparatus shown in Fig. 2 will now be understood with little explanation, as the principle on which it operates is the same as that of the more simple form. The mirrors are each supported by two parallel steel wires, which are really but the ends of the same wire. The extremities of the wire are securely fastened in the T-shaped head of a bolt, which in the case of the horizontal wires extends through one of the posts, and receives a milled nut, by which the tension of the wires may be varied.

The wire at its mid-length passes around a small sheave in the other post, so that as the wire is tightened the tension of its two branches will be equalized. The vertical wires are supported in the same way by studs projecting from the central post—the lower stud being provided with a sheave for receiving the wire, the upper stud being mortised for receiving the tension screw.

The mirrors are attached by small clamps which embrace both wires, and the arms supporting the adjustable weights are pivoted to the clamps. The weights may be swung in the plane of the mirror, and they are made adjustable on their supporting arms.

The best illumination aside from sunlight is that of a small parallel beam from an oxyhydrogen or electric lantern. The apparatus may be coarsely adjusted by turning the weighted arms on their pivots, and a finer adjustment may be secured by increasing or diminishing the tension of the wires.

ANTISEPTIC MOUTHWASH.—One of the greatest living authorities upon buccal bacteriology, Dr. Miller, finds that by using the following mixture he could completely sterilize the mouth, cavities in carious teeth, etc.: Thymol, 4 grains; benzoic acid, 45 grains; tincture of eucalyptus, 3½ fluid drachms; water, 25 fluid ounces. The mouth is to be well rinsed with this mixture, especially before going to bed. For retail, a mixture of water and spirit is required for a presentable preparation, and it should be made much stronger, say five ounces instead of twenty-five ounces, and diluted when required.

Paper.

To properly mix fibers we must know the way they combine to produce paper and the qualities which they should possess to that end. It was a generally accepted idea until very lately that the fibers of the paper sheet close or lock together in the same way as animal hair in felt. At the beginning of this work even, paper is described as a felted sheet. Dr. Wurster sent us at the beginning of the present year the following communication, from which it would appear that paper is not felt in the hitherto acceptation of the word, but simply "a confused mass of fiber." Here is what Dr. Wurster says:

However great progress may have been made in telling what paper is, we have yet no correct explanation of the origin and nature of the paper sheet. It has become a matter of course to consider paper as a felt of fibers, although at the beginning of the century the discoverer of the nature of the felting of animal fibers objected most decidedly to calling paper a felt. The peculiar clinging together occasioned by the animal scales in wool or hair felt, and the intertwining the hair more together by pressure and motion, making the felt thicker and smaller in its dimensions, are lacking in paper fibers.

Merely placing dry paper fibers on one another will not make a sheet of paper, as can be easily seen by using dry rag fiber or lint. Neither will short cut-wool or silk filaments make a sheet of any strength. The capacity for producing a consistent sheet of paper belongs solely to those fibers which lose their elasticity in water as they become softer, but recover that quality again in drying. In the moistened state the ductile fibers, aided by the shaking, settle down in all directions and form a confused fiber mixture. In drying, every fiber gradually recovers it original form and elasticity, and the individual fibers exert a certain pressure on each other. The longer the fibers, and the more intricate the mixture of the fibers when wet, the stronger will be the sheet of paper when dry.

When wet, or when its fibers have lost their elasticity by heat, paper cannot be drawn in every way like felt, in which each hair is, so to say, anchored to another by its scales. A sheet of paper must no longer, therefore, be designated as a felted, but as a confused, mixture of such fibers as are soft and pliable when moist, but hard and elastic when dry. The greater the shaking together of the wet fibers in both directions of the wire, the firmer and stronger will be the sheet. The shorter the fibers, the less pliable will they become with water, as in the case of ground wood, and the less will be the pressure which individual fibers exert on each other, and the more brittle will the paper sheet turn out.

Every strange material mixed with the fibers and then placed between them in the formation of the sheet prevents them from lying close together, thus lessening the solidity of the paper. We shall speak of the results of experiments in this line with sizing, mineral loading, and ground wood in future issues.—*Praktisches Handbuch.*

An English Salt Mine.

The exploration for salt at the Imperial Iron Works, South Bank, near Middlesbrough, for Mr. Coulthard, of London, has just been completed. One bed of salt, 82 feet thick, was penetrated, and a parting of anhydrous gypsum bored through into another bed of salt, 14 feet thick. As the bottom of the salt measures has not been reached, there is the possibility of other beds of salt existing. The total depth of the brine well is 1,692 feet.

TEXAS is well off in dogs, or badly off, rather, for, according to the Galveston *News*, they cost the State $50,000,000. There are 2,500,000 of them. They cost their owners 5 cents a day, or $45,000,000, and they cost sheep owners $5,000,000 more.