demonstrate that the machines constructed by Mr. Gramme are lighter, cheaper, and better, from every point of view, than those recently experimented with on the Railway of the North."

These reservations made (and we see how necessary they were), we may go on to describe the experiment performed by Mr. Fontaine, with the concurrence of Messrs. Nysten, Dehenne, and Chretien, at the Electric Company's laboratory.

The transmission was effected by means of seven machines of a unique type called "Superior," manufactured by the inventor, Mr. Gramme. Four of these served as generators and three as receivers. Each of them developed, at its normal angular speed of 1,400 revolutions per minute, an electromotive force of 1,600 volts and a current of 10 amperes. The four generators, excited in series, were mounted for tension, with three receivers mounted in the same way with a resistance of 100 ohms. The resistance of the armature was 4·75 ohms and that of the inductor 6·5 ohms, say about 179 ohms for the resistance of the circuit.

The four generators (in the back part of the engraving) received their motion through the intermedium of two friction pulleys mounted on a shaft actuated by the engine belonging to the works. These machines oscillated upon an axle placed beneath their base; and springs regulated the pressure of the friction rollers against the driving pulleys. It was an improvement on the system employed at Sermaize in the experiments in electric plowing.

At the receiving station (foreground of engraving) the three Gramme machines were mounted in a line and connected by coupling plates of the Raffard system. The mechanical power developed was measured by means of a Prony brake placed between the first and second machines. The total weight of the seven machines was 18,480 pounds, and their total cost was $3,300.

The following table summarizes the chief conditions of the experiment performed on the 19th of October, 1886:

Speed of Gramme generators, 1,298 revolutions per minute.

Difference in potential at the origin of the conducting line, 5,996 volts.

Intensity of the current, 9·34 amperes.

Power received by the driving shaft, 95·88 horses.

Speed of receivers, 1,120 revolutions per minute.

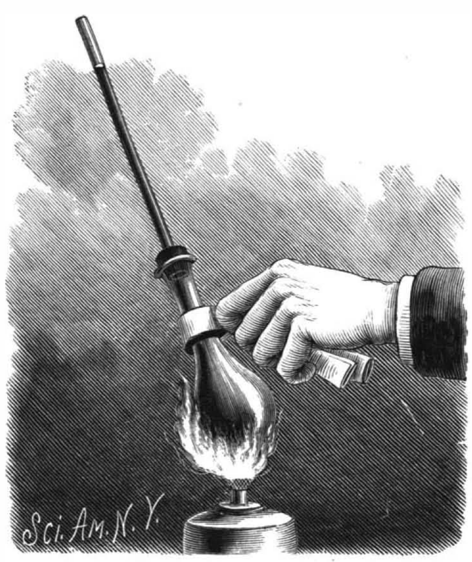
Power collected at the brake, 49·98 horses.

Industrial performance, 52 per cent.

The information gained from these experiments is that with seven Gramme machines of an ordinary type, weighing together about nine tons, and costing $3,300, it is possible to transmit a utilizable mechanical power of 50 horses through a resistance of 100 ohms, with an industrial performance of 50 per cent. But to conclude from this that material forces can be utilized to a distance of 30 miles is another matter. In fact, it does not suffice to produce this motive power at a distance, it is also necessary to distribute it, if we may be pardoned the expression, in several distinct packages, each operating independently of the others, and with a satisfactory performance.

Up to the present the problem remains intact. We do not by this mean to say that it is insoluble (the rational use of accumulators would cause many difficulties to disappear), but that it is not yet solved; and none of the experiments made in recent years shows an acceptable solution of it, since we cannot admit as practical the system that consists in actuating through the general transmission an electric generator, which in its turn sends the current into other receivers, thus interposing four transforming apparatus between the first motor and the utilizing apparatus, and reducing the performance to 15 or 20 per cent.

It is therefore necessary to make a distinction, and an important one too, between the transmissions and distributions to a slight or medium distance that have passed into industrial practice, and of which numerous applications may be cited, and transmissions to a great distance, with high tensions, for the purpose of utilizing those natural motive powers so improperly styled gratuitous. It is not necessary to enter into any great calculation to demonstrate that, in most cases, the best transmission, from an economical standpoint, is that by coal. This is the material that, for the many years still in store for it, will most simply and cheaply effect the transmission and distribution of motive power to great distances.—*E. Hospitalier, in La Nature.*



EXPANSION OF WATER.

EXPANSION OF SOLIDS, LIQUIDS, AND GASES.

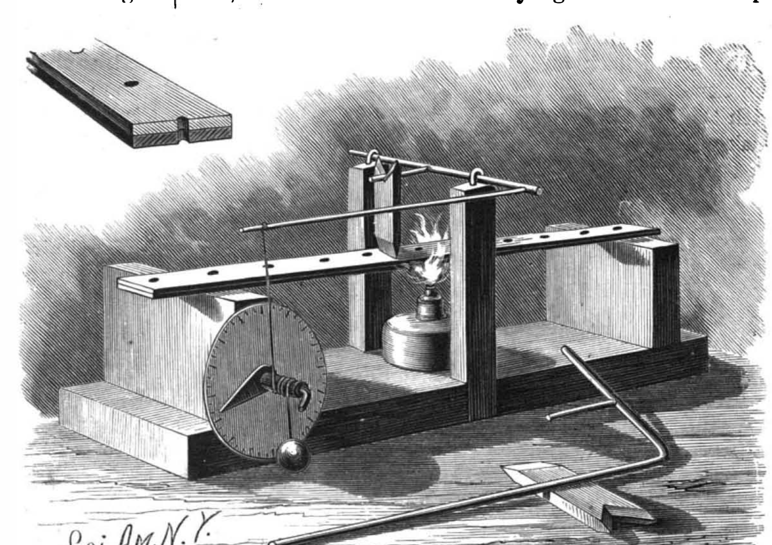
T. O'CONOR SLOANE, PH.D.

The fact that solids expand when heated having been shown, the unequal expansion of different solids when subjected to the same degree of heat should next be illustrated. An old-fashioned piece of apparatus, the compound bar, is generally used for this purpose, composed of a strip of brass riveted to a strip of iron. Each piece may be ten inches long, five-eighths inch wide, and one-eighth inch thick. A rivet every inch holds them firmly together. If such a bar is heated, the brass expands about one-third more in lineal direction than iron. As the two are rigidly connected, the only way in which this condition can be fulfilled by the components of the bar is by bending. The iron and brass bend, the brass following the outside of the curve, or position corresponding to the outer and longer arc.

While this apparatus is very sensitive, owing to its absence of lost motion, all parts being solidly connected, its movements have the disadvantage of being very small in extent. After a high temperature has been reached by five minutes' heating in an alcohol lamp, a straight-edge has to be held upon the bar to show the curvature. This is always unsatisfactory. Not only is it hard to be seen by many observers at once, but, owing to the heat of the bar, it is far from pleasant to hold the straight-edge in contact with it.

In the cut, a modification, as it may be termed, of the apparatus used for illustrating the expansion of metals is shown adapted to the compound bar.

The base and two end standards are preserved. At the center of the base two higher upright pieces are placed. A bent wire runs across the top of the wooden uprights and is attached thereto by staples, or passes through holes bored through them. Instead of a bent wire, one of which is shown lying in front of the apparatus, a straight piece just long enough to reach across may be used. In that case, a longer piece passes through a hole drilled in its end, so as to represent the arm of the other piece. In the center of the transverse portion a hole is drilled, and a piece of wire is soldered therein. This piece should be about two inches long.



THE COMPOUND BAR.

The relative sizes of the wires are largely matters of judgment. The cross piece may be about one-eighth inch, and the others one-sixteenth inch thick. The long arm is provided with a thread and weight, which are attached to its end. The thread is wound two or three times around the tubular axis of the index.

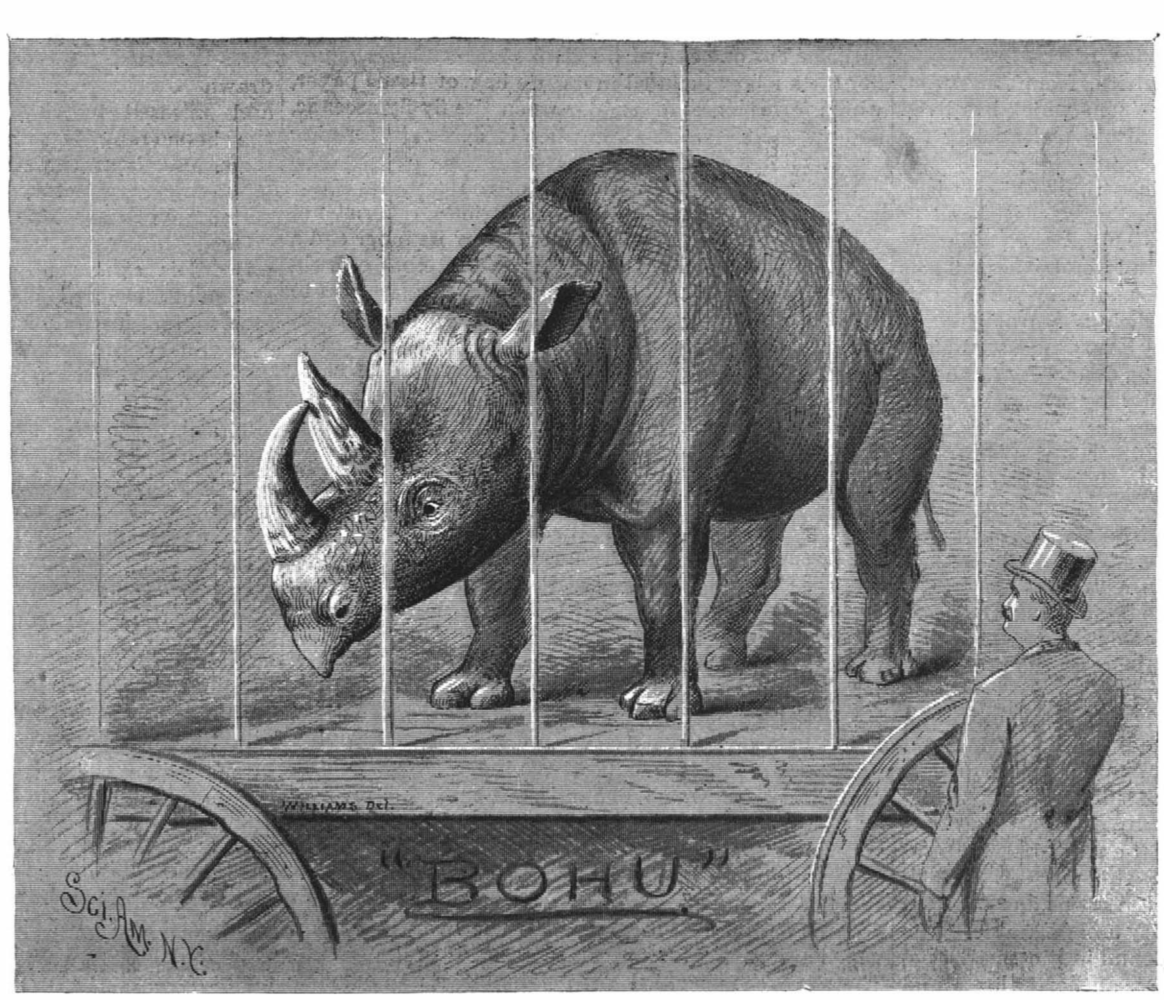
The compound bar is placed loosely over the base, resting on the two end uprights. A small piece of metal or even of wood of the general shape shown in the cut is placed vertically, one end resting on the center of the bar and the other end supporting the short arm of the wire above it. Now, it is clear that the least elevation of the center of the bar will raise the end of the short as well as long arm of the wire, and so will move the index. The bar can be lifted by hand to prove this, when the index will immediately begin to rotate.

All being thus prepared, a light is held under the center of the bar. It may be a lighted match, or an alcohol lamp may be used to better advantage. The instant that heat is applied, the index begins to rotate, and continues for some time to do so until the bar has acquired the final temperature due to the heat applied. Then all remains at rest.

The great sensitiveness of what is usually regarded as a very sluggish piece of apparatus is thus well exemplified. An experiment that generally requires five to ten minutes' time for an unsatisfactory demonstration is here carried out in a most effective manner in a few seconds.

The expansion of liquids is shown in all alcoholic or mercurial thermometers. It may, by the very simple apparatus next illustrated, be shown to an audience.

A small round-bottom flask is provided; a perforated cork and long glass tube that fits it tightly are adapted to the neck of the flask. Now, if water is introduced into the flask, and is heated, bubbles will gradually appear, due to separation of dissolved gases, principally nitrogen or carbonic acid gas. These would interfere with the demonstration, which should be carried out with a perfect liquid. Some water, therefore, is boiled



THE RHINOCEROS IN THE PARK.—[For description see next page.]

[For description see next page.]

for ten minutes, is cooled, and the flask is filled to the brim with it. The tube is inserted in the cork, so as barely to reach through it. The cork is now inserted in the flask, when water will rise a short way in the tube. It should stand only an inch or two above the cork. If it stands too high, the cork should be removed and replaced, less water being introduced into the flask. Absolutely no air must be inclosed. On heating the flask, the water will very slowly rise in the tube as the heat expands it.

The minor point of boiling the water should be attended to, as the effect is much better, and the demonstration is a true one, when no bubbles are discernible.

The same flask and tube may be used to show the expansion of gases. It is emptied, and inverted with the end of the tube under water. On heating the flask with a lamp, the air expands, and escapes in bubbles from the end of the tube. On removing the source of heat the water rises into the tube, and perhaps into the flask, owing to the contraction of the air as it cools.

THE RHINOCEROS IN THE PARK.

Bohu came to the Park only a short while ago, and is of that kind of rhinoceros which has two horns. Those of Asia have only one horn, and their skin lies in thick folds and segments, in shape like that of the armadillo. Nor are they by any means so rare as the one we have in the Park. As will be seen by the picture given of Bohu, drawn by our own artist, the upper lip of this strange beast is much larger than the under one. It is prehensile, that is to say, it can be made to curl about a branch or a wisp of straw, like the end of an elephant's trunk and with quite as much ease. Bohu is in the lion house, and at one end of it. The hippopotamus is at the other. This gives those who like to study animal life a fine chance to compare two rare forms, often mistaken, the one for the other. The last named, as will be seen by a visit to the Park, looks like a great hog in more ways than one. He has a blunt snout, short, thick legs, knows no such thing as grace when he moves, and to wallow is his chief delight. The rhinoceros, on the other hand, though in some ways like the hippopotamus, differs in these respects. It is more comely, or, rather, it is less hideous; its legs are long, its snout sharp, it does not need water to lie in, can stand for a long time, and walks with a free motion.

Bohu is still housed in the circus wagon which has wheeled her from town to town, over highways and country roads, for more than a year, and its keeper told the writer that when, during her pilgrimage, she caught sight of a fine wooded slope with verdant foliage and velvety grasses, she was sure to "make a break" to get out; for the rhinoceros takes the same pleasure in roaming over a wooded hill that the hippopotamus does in wallowing in muddy, sedgy river bottoms. Unlike the river hog, however, the rhinoceros is at times fierce, and visitors to the "show" of which Bohu formed a part had to be warned not to come too near, and it was not thought safe to let any other than her keeper enter her cage.

She belongs to the family *Rhinoceros bicornis*, has, as the name indicates, two horns on the snout, one almost straight, the other curved, and a narrow, compressed, deep symphysis, or union, of the lower jaw. She came from the north of Africa, from Abyssinia, and is said to resemble the specimen which has lived in the gardens of the London Zoological Society for nearly twenty years.

In their native wilds the rhinoceri, like bison, sleep during the heat of the day, feeding at night and in the early morning on leaves and the succulent branches of the trees and on certain kinds of bushes. Their sight is bad, and it is thought by naturalists that this comes, at least in part, from their nocturnal habits. They make up for this defect by a very keen scent, and are otherwise aided in escaping danger by feathered friends, called "rhinoceros birds," by which they are usually accompanied while roaming. These birds, at the slightest alarm, run about their heads, flap their wings, and screech a warning into their ears.

When frightened, they go off at a sharp trot, and, if danger really menaces, break into a gallop, but are easily overtaken by a good horse. The broad-nosed, or Asian, variety invariably run in a straight line, and it is said that all the hunter has to do to bring one down is to ride ahead, take a position to one side of the course followed, and let fly at short range as the beast goes by. The prehensiled lipped, or African, variety, however, will change his course when he sees the hunter close at hand, and is not, therefore, so easily brought down.

A strange habit of this kind of rhinoceros is the guiding of the calf when in flight by pressing the horns against its flanks, as if goading it on and steering it at the same time. The meat of the rhinoceros is said by hunters to be very good during the spring and summer, the rump being particularly juicy and palatable. The remains of the rhinoceri were found in the earliest deposits of this continent, and an authority has found reason for the belief that it made its first appearance here. He says:

"In the Eocene formation of the Rocky Mountains are found many modifications of the primitive perissodactyle (odd-toed) type, from which the rhinoceros may have originated, and various existing and distinct species and groups in a family, Rhinocerotidæ, which is a division of the perissodactyle section of the great order of *Ungulata*, or hoofed mammals, of which section the only other surviving members are the tapirs and horses."

SCIENCE IN TOYS.

IV.

The ascensional power of heated air is exhibited by the draught of every chimney. It is shown by the fire balloon and by the upward tendency of every flame. It is the prime factor in the propelling power of one of the ancient motors—the windmill; wind being only air rushing forward to take the place of air which is rising because it is rarefied by heat.

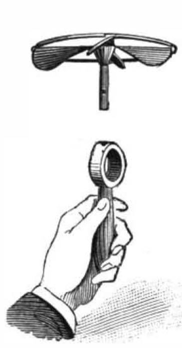
The power derived directly from an ascending column of heated air has never been utilized except as a motor for running mechanical toys, and to some extent for operating small mechanical signs.

The toy motor shown in the annexed engraving is too familiar to require description. It is generally placed over a lamp chimney or at the side of a stovepipe, where the rapidly ascending heated air may impinge on the inclined vanes. The air, acting on the vanes according to the well known law of the inclined plane, produces a lateral movement of each vane, and the vanes being restrained at the center of the wheel while free at their outer ends, are compelled to move circularly.

HOT AIR MOTOR.

The aerial top is the reverse of the toy just described. Instead of being made to revolve by a rising column of air, it is made to rise on a column of air by being revolved.

It is of substantially the same form as the hot air motor, but it is made much heavier, in order that it may acquire sufficient momentum to carry it high up in the air. With the application of a sufficient amount of force, this top will rise to a height of 150 to 200 feet. It can hardly be called a flying machine, as it does not carry its own motive power. In the next illustration, however, is shown a flying machine which in one sense carries its own power, that is, stored power.



AERIAL TOP.

It consists of a light frame furnished at one end with a slender rattan bow inclosed in a little bag of tissue paper, which forms a sort of rudder when the fly-fly ascends, and opens like an umbrella when it descends, forming a parachute, which greatly retards the fall. In the crosspiece of the opposite end is journaled a little shaft formed of a wire having on its inner end a loop receiving a number of rubber bands, which are fastened to the opposite end of the frame. To the outer end of the little shaft is secured a piece of cork, in which are inserted two feathers inclined at an angle with the plane of the shaft's rotation, and oppositely arranged with respect to each other.

THE FLY-FLY.

By turning the propeller wheel thus formed, the rubber bands are twisted, and sufficient power is stored in them to turn the propeller wheel in the direction opposite to that required for winding, and thus propel the device through the air.

Another device still more nearly approaching the ideal flying machine is shown in the annexed cut, Fig. 1 being a perspective view of the entire bird and Fig. 2 an enlarged perspective view of the working parts. It is known as Penaud's mechanical bird.

It is a pretty toy, imitating the flight of a bird very well indeed. It soars for a few seconds, and then requires rewinding. Two Y-shaped standards secured to the rod forming the backbone of the apparatus support at their upper ends two wires, upon which are pivoted two wings formed of light silk. The wings are provided with light stays, and are connected at their inner corners with the backbone by threads. In the Y-shaped standards is journaled a wire crank shaft carrying at its forward end a transverse wire forming a sort of balance, and serving also as a key for winding. The inner end of the crank shaft is provided with a loop to which are attached rubber bands which are also secured to a post near the rear end of the apparatus. Two connecting rods

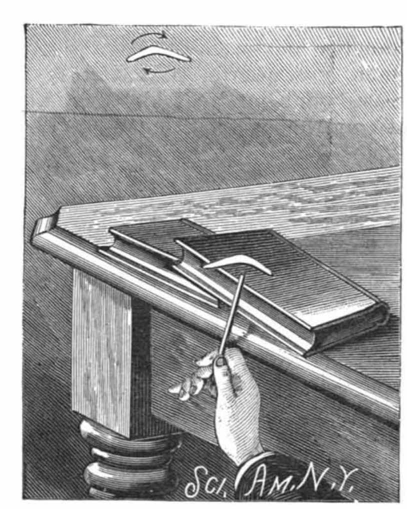
MECHANICAL BIRD.

placed on the crank are pivotally connected with the shorter arms of the levers of the wings. The rear end of the backbone is provided with a rudder.

The rubber bands are twisted by turning the shaft by means of the cross wire. When the shaft is released, it is turned by the rubber bands in a reverse direction, causing the crank to oscillate the wings, which beat the air in a natural manner, and propel the device forward. The principle of the inclined plane is involved here, but the plane, instead of being rotated, as in all the cases mentioned above, is reciprocated.

The toy boomerang, which is, in some respects, similar to the regular article, cannot perform all the feats with which the more pretentious implement is credited; but it can be projected, and made to return over nearly the same path.

The toy boomerang is made of a piece of tough cardboard cut on a parabolic curve as shown in the engraving, one arm of the boomerang being a little longer than the other. When laid on an inclined surface, as shown in the engraving, and snapped by a pencil held firmly in one hand and drawn back and released by the fingers of the other hand, the boomerang is set in rapid rotation by the blow, and is at the same time projected, the first part of the trajectory being practically in the continuation of the plane in which the boomerang is started; but when the momentum which carries it forward is exhausted, the boomerang still revolves, and maintains its plane of rotation, so that when it begins to fall, instead of describing the same trajectory as ordinary projectiles, it returns along the same path, or perhaps in a different path, toward the point of starting.



BOOMERANG.

The flatness or curvature of the boomerang and the form of its edges, as well as the position in which it is placed for starting, and the speed and manner of starting, all have an effect in determining the outward as well as the return course of the projectile.

G. M. H.

Treatment of Whooping Cough.

The following method of disinfection of sleeping and dwelling apartments and clothes is recommended by M. Mohn in the treatment of whooping cough. It is said to cure the cases immediately. The children are washed and clothed in clean articles of dress, and removed to another part of the town. The bed room and sitting room or nursery are then hermetically sealed; all the bedding, playthings, and other articles that cannot be washed are exposed freely in the room, in which sulphur is burnt in the proportion of twenty-five grammes to the cubic meter of space. The room remains thus charged with sulphurous acid for five hours, and is then freely ventilated. The children return the same day, and may sleep and play in the disinfected rooms.—*Lancet.*