straight, and the other is crossed, so that the two propellers rotate in opposite directions. A bevel pinion, which can be thrown in and out of gear, permits the horizontal shaft of the driving propeller to be started and stopped at will. Finally, the whole apparatus is stiffened by shrouds of piano wire so arranged as to resist deformation stresses. A yard, attached at right angles to the lower side of the frame and fastened firmly by stays to the other pieces, assures transverse stability.

Two details are of sufficient importance to deserve special mention. In the first place, in order to prevent deformation of the lifting propellers and to make possible their extraordinary lightness of construction, M. Santos-Dumont drives them, not by the motion of the shaft on which they are mounted, but by means of wires (visible in the diagram) which connect various points of their blades to the bicycle wheels to which the power of the motor is transmitted. In the second place, the rudder, *G*, presents the peculiarity of being movable about a horizontal axis.

I may add that the motor (constructed by the Levavasseur firm of Paris) is of the eight-cylinder type, and that M. Santos-Dumont, in order to reduce the weight of the machine to a minimum, will employ for the operator's seat an ordinary bicycle saddle attached to the platform of the motor.

The complete apparatus, manned and equipped, weighs 160 kilogrammes (352¾ pounds), of which 105 kilogrammes (231½ pounds) represent the weight of the hélicoptère and 55 kilogrammes (121¼ pounds) that of the aeronaut and a few indispensable instruments.

These figures show how far M. Santos-Dumont has gone in eliminating everything that appears to him superfluous. With a lifting power of 10 kilogrammes (22 pounds) per horse-power, the 18 horse-power which the inventor expects to develop at the propellers should produce an ascensional force of 180 kilogrammes (396 pounds), or 20 kilogrammes (44 pounds) more than the total weight of machine and operator.

The Dufaux brothers, who have experimented considerably along these lines, claim, however, that it is impossible to construct a machine within the weight given. They point out that when one deducts the weight of the motor (35 kilogrammes), the large horizontal propellers (18 kilogrammes), and Santos-Dumont (54 kilogrammes) from the total stated weight (160 kilogrammes), only 53 kilogrammes (116.84 pounds) remain for the entire framework of the machine, the vertical propeller, four bevel gears, two pulleys, two bicycle wheels, two belts, and two strong power-transmitting shafts. This, they maintain, is entirely too light a weight for all this material. Granting that the main propellers weigh only 18 kilogrammes and the motor 35, they consider that the frame and its steel wire braces will weigh fully 50 kilogrammes, the transmission shafts, gears, belts, bicycle wheels, etc., 40 kilogrammes, and the motor accessories, such as spark coil, batteries, gasoline tank, and the like, 15 kilogrammes, thus making a total weight of 212 kilogrammes, or, exclusive of the motor, 32 kilogrammes more than the propellers will be able to lift with 18 horse-power to drive them. But, according to the Messrs. Dufaux, the probabilities are that fully 9 of the total horse-power developed by the motor will be lost in transmission, which would leave only 15 horse-power, or 150 kilogrammes lift, available at the screws. This would bring the deficiency in lifting power as high as 62 kilogrammes (136.68 pounds). Besides this, no account seems to have been taken of the loss from the air resistance of the entire apparatus, and especially of the vertical propeller. Furthermore, some power must be reserved to work this propeller. In the calculation given this has not been done.

Another point which the Messrs. Dufaux bring out is that once the apparatus was in the air and the vertical propeller was set going, the machine would have a tendency to tip up, and that then the two forces would counteract one another, with the result that it would not move ahead at all, or, if it did so, this forward movement would be accomplished with uncertainty and under extreme conditions of inefficiency.

The Dufaux brothers express the opinion that Santos-Dumont is wasting his efforts and that he might better apply them to the aeroplane solution of the problem in view of the "present state of the science and the actual deplorable inefficiency of sustaining propellers." They recall the fact that nine years ago the "Avion" propeller machine of M. Ader rose from the ground by its own power, and that there have been several other attempts besides their own in this direction. The Dufaux brothers' apparatus was described in our issue of October 21 last, and still other experiments with horizontal propellers were illustrated in the Scientific American of December 9, 1905.

As to the danger of falling due to the possible stoppages of the motor, M. Santos-Dumont claims that there is nothing to fear, because the motion of the propellers would not be arrested instantaneously and they would consequently retard the fall in the manner of a parachute.

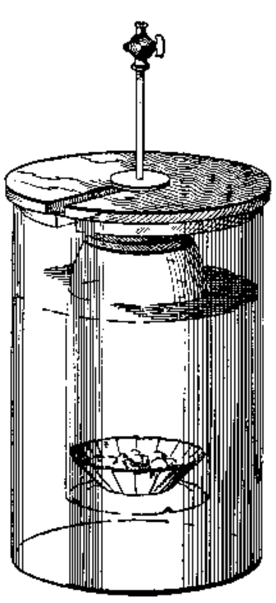
A CONVENIENT HYDROGEN GENERATOR.

BY H. B. DAILEY.

A hydrogen generator of simple and durable construction is herewith illustrated.

The apparatus will be found highly convenient for a variety of experimental uses requiring an ever-ready supply of hydrogen in small quantities. Among its particularly obvious utilities might be mentioned its use in electrostatic experimentation, for furnishing gas for exhibiting the chemical union of oxygen and hydrogen in the gas-gun or "Volta's pistol," for filling Geissler tubes before exhaustion, etc.

Beneath a flanged, radially-slotted wooden cover, resting on the rim of a 6-inch by 8-inch glass or earthen jar, is suspended a quart size glass fruit can. The suspension is effected by means of a short brass tube soldered into a central aperture in the zinc screw cover of the can, the latter being held snugly up against the wooden cover by a centrally-drilled disk of sheet brass soldered on the tube just above the wooden cover. In the bottom of the inner jar, close to the outer edge, are four openings made by filing across the corner of the can with a sharp coarse square file, kept wet with turpentine. These openings must not extend any distance up the sides of the jar; hence, the file should be held at a rather small angle with the bottom. When the square file has made a small opening, the hole should be enlarged to about 5-16 inch diameter with a small, sharp rat-tail file, wet with turpentine, the enlarging to be done in the bottom wall of the jar. Within the inner jar is a copper tray or pan with a perforated bottom, containing some lumps of cast zinc or some sheet zinc clippings. The pan is formed from a four-inch disk of sheet copper cut radially from a number of points around its circumference to within an inch of the center. The flaps or leaves thus formed are bent vertically upward until the copper will pass through the top of the can; the leaves are then sprung outward again until they fill the jar. The outer jar contains dilute sulphuric acid, whose surface should not quite reach the zinc top of the inner jar when the latter is empty of fluid. On opening the stopcock for a moment, the acid enters the inner chamber, submerging the zinc and copper, when the cock may be closed. The presence of the copper in contact with the zinc greatly hastens the evolution of the hydrogen through galvanic action. The expanding gas soon expels the acid from the inner chamber, protecting the zinc from further action, and leaving the chamber full of hydrogen under mild hydrostatic pressure. When the stopcock is opened, the escaping gas allows the acid to re-enter the inner chamber, and the generation begins anew. Before screwing on the zinc cap, its inner surface should be well smeared with tallow, to protect it from the acid-laden spray from the interior. Both sides of the rubber gasket under the rim of the cover should also be greased, to insure an air-tight joint. The slot in the wooden cover allows the removal of the fruit jar for renewal of the zinc. A sufficiency of leaden weight is attached to the under side of the wooden cover, to resist the floating tendency of the inner jar when empty. With the stopcock closed the apparatus can remain inactive indefinitely, always containing a supply of hydrogen ready for use.



A CONVENIENT HYDROGEN GENERATOR.

Simplon Tunnel Open to Traffic.

The first passenger train, carrying notabilities and officials, passed through the Simplon tunnel on January 25, 1906, amid artillery salutes.

Undertaken jointly by the Italian and Swiss governments in 1898, the Simplon tunnel was completed at a cost of more than $15,000,000. It is twelve miles long, extending from Brigue, Switzerland, to Isella, Italy.

Difficulties that at times seemed insuperable were met by the engineers. In September, 1904, came the most serious trouble; springs of hot water were encountered and the tunnel was flooded. The temperature rose to 131 deg. F. Earlier still the laborers from the Italian end struck soft material, through which it took six months to drive 150 feet of tunnel; and the cost of this stretch was $100,000.

The tunnel was opened last April. Two trains met in the middle, one being in charge of M. Brandau, the engineer who had conducted the work from the Italian side, and the other in charge of M. Rosemund, who had conducted the work in the opposite direction.

A New Brooks Comet.

A new comet was discovered by Dr. William R. Brooks, director of the Smith Observatory, and professor of astronomy in Hobart College, Geneva, N. Y., on the morning of January 26 at 15 hours. The position of the comet at discovery was Right Ascension 16 hours 19 minutes 30 seconds; declination north 47 degrees 10 minutes, with a moderate motion in a northwest direction. The new comet appears fairly bright, large, and diffused, with considerable central condensation and a very short tail. The comet is visible with a three-inch telescope, and at discovery was in the northern part of the constellation Hercules.

Burbank's Recent Experiments.

The experiments which Luther Burbank has under way are the most extensive ever carried out, but from their very nature valuable results, either practical or scientific, cannot be obtained at once. The pursuit of long periods of intensely careful and most accurate observations on a broad and comprehensive scale is the only course whereby results which will stand the test of time may be obtained. The laboratory and small field experiments of the past have never included enough species under study at the same time, and it has been impossible to draw general conclusions safely, as the different tribes and species of plants have each a slightly different story to relate. Very strong points are brought out by studying the results of these vast experiments, and much valuable material for thought will undoubtedly be found in the scientific account of the experiments.

Some of the experiments which have been carried on for the last 15 to 38 years are just coming to fruition. A partial list of the plants upon which work is now progressing includes 300,000 new hybrid plums, the work of the past 25 years in crossing about every known species, and about 10,000 seedlings of this year's growth (1905); 10,000 new apples; many thousand peach and peach-nectarine crosses; 8,000 new seedlings of pineapple quince; 400 new cherry seedlings; 1,000 new grapevines; 8,000 new hybrid chestnuts, crosses of American, Japanese, Chinese, and Italian species; 800 new and distinct hybrid walnuts, crosses of American black, Sieboldi, English, Manschurica, butternut, and others; many thousand apricots and plumcots; 5,000 select, improved, thornless "Goumi" (*Elæagnus*) bushes; very numerous other fruits in less numbers, and 10,000 new, rare, hybrid seedling potatoes.

For the past eight years Opuntias and other cacti have been secured from all parts of the world. Selections have been made and crossed and thousands of hybrid seedlings raised, some tender or hardy or gigantic or dwarf; some bearing gigantic fruits in profusion and others small ones of exquisite flavor. Some large groups have been developed which produce enormous quantities of nutritious food for all kinds of stock and poultry. This work promises well for science and economics. Perhaps the next in importance are the experiments on grasses and forage plants. Some new ones of great value are being produced and some of rare scientific value in the study of heredity and variation.—From the Year Book of the Carnegie Institution.

The Current Supplement.

The current Supplement, No. 1571, opens with an interesting article by Dr. Alfred Gradenwitz on a comparison between torpedo-boat and merchant-steamship engines. It seems that in one of the German shipyards two sets of engines, each of 3,000 horse-power, happened to be standing side by side, one destined for a merchant steamer, the other for a torpedo boat. The smallness of the torpedo-boat engine compared with the other was so great, that our correspondent thought the two would make a striking picture. The picture is published in connection with this article. Rear-Admiral George Melville continues his exhaustive discussion of liquid fuel for naval and marine uses. Lieut. Henry J. Jones concludes his admirable treatise on armored concrete. Mr. A. Frederick Collins presents a most thorough account of the De Forest syntonic system of wireless telegraphy. Interesting to automobilists is an illustrated description of a gasoline-motor-propelled roller. Franz Pabisch writes on a proposed solution of the problem of flight which is noteworthy, although not altogether unobjectionable. A short, but valuable, article is that on the transportation routes and systems of the world. One of the most valuable articles read before the recent meeting of the British Association for the Advancement of Science was that by Prof. A. E. Shipley on insects as carriers of disease. Mr. William Mayner writes on new uses of peat and various products in Germany. Maize, although an excellent food, may injure health if it be at all diseased. Hence the question of its preservation, especially during long ocean voyages, becomes of great importance. One of the simplest methods which have been devised for the preservation of maize during transportation is known as the Clayton process. This is clearly described. Dr. George F. Kunz writes instructively on the genesis of the diamond.