EXPERIMENTS IN SOUND.

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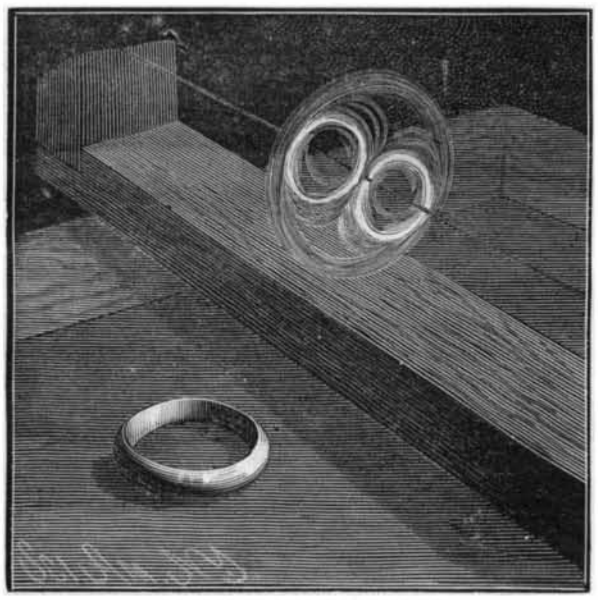
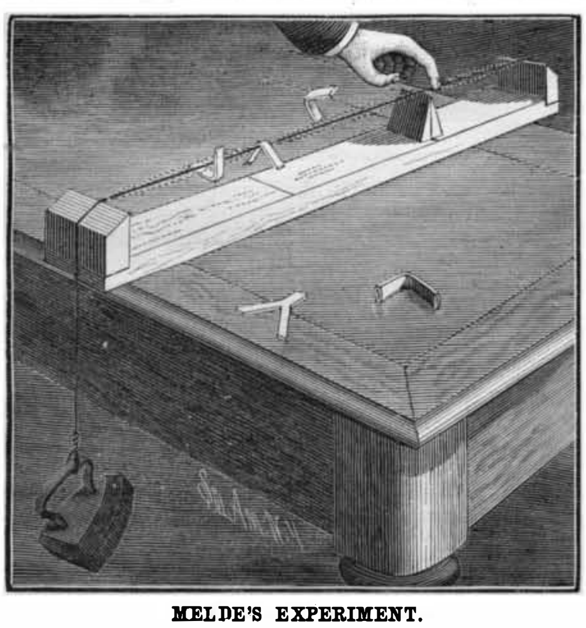
Few experiments are more interesting than those relating to sound. Although they involve some of the most delicate measurements and intricate calculations of science, yet much can be shown with the simplest form of apparatus. One of the commonest sources of musical sound is a vibrating cord. When an elastic filament is stretched between two points, and its center is drawn aside and suddenly released, it springs back under the influence of its inherent elasticity. In so doing it passes its point of rest, and swings to the



EXPERIMENT WITH RING.

other side, and returns, and thus, pendulum fashion, oscillates rapidly through the air, producing sound waves. The moving agent is the elasticity of the wire; the resistance to be overcome is the inertia of the air and of the material composing the cord. As the first and last named of these factors vary in efficiency, so will the number of vibrations. By tightening the cord, its acting elasticity is increased and the vibrations quickened. By loosening it, the reverse effect is produced. On loading it, by winding another cord or wire tightly around it, its inertia is increased, and the vibrations are made less frequent. By shortening it, it vibrates faster.

A convenient apparatus for stretching a cord is needed for experimental purposes, and such in its simplest form is shown in the cuts. It is a board with stationary bridges secured at each of its ends, over which a wire is stretched by a heavy weight. As a rule, the heavier the weight, the better. It is well, for security, to fasten down the unweighted end of the board. This constitutes a simplified monochord, or sonometer. Its base is divided by pencil lines into integral parts; thirds and fourths are shown in the drawings. A movable bridge very slightly higher than the end bridges is used to change the length of the vibrating portions of the cord. The tension of



MELDE'S EXPERIMENT.

the cord may be varied by pressure on the weight with the hand, when its note will be found to run up as the pressure is increased. This proves the first general law. By placing the bridge in the center, the note will be carried up also, one octave in amount. Loops and nodes produced by sympathetic vibration may next be shown. The movable bridge is placed over one of the end division lines. If now the short portion of the string is made to sound, by a violin bow or by the finger, the rest of the cord will be thrown into sympathetic vibration. It will sound the same note. To do this it must divide itself up into vibrating portions, each of the length of the part sounded. If the bridge is placed at the ⅓ mark, the remaining two-thirds of the cord will divide, and vibrate in two parts. Hence at the next ⅓ mark the cord will be at rest. This point is called a node, and it determines two loops of vibration, one on each side. Paper riders, cut out of light cardboard, or, what is inferior, made of paper folded and bent transversely, are placed on the cord. One rests over the ⅓ mark, and the other two are placed in the center of the loops. Now, on sounding the short portion of the cord, the middle rider is but slightly shaken, while the others are thrown off. By placing the bridge at the ¼ mark, three loops and two nodes will form, and can be proved to exist in the same way, five riders being used, of which three will be thrown off.

This proves the formation of loops and nodes. The next thing is to show them. A thread, white, and preferably of silk, is tied to the center of the cord. The other end is carried through the eye of a key, and weighted lightly, with a button or smaller key. The thread should be from four to six feet in length. Then, on sounding the cord, if all adjustments are right, the thread will be thrown into a series of beautiful loops and nodes, that can be seen with perfect distinctness, and which illustrate clearly the experiment with the riders. This is a simple version of a very famous experiment, due to Melde originally. It is usually executed with a tuning fork, and for anything on a large scale requires a diapason twelve inches long or more. The advantage of this method as a simplification is obvious. By varying the weighting of the thread, most peculiar and varied effects can be produced. A single node may be several feet long or only a few inches, the tightening or loosening of the thread producing the change.

A ring may be strung upon the cord, and the latter vibrated, when, if the ring is light enough, it will be thrown into very rapid rotation. If heavy, it may need to be started by hand, and then the cord may be vibrated. A curtain ring is of good size. It will whirl around with great rapidity, producing a very pretty effect. It operates also to prevent the cord vibrating. A light ring will rotate for a considerable period, but it will immediately stop the vibrations of the cord. Thus, after pulling or sounding the cord, a finger may be placed on it. It will be found that it is at rest, but the ring will continue rotating by its own mechanical energy. A rider may be used to show the quick cessation of vibration.

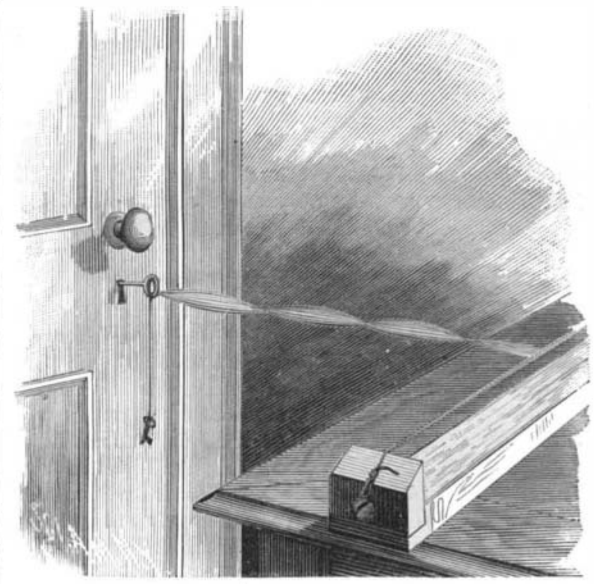
If the experimenter has a good ear, he may, even with the simple apparatus shown, go further. Thus, by shortening the string, the change of length corresponding to changes in pitch may be determined. The weights may also be doubled and quadrupled, in each case raising the note one octave, or doubling the number of its vibrations. Where a louder sound is desirable, the sonometer should be constructed of a long box, and be fitted with a thin sounding board of pine wood. More divisions may be used, so as to get any number of loops and nodes. The length may vary from two feet upward. For a vibrating cord, nothing is as good as steel wire, that may be of various sizes. A No. 16 wire should be stretched with fifteen pounds or more. For Melde's experiment, a heavy and elastic wire is requisite. Catgut is very troublesome, because of its tendency to untwist. For sounding, a violoncello bow is best, though the hand will answer.

The same experiments can be done on the large scale with a cord or wire fifteen or twenty feet long. It can be stretched across a room, and loops determined by holding it between the finger and thumb at some point of integral division. For this work, a drum snare is very good. The great point is to subject the cord to a heavy strain. Unless the cord is very tight, the experiments will fail oftener than succeed.

In the last issue of this journal, a simple whirling apparatus was described. As a matter of interest, an approximate determination of its velocity of rotation has been made, with the result that a speed of 600 to 1,000 revolutions a minute can be attained. This is ample speed for almost all experiments, and is too high for most.

Belting Experiments.

At the recent meeting of the American Society of Mechanical Engineers in Chicago, a paper was read by Mr. Wilfred Lewis, of Philadelphia, on "Experiments on the Transmission of Power by Belting." Among the conclusions reached from these experiments are the following: That the coefficient of friction may vary under practical working conditions from 25 per cent to 100 per cent; that its value depends upon the nature and condition of the leather, the velocity of sliding, temperature and pressure; that an excessive amount of slip has a tendency to become greater and greater, until the belt finally leaves the pulley; that a belt will seldom remain upon a pulley when the slip exceeds 20 per cent; that excessive slipping dries out the leather, and leads toward the condition of minimum adhesion; that raw hide has a greater adhesion than tanned leather, giving a coefficient of 100 per cent at the moderate slip of 5 feet per minute; that a velocity of sliding equal to 0·01 of the belt speed is not excessive; that the coefficients in general use are rather below the average results obtained; that the sum of the tensions is



LOOPS AND NODES.

not constant, but increases with the load to the maximum extent of about 33 per cent with vertical belts and indefinitely with horizontal belts; that as the economy of belt transmission depends principally upon journal friction and slip, it is important to make the belt speed as high as possible within the limits of 5,000 feet or 6,000 feet per minute; that quarter twist belts should be avoided; that it is preferable in all cases, from considerations of economy in wear on belt and power consumed, to use an intermediate guide pulley, so placed that the belt may run in either direction, and that the introduction of guide and carrying pulleys adds to the internal resistances an amount proportional to the friction of their journals.

DISINTEGRATION OF CAST IRON BY COAL GAS FLAME.

The engraving faithfully represents a portion of a flanged beam of cast iron recently taken from a boiler furnace in this city. The beam has never been in contact with the coals, but has been licked by the flames for about two and a half years. The cracks appearing in the surface of the iron extend in every direction throughout the mass. The character of the iron has been changed from that of the crystalline structure of ordinary soft gray iron to an apparently non-crystalline mass, to which has been given the appearance of crystallization by the cracks.

THE EFFECTS OF BURNING COAL GAS ON CAST IRON.

In some portions of the surface of the iron, the cracks give it the appearance of the bark of a tree, as shown in detail in the smaller figure.

The iron appears to be thoroughly carbonized, and is so hard as to completely resist the action of a file. The bar in its present state has scarcely strength enough to hold itself together. These facts seem to clearly indicate that unprotected cast iron is unfit for application to any portion of a boiler furnace exposed to the action of the burning coal gas.