trestles were built along the toes from which to dump material from Culebra cut. The trestles failed after the dumping from them began, and the material overlying the rock moved laterally, carrying the superimposed mass with it. When the unsuitable nature of the ground became evident, a careful examination of the canal route from Pedro Miguel to the Pacific was undertaken, and a study of the data thus obtained led to the conclusion that one lock at Pedro Miguel and two at Miraflores offered the most economical and desirable solution. The advantages of this plan over the then existing project were that dams of lower height, less length, and resting on rock comparatively near the surface could be more easily constructed and could be completed at an earlier date; and finally that the locks in this location would be protected against all possibility of distant bombardment and would be less exposed to gunboat or torpedo boat attack. As a consequence, the commission recommended a change in the project, which received the approval of the President on December 19, 1907.

The designs for the locks are still in course of preparation, but the studies have reached such a stage that the general features will be definitely determined at an early date.

Gatun locks.—Investigations were continued during the year to ascertain the depths of the underlying strata and to determine also whether suitable material extended sufficiently far below the level on which the lock walls are to be built to carry the weight; a depth of 50 feet below this level was fixed and the borings were so made. The materials encountered may be briefly summarized as a layer of argillaceous sandstone, overlying a layer of conglomerate which is composed of pebbles and other hard aggregates held together by a cementing material, and which subsequent excavation shows to be hard enough in texture to require blasting for its removal. The borings disclosed an underground flow through the sandstone, the source of supply being apparently ground water from the hills to the southeast and at a considerably higher elevation than the lock site. It is intended now to prevent access to the foundation of this water by means of curtain walls connected with the underlying impervious stratum of argillaceous sandstone, and additional precautions will be taken if developments during construction make such advisable or necessary.

The excavation for the locks was continued throughout the year,. The total amount removed from the site was 1,769,115 cubic yards.

Gatun dam.—Investigations, primarily undertaken to verify data already on hand concerning the character of material for the foundation of the dam, were continued. A test pit, 12 feet square, was sunk in the hill through which the spillway is being cut and near its head, and this has been carried down to about 35 feet below sea level. The rock formation here is practically the same as that at the lock site. On Gatun Island a test pit 20 feet square was sunk to a depth of 68 feet below sea level. Wash borings were resorted to, but care was taken to secure drive samples whenever there were indications of any change in the character of the material.

The examinations made of the spillway indicate that the rock is of sufficient strength to bear safely any of the loads that will be placed upon it. What seepage there is occurs in the top stratum; and though this is small, it is proposed to cut it off by sheet piling projecting up into the core of the dam and down into the impervious layer.

Two experimental dams, with dimensions corresponding to the dam as it is to be built, were made on the scale of 1 inch to the foot, and these experiments show not only the suitability of the available material, but that a stable and water-tight dam can be built by hydraulic methods. Construction work at the dam during the year consisted in the removal of 918,920 cubic yards of material from the spillway.

Pedro Miguel.—As it was more advisable and economical, the Culebra division excavated the lock site down to reference 40, practically completing it to this grade at the close of the fiscal year, and removed 1,071,696 cubic yards, which amount is included in the total yardage under Culebra division.

Miraflores locks and dams.—It is shown conclusively by test pits and borings that the locks will rest on rock of ample strength to make suitable foundations. A hard limestone is found for the upper part of the site, changing to argillaceous sandstone at the lower end. The borings disclosed no such variations in the formation as exist at Gatun.

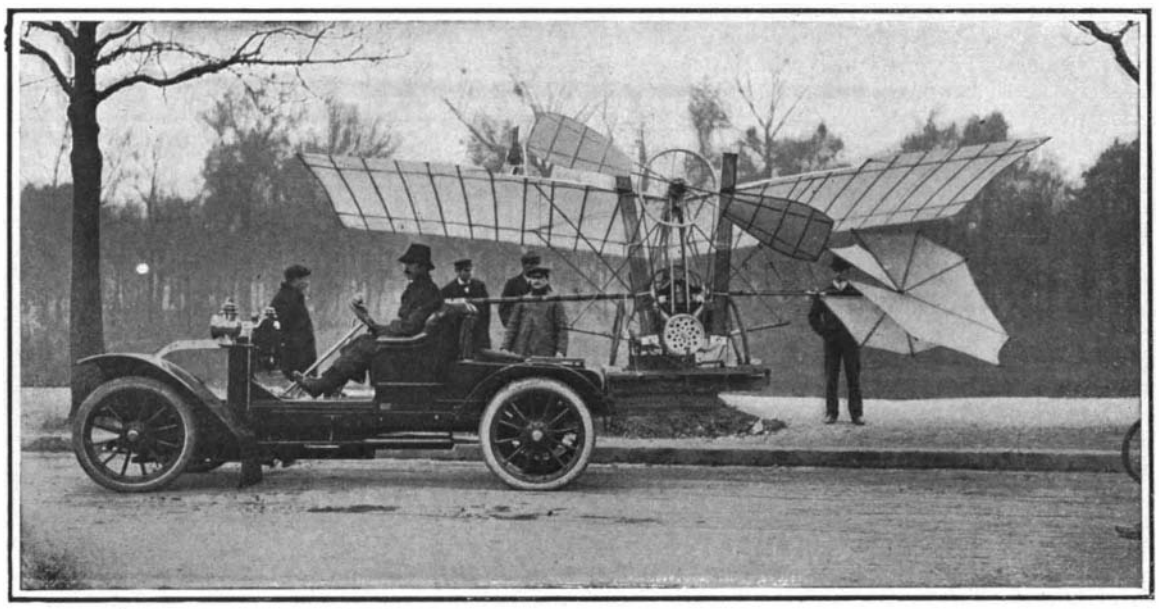
Municipal engineering.—The work of this division consisted of the completion of the waterworks, sewerage system, and paving in Panama and Colon, the cost of which is to be reimbursed to the United States through the collection of water rates in those cities, and of the construction of waterworks and sewerage systems, paving, grading, and road making in the Canal Zone. The total cost of the work done was $1,067,150.52.

Work in Panama and Colon, as originally planned, is practically completed.

SANTOS DUMONT'S LATEST AEROPLANE.

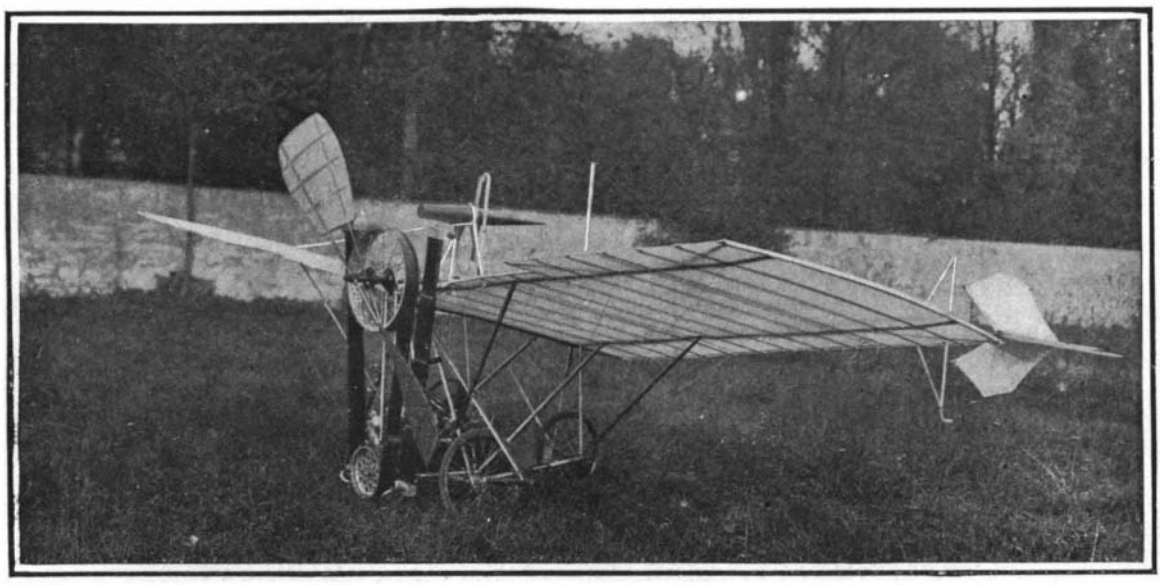
The tiny aeroplane illustrated on this page is the latest one to be produced by Santos Dumont. The noted Brazilian experimenter has not been actively engaged in continuing his experiments in aviation for the past few months, but he has now taken up the subject again, and has brought out once more the tiny aeroplane with which he made some experiments last spring.

To give his monoplane good transverse stability, Santos Dumont has placed the two wings at a slight dihedral angle and has located his seat and the motor about 3 feet below. This brings the center of gravity well below the line of support. The propeller, which is mounted upon a hollow steel shaft running in ball bearings, is placed at the front edge of the plane at the center. It is about 6 feet in diameter, with a 6½-foot pitch, and runs at a speed of 700 R. P. M. The machine as it now stands has a 24-horse-power 8-cylinder Antoinette motor, arranged on a 3-wheeled running gear. The motor drives the propeller by a wide belt. A speed reduction of about one-half is arranged for from the motor to the propeller. The normal speed of the motor is 1,300 R. P. M. Its weight complete is 127.6 pounds. A seat is provided just back of the motor for the aviator, who controls the combined vertical and horizontal rear rudder by means of a vertical wheel placed beside the motor. The entire machine complete in running order weighs only 297 pounds. The spread of the wings is but 5 meters (16.4 feet), the dimensions of each wing being 2.5 x 2.1 meters. The total supporting surface is only 10.5 square meters (113.02 square feet). A speed of about 36 miles an hour must be developed upon the ground before the machine will rise in the air.



Santos Dumont transporting his new monoplane on his automobile from Paris to his experimental field at St. Cyr.

This miniature aeroplane complete with its 24 horse-power motor weighs only 297 pounds. A speed of about 36 miles an hour must be attained with it on the ground before it will rise in the air.



The 24-horse-power, 8-cylinder motor drives the large propeller by means of a belt. The motor is mounted upon a 3-wheeled running gear and the aviator's seat is immediately behind it. Note the long vertical radiators on each side of the propeller, the gasoline tank above the wings, and the combined vertical and horizontal tail at the rear.

SANTOS DUMONT'S LATEST MONOPLANE, THE "DEMOISELLE."

This reconstructed monoplane is by far the lightest and most powerful machine of its kind that has ever been produced. With Santos Dumont in the aviator's seat the total weight to be lifted is about 411 pounds, which gives a loading of the single surface of 4 pounds per square foot. This is about the highest ratio of weight to surface that has ever been employed.

On the 12th ultimo M. Dumont tried his new monoplane (which he has christened "Demoiselle") at St. Cyr. A number of short flights were made, no particular difficulty being experienced in getting up in the air. One of these flights terminated rather suddenly, with the result that one of the wheels buckled.

On account of the small size of his monoplane, Santos Dumont was able to carry it from Paris to St. Cyr on the rear of an automobile, as is shown in one of our illustrations. This is the first time, so far as we know, that an automobile has been used for transporting an assembled aeroplane from the city to a suitable place in the country, where the aviator can conduct his experiments.

THE FOURTH AEROPLANE OF THE AERIAL EXPERIMENT ASSOCIATION.

The photographs reproduced herewith show the latest aeroplane—"The Silver Dart"—of the Aerial Experiment Association, and also the third, or "June Bug," aeroplane, which has been remodeled and mounted upon pontoons for experiments upon the water.

The fourth aeroplane which the association has constructed has the same general lines as the "June Bug," which preceded it. Some modifications, however, have been made in the curve of the surfaces and in their size and spacing, while the new machine has no tail whatever, since the later experiments with the "June Bug" showed this to be unnecessary.

While the ribs of the former aeroplanes had a reverse curve at the rear (which form of curve the experiments of W. R. Turnbull demonstrated to be the most efficient), it was thought that the upward pressure of the air upon the flexible rear edges of the planes made this reverse curve too pronounced, and tended to check the forward motion of the aeroplane. Consequently, the ribs of the new machine have only a single curvature, and it is believed that the air pressure upon the rear edges of the planes will automatically produce the slight upward curvature at this point. The width of the planes from front to back at the center has been reduced from 6½ to 6 feet, and the spacing apart of the planes also has been reduced to this figure. The width of the planes at their outer

ends is 4 feet, and they are spaced 4 feet apart. These changes have given the new machine somewhat finer lines than its predecessor. As the movable wing tips of the "June Bug" were not sufficiently powerful, larger tips have been fitted to the "Silver Dart." The total area of these is 40 square feet. The spread of the planes has been increased to 49 feet. This, added to the greater area of the tips, will doubtless give better transverse control. The total area of the supporting surfaces is 420 square feet.

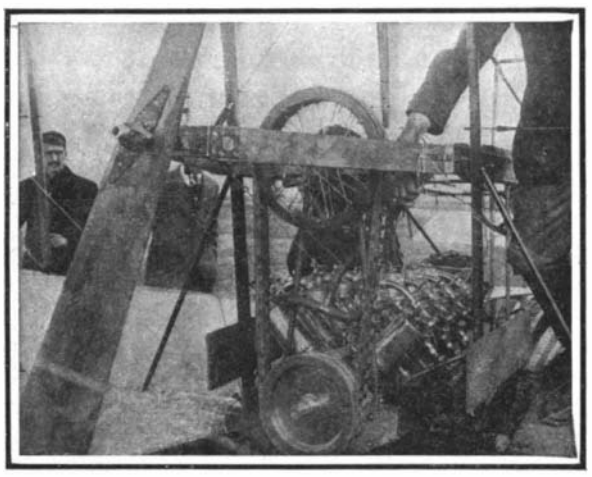
The central part of the machine, which contains the power plant, steering wheel, and control mechanism, is very substantially built, and is complete in itself. The four planes are attached to this central section (which has sockets to receive their frames), and are secured in place by guy wires tightened by turnbuckles. The rubber-covered silk forming the surfaces is made in sections, which are laced over the ribs to the frames of the wings. The ribs slide in pockets in the silk. They pass beneath the rear part of the wing frames, and abut against the back edges of the front members of these frames. Small tin caps strung on a wire that runs through a seam in the rear edge of the silk, slip over the rear ends of the ribs. This wire, which forms the rear edge of each plane, is secured to the central section and to the outer ends of the wing frame, and is drawn taut by means of a turnbuckle. The wing tips and the rudder surfaces are covered by two thicknesses of silk, sewed together, and forming a pocket that is slipped over the frame of the wing tip or rudder. This gives a smooth surface on either side of the wing tip or rudder. A rib of steel tubing is used in the main planes, at the points where uprights connect them, as this has been found to greatly strengthen the planes. The uprights fit into suitable sockets on the frames of the upper and lower planes, and are held firmly in place by the guy wires, all of which are provided with turnbuckles.

The vertical rudder is carried on hinged bamboo struts about 11 feet back of the rear edge of the central section of the planes. The dimensions of this rudder are 2 by 4 feet. A wire cable runs to the tiller of the front running wheel (which steers the machine when it is on the ground). The tiller is in turn connected to the hand steering wheel of the machine, which thus operates the vertical rudder.

The horizontal rudder is of the double-surface type, and is placed 15 feet in front of the planes. It has a direct connection to the steering post, so that by pushing or pulling on the steering wheel, the rudder is directed downward or upward. The dimensions of the planes of this rudder are 12 feet long by 28 inches wide, and they are spaced 30 inches apart. The rudder is pivoted at a distance of 5 inches back of its forward edge, and is supported upon a bamboo cantilever truss.

The center section of the aeroplane is mounted upon a three-wheeled running gear consisting chiefly of two longitudinal wood girders similar to those used on the "June Bug." There are some improvements in the construction and the material used is heavier, however. The same may be said of the fish-shaped uprights and plane frames, which are all of heavier material, and hence are capable of withstanding greater shocks.

The new aeroplane is intended to carry two persons, one sitting directly behind the other. An adjustable seat has been arranged, so that it can be slid forward or backward to the proper point when only one man is carried. The passenger is expected to sit directly over the theoretical center of pressure when the machine is under way. As a result of this, if no passenger is carried, the balance of the machine would not be affected materially. The movable wing tips are controlled by a device which does not interfere with the passengers, and which may be adjusted with the seat. The tips are controlled by the swaying of the body of the aviator from one side to the other. The rod connecting the steering column to the front rudder can be lengthened or shortened by means of a telescopic tube, in case the aviator wishes to move his seat to a point farther forward or backward. The engine of the "Silver Dart" is a 3¾ by 4-inch 8-cylinder, water-cooled, Curtiss motor, capable of developing 50 horse-power at 1,600 R. P. M. Including the radiator, water, oil, etc., the weight of the complete power plant is 250 pounds, but the engine alone can be stripped to 165. The cylinders are fitted with copper water jackets and auxiliary exhaust ports. Circular concentric valves are located in the cylinder heads, the inlet valves being automatic. The crankshaft is of specially treated vanadium steel. It is bored out hollow and is 1⅜ inches in diameter. The connecting rods are steel forgings, the cylinders and pistons being cast iron. The crank case is made of special aluminium alloy. The main bearings of the crankshaft are continuously flooded with a bath of oil by means of an oil pump of the gear type. Individual



The power plant of the "Silver Dart."
The 8-cylinder Curtiss drives an 8-foot wooden propeller by means of a V-shaped belt. The propeller makes 1,000 revolutions per minute to 1,600 of the motor.

aluminium carbureters are employed with all eight cylinders. The engine is placed upon a bed located on top of the rear part of the lower plane, and it is braced from the chassis below. The placing of the engine at this point will put less strain on the machine when landing, and will also bring the center of gravity somewhat lower than was the case with the "June Bug." The propeller, which is 8 feet in diameter, and of about the same pitch, is mounted upon a short shaft above the engine and halfway between the two planes. It is driven by twin V-shaped belts similar to those used upon motorcycles, and there is a speed reduction from the engine to the propeller of 1½ to 1. The propeller is made of laminated wood and weighs, including the two clamps on each side of the hub, 8¼ pounds. The line of thrust is about on a level with the line of resistance of the machine, but is inclined above the horizontal about 3¼ degrees.

The angle of attack of the surfaces of the aeroplane at their outer ends is 9¼ degrees. This angle is somewhat excessive, but it makes it easier for the aeroplane to rise, and probably when the machine is in flight the angle will be reduced to 5 or 6 degrees. It is on this supposition that the angle of the propeller shaft has been slightly raised above the horizontal. The proper angle for the shaft can only be found by experiment.

All the framework of the aeroplane, as well as the brace wires, etc., has been carefully measured, and the head resistance of the machine computed by the methods and coefficients employed by Mr. Octave Chanute. The equivalent head resistance of the machine in square feet of flat surface has been figured out to be 2,188.47 square inches, or 15.19 square feet.

The weight of the machine complete with a 150-pound man, and with the tanks filled with oil, gasoline, and water, is about 860 pounds, so that the loading of the surfaces is but 2.04 pounds to the square foot. This is a low figure, and should make it possible for the machine to carry a considerable amount of additional weight, and to fly at high speed.

The aeroplane "Loon," in a recent test upon Lake Keuka, at Hammondsport, N. Y., covered two miles (one mile against and one mile with a wind of 5 or 6 miles an hour) in 2 minutes and 26 seconds, or at an average speed of 27.06 miles an hour. This speed was not sufficient to enable the aeroplane to rise in the air and lift the floats upon which it was mounted. It is intended to make further experiments with a type of hydroplane hull.

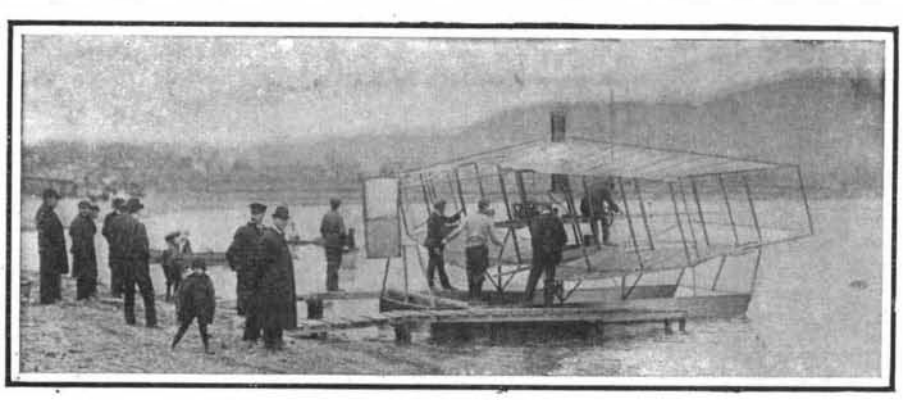
The Current Supplement.

The opening article of the current Supplement, No. 1719, describes a novel type of traction road train which has met with success in Germany. The British metallurgist Cowper-Coles has devised a process of producing electrolytic iron in the form of finished sheets and tubes. This process is thoroughly described. Selenium cells and their varied uses are ably discussed by R. A. L. Snyder. Objections have been raised to the use of water resistances for the testing of alternating-current machinery. Karl Wallin has carried out tests at the Technical School of Stockholm in order to investigate the problem, using low voltages. The substance of his experiments appears in the current Supplement. Prof. S. J. Meltzer discusses in the Supplement whether or not, as in the human-made machines, the structures and functions of the animal mechanism are provided with factors of safety. Mr. Edgar A. Custer's paper on Casting Pipes in Permanent Molds is concluded. Some time ago, the American Society for the Prevention of Cruelty to Animals offered a prize of $500 for a device which would slaughter animals for food purposes more humanely and practically than is at present the case. The report of the prize committee on the subject is published. The cash value of the prizes which have been offered up to date to stimulate aeronautic inventors amount to nearly $350,000. In the current Supplement will be found a complete list of them.

Detection of Soap Bark.

Soap bark (*Quillaja*), soap wort (*Saponaria*), and other vegetable substances containing the glucoside saponin are often added to effervescent beverages in order to give them body and to produce foam. The presence of saponin is most surely detected by Brunner's process. To 100 parts of the liquid, previously neutralized with magnesium carbonate, 20 parts of ammonium sulphate are added, and the mixture is shaken thoroughly with 9 parts of phenol. The phenol, after it has separated, is next shaken with 50 parts of water, 100 parts of ether and 4 parts of alcohol. The supernatant aqueous portion is then poured off and evaporated to dryness, and the dry residue is tested with acetone for saponin. If the liquid contains dextrine this must be removed before the process is applied.

The first annual exhibition of the Junior Aero Club of the United States will be held December 18 to 26 at Madison Square Garden, New York city, space for the purpose having been set aside by the management of the Holiday Bazaar. The Juniors will be pleased to receive for exhibition anything relating to aerial transportation from anyone under twenty-one years of age, whether members of the club or not. Contests for prizes will not be held until later in the winter, and non-members will not be eligible for such contests. All those who do not send models are cordially invited to send drawings on paper 10 x 15 inches in size, with their name, age, and residence written in the lower corner. Any boy in the United States may enter a model or drawing of a novel kite, miniature glider, aeroplane, spherical or dirigible balloon, or motor suitable for model work, etc., designed or made by himself. No models may be more than six feet in length over all, and preferably not more than four or five feet. Any kind of motive power may be used. Drawings are to be sent to Miss E. L. Todd, 131 West 23d Street, New York, at any time before December 16. Applicants should write for information with regard to the exhibiting of models.



The remodeled "June Bug" (now called the "Loon") mounted on floats.
A water-cooled motor is now used, the radiator for which can be seen projecting through the upper surface.

Front view of the Aerial Experiment Association's aeroplane "Silver Dart."
Note the two-surface horizontal rudder and the movable wing tips on the ends of the planes. There is a single vertical rudder in the center at the rear.

THE FOURTH AEROPLANE OF THE AERIAL EXPERIMENT ASSOCIATION.