SIMPLE EXPERIMENTS IN PHYSICS.

BY GEO. M. HOPKINS.

The application of the pendulum to the measurement of time dates from 1658. In that year Huyghens applied it to clocks. Singularly enough, this has proved to be the only practical use of any importance to which the pendulum could be adapted. The fact that millions of clocks have been made which depend on the pendulum for regulation proves the great value of Huyghens' invention.

A simple model, showing the application of the pendulum to clocks, is illustrated in Fig. 1. It is readily made, and serves to show how the pendulum acts in the regulation of a clock, and is useful for measuring seconds in experimental work. The frame is made entirely of hard wood. The three parallel plates are connected by wooden studs. The wooden arbor of the scape wheel is provided with steel wire pivots, the outer one being prolonged beyond the front plate to receive the second hand. The scape wheel consists of a disk of wood about three inches in diameter, provided with a circular row of steel pins, uniformly spaced and projecting from the face of the disk parallel with the arbor. With a disk of the size given thirty pins will be sufficient, with a larger disk sixty pins may be used.

Above the scape wheel arbor there is a wooden roller furnished with steel wire pivots. In the roller is inserted a steel wire forming the escapement or crutch, the ends of the wire being bent inward to form pallets which engage the scape wheel pins in alternation. The rubbing surfaces of the pallets are flattened and polished and the ends are beveled. In the roller is inserted a wire which extends downward obliquely through a hole in the middle plate, and is finally bent into an oblong loop extending rearward. In a split stud in the back piece is inserted the flattened upper end of the pendulum rod. A small rivet passes through the upper extremity of the rod, and prevents it from slipping through the split stud. The rod passes through the oblong loop above referred to, and is provided on its lower end with an adjustable weight of 1½ to 2 pounds.

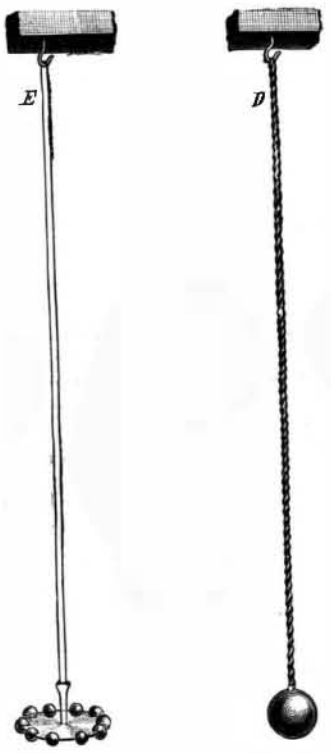

Fig. 4. Fig. 2.

TORSION PENDULUMS.

The scape wheel arbor is provided with a circumferential V-shaped groove forming a very small pulley for receiving the driving cord. Upon the middle plate above the arbor is fixed a circular block having a deep V-shaped circumferential groove for receiving and holding the endless driving cord, which passes round the arbor and grooved block as shown, and also passes around the pulley block attached to the weight. It is necessary to have the V-shaped grooves very deep and very narrow to enable them to pinch the driving cord. To insure uniformity in the action of the cord and weight, it is advisable to place in the second loop of the cord a pulley and connect with it a very light weight. When the driving weight has nearly run down, the cord may be pulled upward over the grooved block and fastened. The pendulum rod is made very thin and flexible at the upper end by hammering. The rod is made of a wire of sufficient diameter to prevent springing by the action of the escapement, and the pendulum bob is made adjustable. The distance between the center of the bob and the split stud is 39·1012 inches.

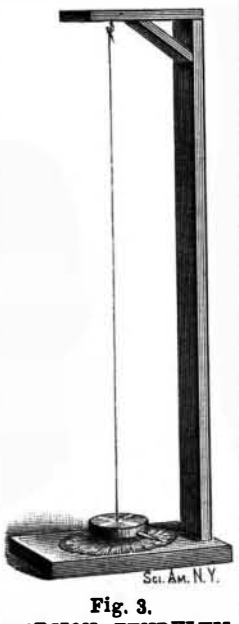

Fig. 3.
TORSION PENDULUM.

The motion of the pendulum is a result of the downward pull of gravitation and the restraint of the pendulum rod. It is forced by gravity to move until the lowest point of its arc is reached, when the momentum acquired carries it forward and upward, in opposition to the earth's attraction, until its momentum is overcome by gravity, when it stops and is again drawn down by gravity, causing it to return to the lowest part of its arc and repeat the movement just described, but in the opposite direction. But for friction of the air and of its parts, the pendulum would swing on indefinitely.

A torsion pendulum is one that depends for its action upon the twisting and untwisting of an elastic suspension. The simplest pendulum of this class is the toy known as the return ball. It consists of a wooden ball attached to the end of an elastic rubber cord. By grasping the free end of the cord and swinging the ball so as to cause it to roll in a circular path on the floor, the cord will be rapidly twisted. If, after twisting, the cord be fastened to a support, as shown in Fig. 2, it will be found that the ball will rotate rapidly by the untwisting of the cord. The momentum of the ball acquired during the untwisting will again twist the cord, but in the opposite direction. This pendulum will run more than an hour with a single winding. The period of such a pendulum, taken at random from a pile of return balls, was 1½ minutes, the rubber cord when not extended being about a foot long.

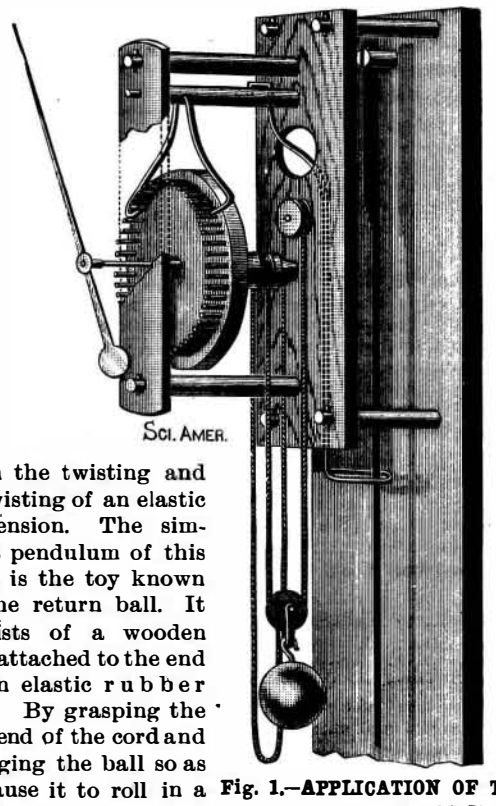

Fig. 1.—APPLICATION OF THE PENDULUM TO CLOCKS.

By means of apparatus similar to that shown in Fig. 3, Coulomb determined the laws of the torsion of wires. The wire by which the weight is suspended is firmly secured to the hook, and the weight is provided with an index. The angle through which the index is turned from the position of rest is the angle of torsion. After turning the weight and releasing it, the elasticity of the wire returns it to the point of rest and the momentum of the weight carries it forward, twisting the wire in the opposite direction, until the weight reaches a point where the momentum of the weight is overbalanced by the resistance of the wire, when the wire again untwists, turning the weight in the opposte direction. These oscillations continue until the force originally applied is exhausted in friction. The oscillations within certain limits are very nearly equal.

A torsion pendulum, with a bifilar suspension, is shown in Fig. 4. The wheel is formed of a disk of metal, with a series of split lead balls pinched down upon its edge. The wheel weighs 1½ pounds. Its diameter is four inches. It has a double loop at the center for receiving the parallel suspending wires, which are ⅜ inch apart and 5 feet long. No. 30 spring brass wire was used in this experiment. The period of the pendulum was five minutes.

The torsion pendulum has been successfully applied to clocks. Either of two results may be secured by its use. The time of running may be prolonged in proportion as the period of the torsion pendulum is longer than that of an oscillating one, or the number of gear wheels required in the clock may be greatly reduced. Ordinary clocks constructed on this principle run a year with a single winding. Clocks have been made on this plan which would run for one hundred years.

In the same year that Huyghens applied the oscillating pendulum to the clock, Hooke applied the spiral spring to the watch balance, thereby causing it to act as a pendulum. The principle of Hooke's invention is illustrated by Fig. 5. The apparatus here shown has a vibratory period of one second. The staff rests at the bottom in a small porcelain saucer and turns at the top in a wire loop secured to the base board. The disk on the staff is loaded at its periphery with lead balls. A large watch main spring or music-box spring is attached to the staff and to a fixed standard. The oscillation may be quickened by using a stiffer spring or by removing some of the balls.

In Fig. 6 is represented a model of a pendulum of recent invention which has been applied to clocks with some success.

Two cross bars are supported from the base by two wires. In the lower cross bar and in the base is journaled a wire having a hook at the upper end. This vertical wire carries a curved arm, to which is attached a thread having at its extremity a small weight, such as a button. The propelling power in this model consists of an elastic rubber band placed on the hook on the vertical rod, and received in a hook on the little crank shaft in the upper bar. The rubber band is twisted by turning the crank, and the crank is prevented from retrograde movement by the wire catch at the side of the bar.

As the arm is carried around by the power stored in the rubber band, the weight on the thread is thrown outward by centrifugal force. When it reaches one of the side rods, it wraps the thread several times around the rod, thus holding the arm until the thread is unwound by the action of the weight, when the arm describes another half revolution and the operation just described is repeated.

Antiseptic Values of Various Chemical Substances.

At a recent meeting of the Society of Chemical Industry, London, Mr. C. T. Kingzett read a paper as above. The author contended that all processes of fermentation were more or less similar in character, and that antiseptics behaved similarly toward all the organized ferments. It is not sufficient to kill the organism present, but the antiseptic reagent, to be of any real value, must also be capable of oxidizing and destroying the active poisons or toxic principles which have been produced by the micro-organisms. Most of the chlorides, nitrates, and sulphates of the metals have been examined by the author, and he has tabulated the times at which putrefaction begins in solutions of beef extract to which known quantities of these various salts had been added. Copper and mercury salts were found to be most efficient in arresting decay. The change could be readily detected by the smell, and a color change from red to scarlet, due probably to aerobic micro-organisms, also marked the commencement of putrefaction. Various organic antiseptic reagents were tried, and the periods during which they were capable of staying putrefaction noted. The new antiseptic salufer (sodium fluosilicate) was compared in antiseptic value with sanitas and the "bactericides." By far the most powerful of all antiseptics is, however, corrosive sublimate, but unfortunately this salt has no oxidizing properties, and therefore has no value for destroying the poisons produced in putrefaction. The properties of salufer appear to have been exaggerated; all acids are good antiseptics, and phenol, although limited in its uses, is to be recommended. The investigation has also shown that chloral has marked antiseptic properties, and that free boric acid is superior to borax and to the neutral borate. The bactericides are a class of antiseptics introduced by the author, which consist of any of the well known and approved antiseptic agents to which a five-volume solution of hydrogen peroxide has been added. The presence of this latter compound in the solution is of great value in supplying sufficient free oxygen to bring about destruction of the poisons produced in fermentation.

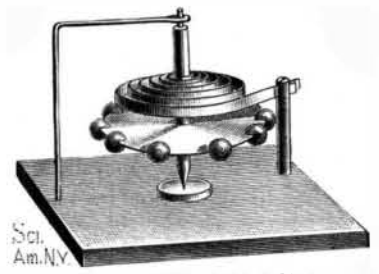

Fig. 5.—THE BALANCE.

Diphtheria from Cats.

The British *Medical Journal* mentions a report made to the Central Board of Health of Melbourne, Australia, describing an outbreak of diphtheria in which the cases occurred almost simultaneously in the neighborhood of Daylesford. The local health officer's report presents strong *prima facie* evidence that the children contracted the disease from cats, numbers of which animals were dying in the neighborhood.

Fig. 6.—FLYING PENDULUM.