THE "JUNE BUG" AEROPLANE—A COMPETITOR FOR THE SCIENTIFIC AMERICAN TROPHY.

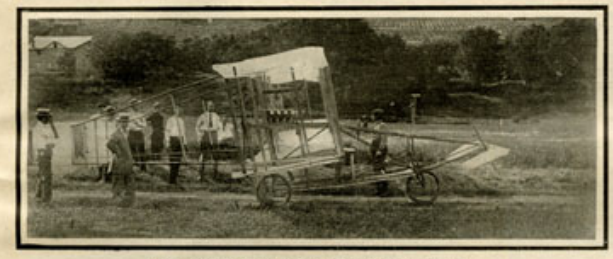
About two months ago we illustrated the second aeroplane to be produced by Dr. Bell's Aerial Experiment Association. This machine made a number of successful flights, the longest of which was made with Mr. G. H. Curtiss acting as aviator, and in the course of which a distance of 1,017 feet was covered. The chief novelty of the second machine consisted in the application of movable triangular tips to the ends of the arched aeroplane surfaces. These tips were pivoted on their forward edge and connected by a cord to the body of the aviator, so that, when making a turn, by inclining his body toward the center of the circle, he would give the inner tips a greater angle, and thus tend to turn the machine by making more resistance at the inner end. The aeroplane had pneumatic-tired wheels and was fitted with a horizontal rudder in front in a similar manner to most of the foreign aeroplanes. It was also fitted with a rectangular box tail which, however, was much smaller than the tails ordinarily used on the Farman and Delagrange aeroplanes. The motor—an 8-cylinder air-cooled Curtiss—was mounted in the center of the aeroplane just back of the aviator, and it carried a six-foot propeller on the rear end of its crankshaft. This second aeroplane was demolished when a flight was attempted in it by one of the members of the association. The construction of a third machine was immediately started. This was recently completed, experiments having been made with it last week.

Our illustrations show this machine on the ground and when in flight. The changes which have been made in the general outline and design are few, the chief of these being the fitting of a rather smaller tail and the arching of the surfaces of this tail from end to end in the same manner as was done with the main surfaces. Another new point in the design is the construction of the surfaces so that they can readily be detached from the main central chassis, a view of which is shown in one of the illustrations. The forwardly-projecting members of this chassis are no longer covered with cloth. They simply form a bamboo skeleton frame which supports the horizontal rudder. This rudder is cut away in the center so that it can move on either side of the frame. A long rod is attached to its forward edge at right angles to the surface of the rudder and connected by wires to a lever for the purpose of operating it. A steering wheel is used for working the vertical rudder in the tail at the rear, while the movable tips connected with the aviator also assist in steering.

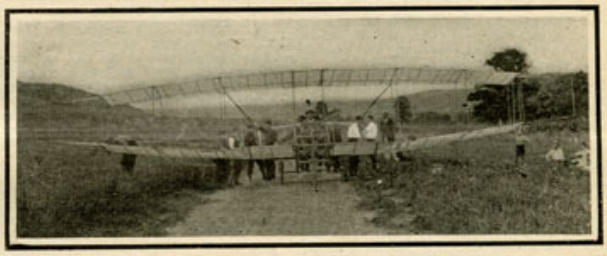
After several preliminary flights ranging from 456 to 1,266 feet, the aeroplane, which has been christened the "June Bug," on June 25 made the two longest flights that have ever been publicly accomplished by a heavier-than-air flying machine in America at any accessible place. These flights were both in a nearly straight line. The distance covered in the first flight, which was made in the morning, was 2,175 feet in forty-one seconds. This corresponds to a speed of 36.17 miles an hour. In this test, the aeroplane rose to a height estimated at about 40 feet, which is quite a considerable height for one of these machines, being about four times as high as they usually fly abroad.

In the afternoon, another flight was made with Mr. Curtiss again acting as aviator. In this, the seventh flight the machine had made, and the eighth time Mr. Curtiss had been in the air in an aeroplane, a distance of 3,420 feet was covered in a slightly-curved course in exactly one minute. This is a rate of speed of 38.86 miles an hour. Thus, in his eighth flight and his second or third attempt at flying a kilometer (3,280 feet) in a straight line (which is the distance required in the first contest for the SCIENTIFIC AMERICAN trophy), Mr. Curtiss succeeded in covering 140 feet more than the required distance over a slightly curved course, which certainly speaks well for the machine and for its aviator. Notice has been filed with the Aero Club of America for a trial for the trophy. The Fourth of July and Hammondsport, N. Y., have been appointed as the time and place for the trial. It is to be hoped, also, that this machine will be developed sufficiently so that it can fly in competition with Delagrange and the Wright and Herring aeroplanes in August, when it is proposed to have a competition for the trophy either in the vicinity of New York or Washington.

As we have no particulars of the conditions under which these two long flights were made, we can only say that according to report the aeroplane surfaces were thoroughly varnished and made airtight before the flights were attempted, and that this varnishing of the surfaces increased the lifting capacity of the aeroplane and made it possible to fly with less power air propeller. The construction of the machine in this manner is a great advantage, since it can readily be taken apart and packed for transportation when desired.



Side View of the "June Bug" Aeroplane.



Front View, Showing Movable Wing Tips.

AN AERONAUTIC SOCIETY FOR INVENTORS.

A new society to be known as "The Aeronautic Society" has just been incorporated in New York State for the purpose of exploiting aeronautics in general and the heavier-than-air flying machine in particular. This society will take the place of the Aviation Section, which the Aero Club of America started to form last spring, but which was subsequently dropped. The main idea of this new society is to help the worthy inventors to try out their ideas in a practical way. It is proposed to have a suitable ground within a convenient distance of New York city where experiments in aviation can be made; to furnish a gasoline motor for the conducting of such experiments; and to aid the members of the society in every way possible to test their ideas. Full particulars can be had from the Secretary of the Society, at 2 E. 29th Street, New York.

The society expects to bring Leon Delagrange to America, about the 20th of August, and to have him make a series of flights in the vicinity of New York. It is believed that this will stimulate aviation to a great extent in this country.

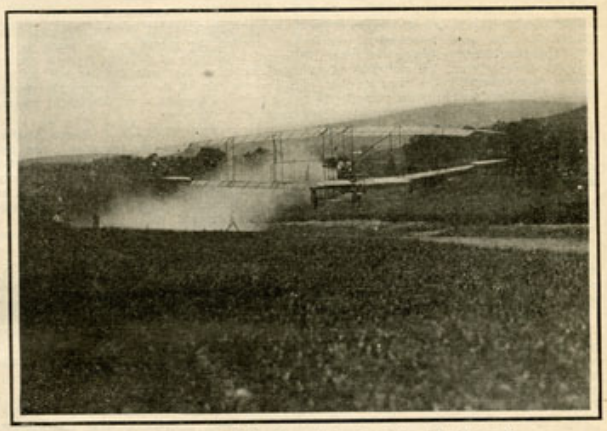
Aeronautical Notes.

On June 22, at Milan, Italy, M. Delagrange circled nine times around the Piazza d'Armi in 16½ minutes. The distance covered was 9½ miles, and the rate of speed 34½ miles an hour. The following day he remained in the air 18 minutes, but touched the ground slightly while making one of the rounds. After some further flights at Turin, it is expected that he will visit America.

The huge new Zeppelin airship, which is 426 feet long and 43 feet in diameter, and which has an envelope constructed of thin sheet aluminium stretched upon a rigid framework, made a successful trial trip on June 23, for the purpose of testing its new steering

The Central Chassis with the Planes Detached.

The horizontal rudder is carried on a forwardly-projecting bamboo frame. The motor and propeller are back of the aviator. The center part of the upper plane is seen at the top.



The Aeroplane in Flight, Just After Leaving the Ground.

Note the cloud of dust raised by the machine; also its apparent stability.

THE "JUNE BUG"—THE THIRD AEROPLANE OF THE AERIAL EXPERIMENT ASSOCIATION.

than had been required hitherto. In the first long flight the machine is said to have tipped sharply to one side shortly after it rose in the air, but the aviator was able to right it again by means of the movable wing tips, and from then on he managed to keep it level. No difficulty was had in rising from the ground after running along on it a distance of about 100 feet.

The center part, or chassis, of the aeroplane, which is shown in one of our photographs, developed a speed of 45 miles an hour when driven along the road by the gear. The airship remained in the air 2 hours and 13 minutes, maneuvering above Lake Constance and several of the towns on its shore. The steering apparatus worked perfectly, and Count Zeppelin was quite satisfied with it. After a few more tests have been made, it is expected to make a long flight.

The new 328-foot French military dirigible "La Republique" made its first flight on the 24th ultimo. The flight lasted 35 minutes. The airship traveled at a height of some 300 feet, and carried a dead weight of 2,800 pounds.

SCIENTIFIC AMERICAN

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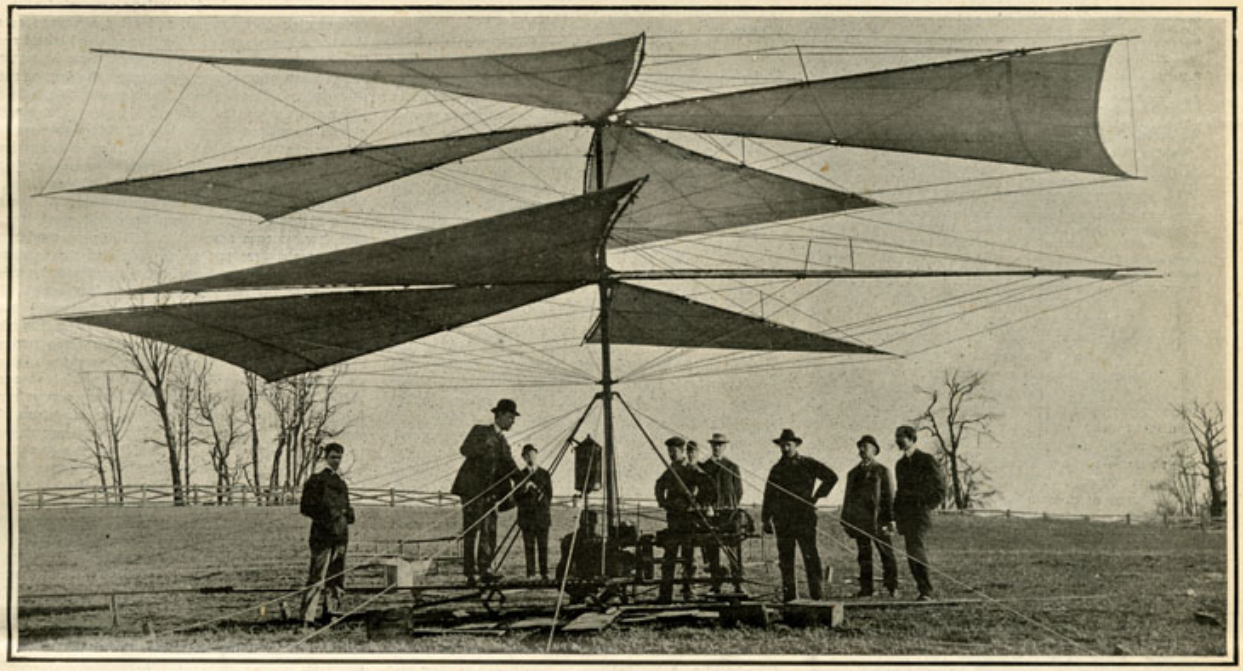
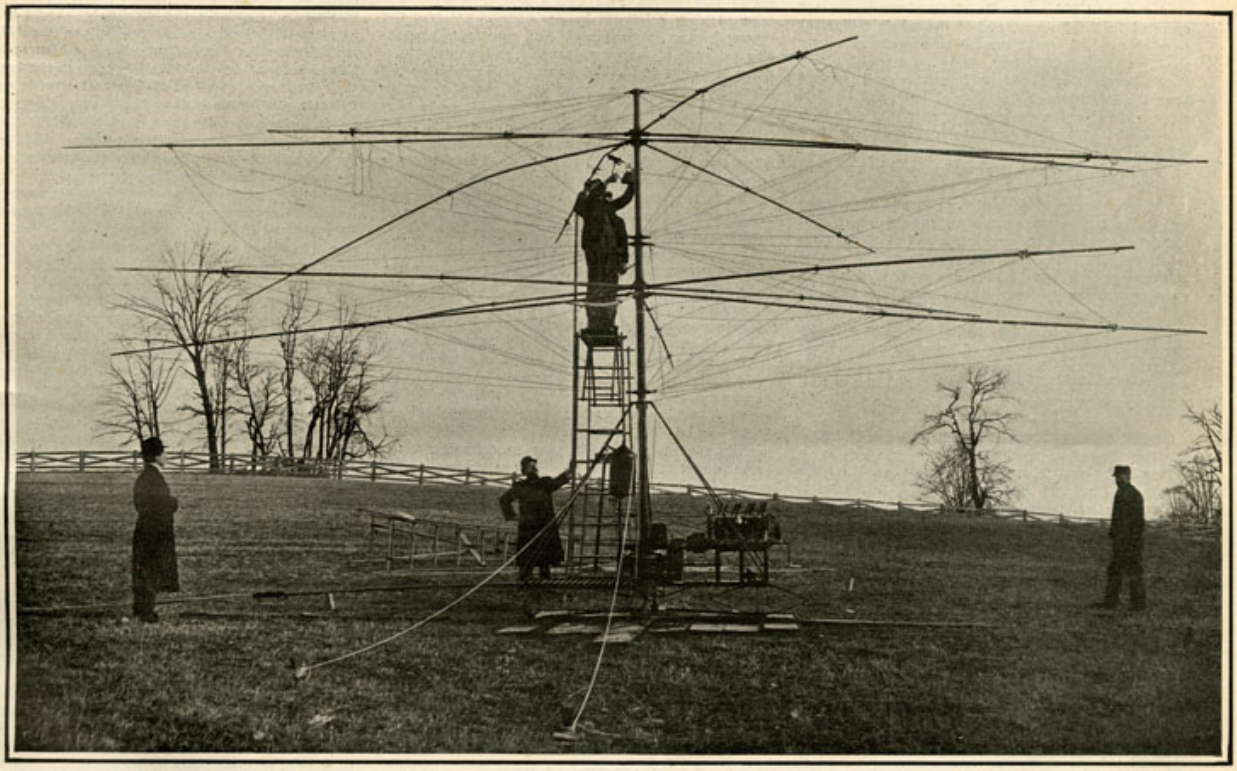


Full-sized Model of a Helicopter Built for Experimental Purposes.



The Revolving Blades Are Attached to Concentric Steel Shafts Rotated in Opposite Directions.

Diameter of propellers, 35 feet. Area, 850 square feet. Revolutions of fans, 31 per minute. Revolutions of engine, 1550. Brake horse-power, 20. Lift on measuring springs, 700 pounds. Lift per horse-power, 35 pounds.

THE LUYTIES HELICOPTER, PROBABLY THE LARGEST EXPERIMENTAL ROTARY FLYING MACHINE EVER TESTED.—[See page 27.]

was taken for the purpose, and the roof of the Chapter House may be detected rising on the western side of the south transept. There was also a school for the choir boys at the east end.

The interior of the cathedral was very spacious, but was much blocked up with monuments. Those to Sir Philip Sydney in the north aisle of the choir near to Sir Francis Walsingham, and one of enormous size to Sir Christopher Hatton, in the south aisle, were there in Shakespeare's time. An older tomb was that of Sir John Beauchamp, popularly believed to be that of Humphrey, Duke of Gloucester, who was however buried at St. Albans. "To dine with Duke Humphrey" meant to wander dinnerless in the cathedral nave. St. Paul's was a cathedral of what is known as "the old foundation." In churches of this type there was a dean assisted by canons, who were responsible for daily services. They were not monks but ordained clergymen, each of them endowed with an estate. Most of these estates were in the neighborhood of London, and the canons, their owners, lived on them as country squires. By degrees they all leased away their prebends, and the modern canons are specially endowed but without estates. The edifice was destroyed in the great fire of 1666, when history records that the lead of its roof and rebuilt spire "ran off like water."

The view of Cheap or Cheapside, that is, the north side of Cheap, shows perhaps more power of realizing an ancient scene from moderate materials than any of the other models. Here we see the old market, with its space for movable stalls, for occasional tournaments, and for the daily and weekly sale of honey for sweetness, of fish for fast days, of wine, of bread, of fruit, of poultry, as well as the more permanent purposes of the mercers, the hosiers, the cordwainers, the furriers, and all the other merchandise of a great city. We can understand when we see the space between the Cross and the Conduit that in the days of Edward I all the "selds," or booths, were cleared out of Cheap for the homecoming of the King and Queen from the Holy Land, and in the days of Edward III, when the young king held a tournament in honor of his young queen. The lists were set up between the Cross and Conduit, near Bow Church, where we may suppose the space was widest. A scaffold fell. The mayor would have prosecuted the carpenters, but the queen saved them from punishment, and we read, "purchased great love of the people."

"The Outfall of the Fleet" is the title of a long and interesting model which shows the edge of the Thames in Elizabeth's time from Bridewell to Banyard Castle. A great point of interest in this model is that it marks the old houses of Blackfriars, which, on account of sanctuary, were the site of the theater, whose place is still marked by Playhouse Yard in the Times office. We know that Shakespeare had some estate here in Blackfriars, and a deed relating to it is in the library of the London Guildhall.

GOVERNMENT TESTS OF MINE EXPLOSIVES.

(*Concluded from page 28.*)

plosives. The characteristic of the safety powders is the production of a small flame, and of short duration, so that the products of combustion after the explosion in the drill hole are cooled down before reaching the surface. The heat being partially absorbed by the surrounding walls, and the flame being small and of short duration, reduces the chance of a gas or dust explosion to a minimum. An explosive in which the rate of detonation is too rapid may blow out the coal too quickly, and project its flame immediately into the inflammable gas mixture. Gelatine dynamite and other high-grade dynamites may be classed in this list. On the other hand, black blasting powder, while it does not detonate in practice and perform its work quickly, causes explosions on account of the large flame and its duration which brings it in contact with the inflammable gas mixture.

Early attempts to reduce the length of flame by surrounding the explosive with material containing water were unsuccessful. The incorporation in the explosive of chemicals containing hydration water, as the class containing less than 30 per cent of nitro-glycerine, have proven quite successful, as have the nitrate of ammonium class in less degree.

The use of dynamite and black blasting powder in foreign coal mines which are known to generate gas or are troubled with coal dust has been prohibited, and they have almost universally been replaced by the so-called safety powders.

The apparatus used at the German station to determine the length of flame consists of a steel cannon, which is loaded with the explosive to be tested and fired. The flame is photographed at night upon a rotary drum. The entire photographic instrument consists of a wooden box provided with a quartz camera lens for focusing the ultra-violet rays. Inside the camera a rotary drum covered with sensitized film is fixed between two pointed screws in a guide bracket. The drum is motor driven, and the number of revolutions recorded on a vibration tachometer. A cartridge of the explosive to be tested is inserted in the borehole of the cannon, and as soon as the tachometer indicates the desired drum speed, the shot is fired electrically. The cannon is seen in Fig. 2.

The Rate of Detonation.—The rate of detonation is to be determined upon a recording device which operates electrically. The apparatus comprises a soot-covered drum, with pointed platinum terminals, tooth gear and measuring adjustment, an electric motor, vibration tachometer, and sparking coils. The rotary drum is made of bronze, the lower edge being fitted with teeth, of which there are the same number as there are millimeters to the circumference, about 500. The drum is operated by the motor, and its peripheral rotation speed and the device for reading it are so that the distance between two points of the drum may be measured with 100th part of a millimeter. An iron pipe is filled with the cartridges to be exploded. This pipe is 30 millimeters inner diameter, and the density of the charges plays a very important part in regard to correctness of results. The apparatus for determining the rate of detonation is seen in Fig. 3. In operating the recorder, the electrical current is shunted through resistances and connected in parallel with primary and secondary coils in such manner that when these circuits are broken by the explosion, a succession of corresponding sparks is emitted by induction from the terminals of the secondary connections, thereby marking the blackened drum. Owing to oscillation, the discharge appears on the drum as a row of points.

The Calorimeter.—This apparatus is constructed to measure the amount of heat given off by the detonation of explosive charges of up to 100 grammes. From the calorimetric results obtained, the maximum temperature of explosion is calculated according to Berthelot's well-known formulas. This apparatus consists of a calorimetric bomb, an inner receiver or immersion vessel with a tub, registering thermometer, and a hooking frame. The charge, about 60 to 100 grammes, is filled into a glass beaker, an electric detonator being also inserted therein. The connecting wires are fixed around the glass vessel, which is suspended in the bomb cavity, and then severally connected to the pin in the stopper and the projecting valve nozzle. After charging and closing the bomb, the air is exhausted and the valve shut. The sheet nickel receiver rests in its tub on a triangular wood block. Inside the receiver a shallow tripod ring is placed, and on to this the bomb in its hooking frame is lowered. The receiver must contain sufficient water to cover the whole of the bomb up to the screw in the lid. The calorimeter is seen in Fig. 4.

THE SCIENTIFIC AMERICAN TROPHY.

A tower for the wireless telephone will be built by Dr. Lee DeForest on the roof of the Terminal Building at Park Avenue and 41st Street. The steel structure will rise 85 feet above the top of the Terminal Building, with poles extending above the tower itself for an additional 40 feet; the tips of the poles will thus be 300 feet above the pavement.

THE FIRST TRIAL FLIGHT OF AN AEROPLANE FOR THE SCIENTIFIC AMERICAN TROPHY.

Over a year ago the proprietors of the SCIENTIFIC AMERICAN presented to the Aero Club of America for annual competition the handsome silver Trophy shown in the accompanying illustration. The deed of gift provided that this trophy should be competed for annually by heavier-than-air flying machines only, and that the conditions to be fulfilled in competing for it should be changed from time to time so that they would always be a little more difficult than that which had actually been done. In this way it was hoped that not only aeroplanes, but that all types of flying machines (such as helicopters, or lifting-propeller apparatus, and ornithopters, or flapping-wing flyers) would receive encouragement and be rapidly developed.

The date set for the first contest for the SCIENTIFIC AMERICAN Trophy was September 14, 1907, and the place the Jamestown Exposition. A flight of a kilometer (3,280 feet) in a straight line was required, as this was thought to be sufficiently easy for any new aeroplane to accomplish. As no machines were ready at that time, there was no contest for the year 1907, and up to a short time ago no machine had been brought forward in America capable of making a straight-line flight of this length, with the exception of the Wright brothers' aeroplane.

Of all the efforts being put into the development of flying machines in America, none has been more systematic and thorough than that of the members of Dr. Alexander Graham Bell's Aerial Experiment Association. This association was formed last summer for the purpose of assisting Dr. Bell to develop his tetrahedral-cell aeroplane. In the last six months the members have experimented with no less than three separate aeroplanes—the "Red Wing," the "White Wing," and the "June Bug." The first of these was fitted with runners, and it rose successfully from the frozen surface of Lake Keuka on March 12 and made a short flight of 318 feet and 11 inches. This was the first aeroplane that has ever been tested in this way. The farthest distance flown by the "White Wing," which was mounted on wheels so as to run along the ground and rise in the air, was 1,017 feet. The "June Bug," which was only recently completed, has made a number of flights, the longest of which was 3,420 feet, or 140 feet more than a kilometer. As soon as it had succeeded in covering this distance, the association requested the Aero Club to give their machine a first official trial for the SCIENTIFIC AMERICAN Trophy. Arrangements were made for this trial to be held at Hammondsport, N. Y., on July 4. We expect to describe this test in our next issue.

The holding of the trial on Independence Day was a particularly fitting date for an American machine to fly for a trophy offered by the oldest American mechanical journal for encouraging the development of the new science of aviation—a science which originated in this country as far as the application of mechanics to flight is concerned, and the leading exponents of which in the world to-day are American citizens—the Wright brothers. Although great strides have been made in France during the past year in the development of aeroplane flying machines, the success of the Aerial Experiment Association's latest aeroplane augurs well for an even more rapid development of such machines in this country from now on. As soon as a general interest is aroused by public demonstrations, encouragement will be offered to the inventors of our country to redouble their efforts to develop a successful and commercial flying machine.

As a result of a preliminary correspondence with several leading aviators, we feel certain that within two or three months we shall be able to announce a contest for the trophy in which those most skilled in the new science, both here and abroad, shall meet and demonstrate who has the better machine.

As can be seen from the illustration, the SCIENTIFIC AMERICAN Trophy consists of a handsome silver globe representing the firmament. Prof. Langley's aeroplane is shown soaring through the clouds, surrounded by a number of birds. The American eagle surmounts the globe and on the reverse side of it the North American continent is shown. The globe is mounted upon a handsome pedestal, on the base of which are horses whose riders bear aloft palm branches and wreaths of victory. The trophy is a masterpiece of the silversmith's art. It stands 32 inches high over all and is valued at $2,500, but the real value is much greater, for it will prove a strong stimulus to the science of aviation.

SUCCESSFUL TEST OF NEW YORK'S NEW HIGH-PRESSURE FIRE SERVICE.

(*Concluded from page 24.*)

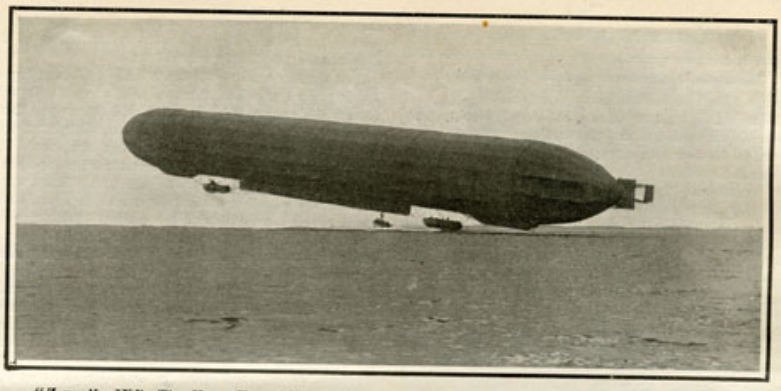
pumps are direct-connected and the former are rated at 800 horse-power each and are constant-speed induction motors using three-phase alternating current of 25 cycles at a pressure of 6,300 to 6,600 volts, and like the pumps were built by the Allis-Chalmers Company. Centrifugal pumps were

which contain 13,000 cubic meters (459,090 cubic feet) of gas. The diameter of the balloon is 14 meters (45.8 feet).

The "Zeppelin III." was only 130 meters (426½ feet) in length, with a gas capacity of 10,000 cubic meters (353,150 cubic feet). Its record for speed was about 33 miles an hour, and it remained in the air eight hours and covered 217½ miles.

After a short initial trial on June 21, some changes were made in the rudders. The manageability of the airship was bettered and, after a few subsequent demonstrations, it made a long flight of some 248 miles, remaining in the air 12 hours, as reported in our last issue.

The new airship has separate power plants, each of which consists of a 120-horse-power 4-cylinder engine driving twin propellers. It is fitted with vertical rudders at each end, and at the rear there are slightly inclined, nearly horizontal stabilizing planes placed at an angle with each other of about 30 degrees. The new airship has shown a speed of 34½ miles an hour. The German government expects to have several duplicate air craft built by Krupp, and to use them upon the frontier.



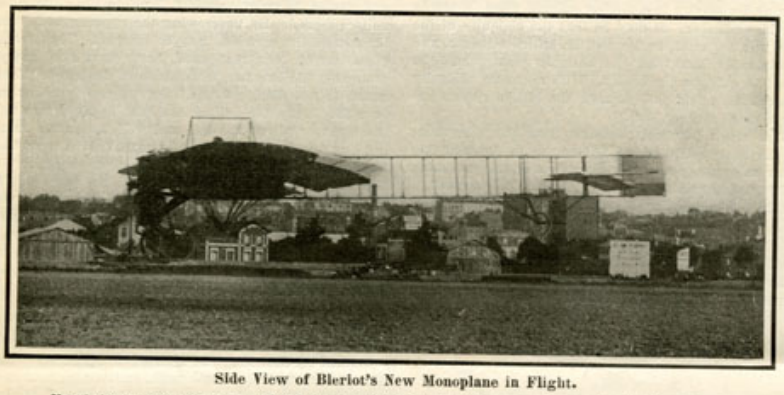
"Zeppelin IV"—The Huge New Airship Which Will Be Acquired by Germany After It Makes a 500-Mile Voyage.

A 120-horse-power engine in each car drives two propellers. Note the stabilizing planes and rudders at the rear. The balloon is made of sheet aluminium laid over a rigid framework.

FIRST SUCCESSFUL FLIGHTS OF BLERIOT'S NO. 8 MONOPLANE.

During the past month, M. Louis Bleriot has been experimenting with one of the two large monoplanes which he built last winter, and the first flights have indicated the success of this, the most advanced form of high-speed aeroplane. Two of our illustrations show the machine in flight and its appearance as viewed from the front. As can readily be seen, the monoplane is attached to the front end of a body frame 45.8 feet in length. The rear half of the monoplane, at its outer ends, has movable planes for correcting the transverse stability. The horizontal and vertical rudders are at the rear end of the body frame, while the 50-horse-power Antoinette 8-cylinder motor is placed at the forward end with the 4-bladed propeller on its crankshaft. The blades of the propeller resemble a feather in shape, and they are rather flexible. The aviator sits back of the motor in the body, which is mounted upon two pneumatic-tired wheels in front and one at the rear.

On June 23, at Issy-les-Moulineaux, M. Bleriot tried his monoplane in a rather strong wind, and succeeded in rising in the air several times for short distances, although the machine did not appear to have sufficient lifting capacity at the rear or to be very readily controlled. After increasing the size of the horizontal rudder, M. Bleriot, on June 29, made an official flight of 600 meters (1,968 feet) before the Aviation Committee of the Aero Club of France, covering three times the distance required to win a medal. The flight was made against the wind in 47 seconds, the machine showing a speed over the ground of about 28 miles an hour. This is the first official record to be made by a monoplane. The machine showed good stability, and traveled very steadily. The photograph shows it descending at a slight angle. Subsequently, M. Bleriot made a circular flight of nearly a kilometer with this machine. The remarkable success that Bleriot had with a Langley-type aeroplane last year causes one to believe that he will yet make some excellent performances with his monoplane, and do much toward the perfecting of this type of flying machine.



Side View of Bleriot's New Monoplane in Flight.

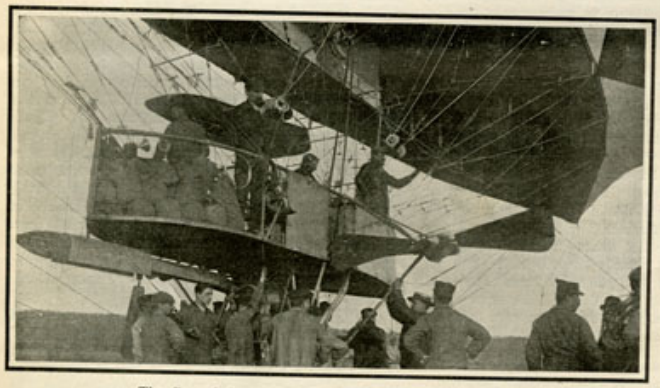
Note the long uncovered body framework with the single horizontal and vertical rudder at the rear. Also the elaborate bracing of the monoplane above and below.

Front View of the New Bleriot No. 8 Monoplane.

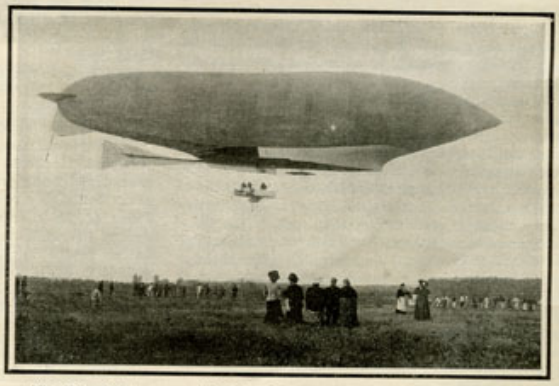
Note the movable wing tips and the 4-bladed propeller with feather-like blades.

FARMAN COMING TO AMERICA AFTER WINNING THE $2,000 ARMENGAUD PRIZE.

Henry Farman recently succeeded in making a 20-minute flight of 18 kilometers (11 miles) and thereby winning the $2,000 Armengaud prize for the first ¼-hour flight above French soil. He has contracted with a St. Louis syndicate to come to America this month, and it is expected that he will begin to make flights at the Brighton Beach race track on July 29. These flights will be made on three successive days, and again, on August 10, four days. They will be held under the auspices of the Aero Club of America, and it is expected that arrangements will be made so that Farman can fly for the Scientific American trophy. Delagrange also is to be brought over by the Aeronautic Society. He is expected about August 20, and he will probably give a series of flights at some place on Long Island.



The Car of the "Republique," Showing One of the Propellers.



The French Government's New Dirigible "Republique," Which Is a Duplicate of the Lost "La Patrie."

THE LATEST EUROPEAN AEROPLANE AND AIRSHIPS.

THE WINNING FLIGHT OF THE "JUNE BUG" AEROPLANE FOR THE SCIENTIFIC AMERICAN TROPHY.

Nearly a score of Aero Club members and others interested in aviation made the trip to Hammondsport, N. Y., to witness the flight of the Aerial Experiment Association's third aeroplane, the "June Bug," on the Fourth of July, for the SCIENTIFIC AMERICAN trophy. The distance to be covered was a kilometer in a straight line, this being the required distance for the first contest. As Mr. Curtiss was the first aviator to come forward with a practical aeroplane and request a trial since the date of the first competition, September 14, 1907, according to the rules, if he performed the flight set, he would be the first winner. In order to permanently win the cup, he would be obliged to win it three times in separate years. The day at Hammondsport was a typical Fourth of July, there being a number of thunder showers throughout the day, with clearing weather late in the afternoon. Consequently, it was not until 5 P. M. that the aeroplane was taken out of its tent and prepared for the trial. The tail was attached, the motor tested, and, after the photographers had taken numerous pictures, everything was in readiness for the flight. Mr. Charles M. Manley, the late Prof. Langley's assistant and an aviator of note, was the sole representative of the Aero Club's contest committee. In the middle of the afternoon, Mr. Manley measured off the kilometer (3,280 feet), the distance laid out being actually 3,300 feet. The course started on one side of an old half-mile race track, and passed directly through a vineyard and several fields. It was also necessary for the machine to cross several barbed wire fences before it could fly over the finishing post, which was surmounted with a red flag. Mr. Alan R. Hawley, the acting president of the Aero Club of America, was located at the finish, and Mr. Manley took the time at the start at the instant when the machine left the ground. Mr. A. M. Herring and the Aeronautical Editor of the SCIENTIFIC AMERICAN were located within a thousand feet of the finish.

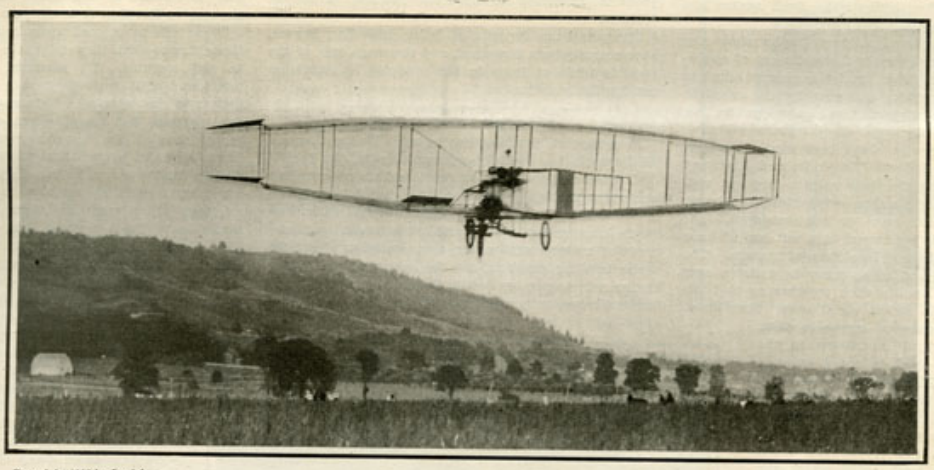
By 6 P. M. everything was ready, and the air was quite calm. The machine was placed at one end of the course, the aviator took his seat, and the motor was started. The instant it was released, the aeroplane shot forward with constantly accelerating velocity. It required only 12 seconds and a distance of about 100 feet before it rose in the air. As he approached the end of the track, Mr. G. H. Curtiss, the aviator, steered his machine to the left, in order to pass around the vineyard. One of our photographs shows the aeroplane making the turn at this point. The machine kept rising, and Mr. Curtiss found difficulty in stopping this, although he directed the horizontal rudder downward to the full extent. Finally, he retarded the ignition of the motor, which caused the machine to slow down and drop. He was unable to rise again, and the machine settled down gently in the high grass about 1,000 feet before it reached the finish.

Upon looking the machine over thoroughly after it had been pushed back to the starting point, it was found that the tail had been attached at too sharp a downward angle. This tended to direct the machine upward, and the horizontal rudder was not sufficient to counteract this. After correcting the inclination of the tail, and after going over the machine thoroughly to make sure everything was in good order, the second attempt was made at 7 P. M. In this flight the machine rose quickly, as before, and following the same course, it sped rapidly on at a height of some 20 feet. As it neared the finish post, it dropped to about 15 feet, and then continued onward, making a wide sweep to the left, and alighting without damage in a rather rough field. The distance traversed was easily a mile, and the time of the flight 1 minute 42 2/5 seconds. This corresponds to an average speed of 35.1 miles an hour; but if the distance of 6,000 feet is taken as the total length of the flight (which distance has been computed by the members of the Association who are most familiar with the course) the speed of the machine was very nearly 40 miles an hour—39.8 to be exact. Thus it will be seen that this aeroplane, with the total weight of 650 pounds including the aviator, and with the expenditure of 25 horse-power, is capable of very nearly the same speed that the Wright brothers claim for their 1,000-pound machine with approximately the same horse-power. The reason that this new aeroplane is able to make such fast speed with so little horse-power as compared with the Farman and Delagrange aeroplanes, is that the tail has been reduced to a much smaller size than those used by the foreign aviators, and that, therefore, there is much less resistance or drag offered by it. The Wright aeroplane has no tail whatever, which is one of the main reasons for its high efficiency.

The dimensions of the bowed surfaces of the tail are 10 feet long by 27 inches wide. The vertical rudder at the rear edge of the tail is 30 inches square, while the horizontal rudder is 30 inches wide by 8 feet long, with a section of 32 inches removed in the center. The surface of the tail is therefore 22½ square feet; that of the vertical rudder, 6½ square feet; and that of the horizontal rudder, 13 1/3 square feet. The planes themselves have a surface of 370 square feet, and there are 35 square feet of vertical surface in the struts and running gear. The propeller is 6 feet 2 inches in diameter, with a 17-degree pitch. As a 17½-degree pitch is equal to the diameter, the pitch, as can be seen, is slightly less than the diameter. The propeller is mounted direct on the engine crankshaft, which makes 1,200 R. P. M. and develops 25 horse-power. At 38 miles an hour, the aeroplane lifts 26 pounds per horse-power, while the amount lifted per square foot of supporting surface of the main planes is 1¾ pounds. For further particulars regarding this machine, we refer our readers to our issue of July 4.

An interesting point brought out by Mr. Curtiss is that whenever he attempts to drive his machine around the vineyard mentioned, it invariably rises suddenly as if struck by some invisible force. Skilled aviators believe this is due to slight ascending air currents set up by the contour of the land at this point, and the vineyard may have something to do with it.

The next day, late in the afternoon, Mr. Curtiss made another flight, at the end of which he turned practically a complete circle. This flight was 4,500 feet in length, and lasted for 1¼ minutes. The front wheel and several struts of the aeroplane were broken in the descent. This was the sixteenth flight of the "June Bug," and next to the trophy flight of July Fourth, it was the longest that had been made. Mr. Curtiss hopes to make exhibition flights with this aeroplane during the summer, and it is probable that after further practice above a suitable ground, he will be able to duplicate the performances of Delagrange and Farman. We congratulate him at his success in winning our trophy for the first time, and we hope that progress in aviation will be so rapid, that he will stand an excellent chance of winning it again in the future and much more difficult contests to be held.



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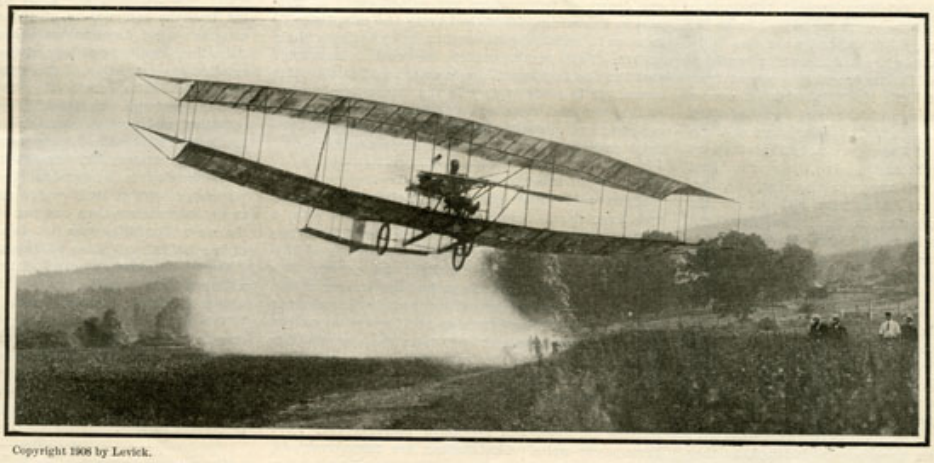
Rear View of the Aeroplane as It Flew Over the Fields.

Note the horizontal wing tips and the downwardly-inclined horizontal rudder in front. The tail and vertical rudder are also outlined against the sky.



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The Aeroplane Tipping as It Made a Sharp Turn After Leaving the Race Track.

Note the downward inclination of the left-hand wing tips for the purpose of righting the machine.

THE WINNING FLIGHT OF THE CURTISS AEROPLANE FOR THE SCIENTIFIC AMERICAN TROPHY.

A Canadian government survey party has been sent to lay out the town site of Fort Churchill, the future metropolis of Hudson Bay. The only settler who is now on the proposed site, which is on the east side of Churchill River, opposite the Hudson Bay post, will be entitled to a free grant of 160 acres. The bill providing for the construction of the Hudson Bay Railway will be introduced into the Dominion Parliament soon, but unless the present deadlock is broken, dissolution must come soon. No progress is being made with legislation at present.

RECENT FOREIGN AEROPLANES.

The illustrations on this page show some of the latest aeroplanes which have made flights or which are soon to be experimented with in France.

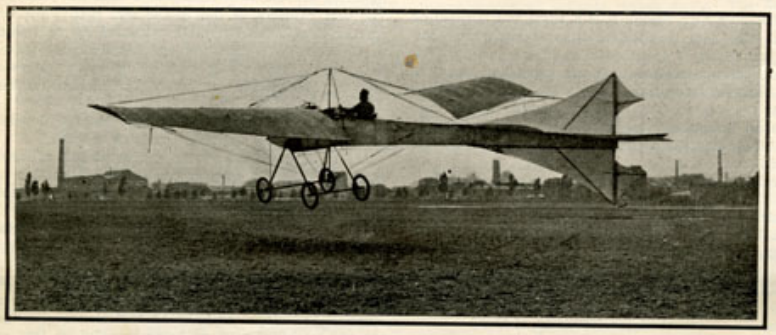
THE FERBER AEROPLANE.

The first of these machines to be noted is that of Capt. Ferber, who has studied the problem of flight by a heavier-than-air machine the most assiduously of any French experimenter. This machine is of the double-surface type, the chief points about it being the slightly curved planes and the location of the motor in front and the aviator himself at the extreme rear edge of the planes. A horizontal projection of these planes shows that their front and rear edges form the arc of a circle. They are also suitably curved in a fore-and-aft direction. The surfaces are constructed of cloth and wood, but the other framework is of bamboo. The horizontal rudder is located well in front, and at a higher point than it is usually placed. The vertical rudder behind is triangular in shape, and is combined with a horizontal surface of the same form. Movable triangular tips at the ends of the planes are used for steering. The machine is mounted upon two wheels, placed one behind the other, and curved runners at the ends of the lower plane take the weight of the machine if it tips to one side when striking the ground. A 50-horse-power 8-cylinder Antoinette motor is placed at the forward edge of the aeroplane, and carries a 2.2-meter (7.22-foot) propeller of 1.1 meter (3.61 foot) pitch. The total weight of the machine is about 880 pounds. The spread of the wings is 10½ meters (34.44 feet), and the total supporting surface is 40 square meters (431 square feet). In its first trials, about a month ago, the aeroplane seemed to show fairly good stability. Several short flights of 10, 30, and 50 meters (33, 98, and 164 feet) were made; but in another trial on July 22, while making a flight of 120 meters (394 feet), Capt. Ferber directed his horizontal rudder downward, to diminish the height of the machine above the ground. This was readily accomplished, but in trying to turn upward again the control gave way, and the machine crashed to the ground and damaged the propeller and chassis. Before repairs could be made, the French aviators were forbidden the use of the parade ground at Issy-les-Moulineaux, and so no further trials have been made.

THE ZENS BROTHERS' AEROPLANE.

This aeroplane represents the greatest advance in the line of simplicity that has thus far been made. Its chief features are the reducing of the tail to a single horizontal plane, 5 meters (16.4 feet) long by 1 meter (3.28 feet) wide in a fore-and-aft direction, and the use of a single horizontal rudder, which is universally jointed and which can be swung around to an inclined position so as to be used as a vertical rudder as well. This rudder has 1.89 square meters (20.334 square feet) of supporting surface, its dimensions being 2.1 by 0.9 meter (6.9 by 2.95 feet). It is operated by a single steering wheel. The superposed surfaces of this aeroplane are not of the same length, nor are they set at the same dihedral angle. The upper surface has a spread of 8 meters (26¼ feet), is 1.2 meters wide (3.94 feet), and has a dihedral angle of 156 degrees; while the lower plane has 8.3 meters spread (27¼ feet), 2.3 meters width (7½ feet), and a sharper dihedral angle. The outer ends of this plane are flexible and curved upward. The surfaces are of varnished Japan paper, and they are shaped with three different curves. The total surface of this machine including the tail is 28 square meters (301 square feet). The tail is located considerably farther back of the planes than it was placed at first. The machine has a 50-horse-power Antoinette motor fitted with a Fiat carbureter. It has also a special radiator of thin copper tubes 2 millimeters (0.079 inch) thick, arranged on either side of the projecting bow that extends from in front of the aviator's seat forward to the horizontal rudder. The radiator is capable of carrying 24 liters (6.34 gallons). A 2-meter (6.56-foot) propeller is carried on the engine crankshaft. The overall dimensions of this machine are 8.4 meters (27.55 feet) long in a fore-and-aft direction, and 8.3 meters (27.22 feet) spread. The total weight is about 320 kilogrammes (705 pounds). The angle of attack of the planes is about 9 degrees.

As stated above, this machine is the simplest one of the double-surface type that has thus far been designed, and in all probability it will make some interesting flights before long.



The Remodeled Gastambide-Mangin Monoplane Flying Above the Parade Ground of Issy-les-Moulineaux, Near Paris.

The Zens Aeroplane, Which Has But a Single Rudder.

The tail consists of but a single plane, while the horizontal front rudder can be swung to a vertical position for side steering.

Capt. Ferber Flying on His New Aeroplane.

The motor and propeller are in front, while the aviator is seated behind. The machine has a small horizontal-and-vertical tail, but for side steering triangular rudders on each end are used.

RECENT FRENCH AEROPLANES.

THE GASTAMBIDE-MANGIN "ANTOINETTE II." MONOPLANE.

The monoplane constructed by Messrs. Gastambide and Mangin, which was illustrated in our issue of March 7 last, was one of the first monoplanes to make an actual flight. It did not fly very steadily, and soon came to grief, as it was not fitted with either horizontal or vertical rudders. After the accident, the machine was remodeled, and one of the present photographs shows it in flight. The tail with its horizontal and vertical rudders is shown very well in this illustration. The machine itself appears to be gliding on a fairly even keel, and with good stability. No accurate information as to the flights it has made of late has come to hand, but the photograph speaks for itself, and shows that in the remodeling of this machine it has been somewhat improved.

WILBUR WRIGHT'S AEROPLANE FLIGHTS IN FRANCE.

After the painful accident he met with on the Fourth of July, when a bursting water-pipe caused him to scald his hand, it is somewhat remarkable that Mr. Wilbur Wright was able, in a trifle over a month, to guide his new aeroplane in its first flights in France.

The first flight was made on August 8, above an old disused racetrack near Le Mans. This flight was about 1¼ miles in length, and was accomplished in 1 minute and 45 seconds. The machine left its starting rail readily, and circled around the track. There were many spectators present, and great enthusiasm was shown at this, the first public demonstration given by the Wright brothers abroad.

After two attempted flights earlier in the day, the first of which failed owing to an assistant not releasing the aeroplane in time and the second of which, 600 feet in length, was cut short by trouble with the motor, Mr. Wright, at 7:30 P. M., August 10, made an excellent flight of about 1¼ miles in 1 minute and 43 seconds, which was at a rate of about 43½ miles an hour. This flight was made in a dead calm and was officially timed. The following day, however, there was a wind of about 10 miles an hour, and about nightfall Mr. Wright made a flight of something over 2½ miles in 3 minutes and 44 seconds. He did not fly very high, but turned readily in and out among the trees with which the field is studded. The machine rose and fell, as well as turning sideways, and seemed to be under perfect control. On Wednesday morning, August 12, a still longer flight lasting 6 minutes 56 2-5 seconds was made. In this flight the machine undulated considerably, and at one time rose to a height estimated to be as great as 90 feet. The flight was officially timed by the Aero Club of the Department of the Sarthe. There was a wind of 10 miles an hour blowing at the time. Toward evening two other short flights were made in a gusty wind, the aviator keeping his machine close to the ground, but controlling it with the same skill as before. The height attained in the first flight was considered by experts as being very remarkable, and as showing the skill and daring of this foremost of all aviators.

The series of flights was terminated for a time on August 13, when, after a splendid flight lasting 8 minutes and 52 seconds in the morning, during which Mr. Wright made seven complete turns of the field at a height greater than the tops of the trees, he, at

the end of a second 2-minute flight, struck one wing in landing while attempting to make a sharp curve, and damaged the machine slightly. The first flight was made at 6:30 A. M., and there was a fresh breeze blowing at the time. This seemed to have no effect upon Mr. Wright's control of the machine, however, and he soared to a height of from 50 to 60 feet, and maintained this elevation with the greatest ease. As no material was at hand for repairing the aeroplane, several days will be required in which to do this.

The flights of Mr. Wilbur Wright have completely vindicated him in the eyes of the foreign aeronautic world, and all the aeronauts and men of science have watched his performances with the greatest enthusiasm. His brother, Orville Wright, expects to experiment with the aeroplane built for the United States government, during the present week, or the week immediately following, at Fort Myer, near Washington, D. C.

THE UNITED STATES AND BRITISH GOVERNMENT AIRSHIPS.

The dirigible balloons illustrated on this page are the two which have been built by Capt. Thomas A. Baldwin for our government, and by Col. Cody for the British military authorities. The Baldwin airship, as noted in our last issue, has been undergoing tests at Washington as to its speed and enduring qualities. The first trial of the three allowed for the purpose of testing the speed of this new airship, occurred on August 12, but owing to trouble with the wiring of the 8-cylinder Curtiss motor, no favorable showing was made in this test. The previous day, however, the airship flew about 4½ miles against a strong cross wind, and developed a speed of some 15 miles an hour. The flight was from Fort Myer to Balston, Va., and back. The distance of 2¼ miles was covered in 8 minutes, or at a speed of 15.2 miles an hour. The return flight was made in the same time, but in returning the airship rose to an elevation of 1,000 feet. Upon reaching its destination the aeroplanes at the forward part of the body framework were directed downward, and the machine was made to descend slowly and gracefully to earth. Capt. Baldwin makes use of a drag rope in alighting, as by means of this the machine can be drawn down if necessary when it comes to rest.

The second and third official speed tests of this new dirigible were made on August 14 over a course extending from Fort Myer to West Cherrydale, Va. In these two tests the airship is said to have averaged between 18 and 21 miles an hour. The official figures were not obtainable at the time of our going to press. Capt. Baldwin expected to make the 2-hour endurance flight, in which he must average 14 miles an hour, the following day.

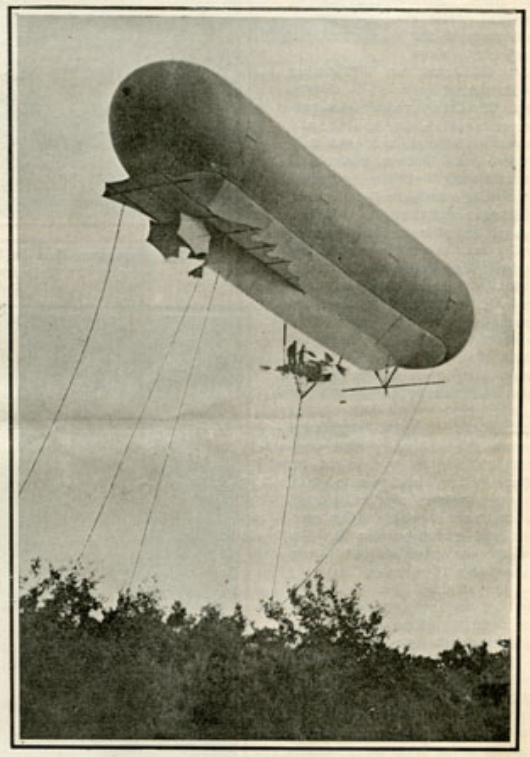
The plans of this new dirigible were published in SUPPLEMENT No. 1684. Unlike most of the foreign airships, Baldwin uses a long quadrangular framework below the gas bag and suspended from it by netting. The motor and the small aeroplanes, which act as a horizontal rudder, are placed at the forward end of this framework. The motor drives the propeller direct. The airship carries two men, one of whom operates the motor and the aeroplanes for up-and-down movement, while the other steers.

The British military dirigible, which we illustrate, is the "Nulli Secundus" of last year remodeled, fitted with a larger motor, and improved in various ways. In place of the old engine, a 50-horse-power Antoinette motor is now used. This is located in a short car placed below the center part of the airship, and it drives two propellers, one on either side of the car. The gas bag has been fitted with a flat surface on its under side, and the car is suspended below this. Hexagonal twin rudders are used at the rear in place of the single one employed before, and a horizontal rudder is placed in front. There is no netting on this airship, the framework of the horizontal plane and car being supported by heavy bands of fabric placed around the gas bag at intervals. The length of this airship is 120 feet, and the diameter 26 feet. Its 56,000 cubic feet of hydrogen gas give it a reserve lifting power of from 700 to 800 pounds. It is capable of carrying three men readily. The car is about 12 feet long, and the total height from the bottom of the car to the top of the balloon is about 45 feet.

On its first trial on July 24, the airship traveled 9 or 10 miles against a wind of 15 miles an hour. It rose to an elevation of about 1,000 feet, and there was no pitching noticeable. The chief trouble met with was the slipping of the driving belts which operate the propellers. After further trials have been made, it is expected that this airship will be put in use by the balloon corps of the British army.

Capt. Baldwin's New Dirigible, Which Was Constructed for the U. S. A. Signal Corps, Making an Ascent at Fort Myer, Near Washington.

This dirigible differs from foreign ones in having a long quadrangular body framework suspended from netting that covers the gas bag. The propeller is at the front end. Small superposed aeroplanes form a double horizontal rudder near the front end.



The Remodeled "Nulli Secundus"—the First British Military Dirigible Balloon.

Note the flat tail and rounded substructure of the gas bag, as well as the horizontal and vertical rudders front and rear, and the small car with its two propellers.

THE NEW AMERICAN AND BRITISH MILITARY DIRIGIBLE BALLOONS.

The Argentine Ant Makes Its Appearance in California.

One of the most dreaded insect pests is the Argentine ant, the scientific name of which is *Iridomyrmex Humilis Mayr*. It is very small, being less than one-eighth of an inch in length, but is so pugnacious that it quickly exterminates or drives out the native ants of any territory of which it takes possession. It is a native of South America, and is almost unknown in the northern part of the continent, except in the Mississippi Valley, where it is found chiefly in the neighborhood of New Orleans. The efforts to exterminate it in the Mississippi Valley have proved fruitless. In Louisiana whole sugar-growing districts have been devastated by the pest, which not only works enormous injury itself, but protects plant scale and cotton-plant lice, rendering them highly destructive to the cotton fields and to fruit and ornamental trees. No wonder, therefore, that its arrival in East Oakland, Alameda County, Cal., where it has occupied a square mile of territory, is viewed with alarm by entomologists. Many residents in the infected region have discovered it, and sent notice of its arrival to the entomological department of the University of California at Berkeley, Alameda County. At a conference held by the members of the entomological department on July 14, the advent of this formidable ant was the chief subject of discussion, and Prof. C. W. Woodworth, who has been investigating the ant, has sent the following communication to J. M. Gillett, Governor of the State of California:

"I have the unpleasant information to report that the Argentine ant has gained a foothold in East Oakland, and now occupies about one square mile of territory. The insect is known elsewhere in the United States only in the region about New Orleans; and the secretary of the Louisiana Crop Pest Commission, in the last report of the Governor of that State, writes that the insect has proven itself to be one of the most injurious that has been introduced into the United States from foreign countries. A most serious aspect of the problem is found in the destruction of orange and fig crops in the southern parishes by the ant, and the danger to sugar cane by its continued increase. It seems to me that the introduction of the insect is a far greater menace than the introduction of the white fly, discovered a year ago at Maryville. I have already reported the matter to State Horticultural Commissioner J. W. Jeffrey, but I consider it important enough to report direct to you."

Japan's advance in machine building is indicated by the fact that its exports during the last year were five times greater than the average for the last five years. A large proportion of the exports consists of cotton gins, textile machinery, and printing presses, for China.

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WILBUR WRIGHT FLYING OVER THE RACE TRACK AT LE MANS, FRANCE.—[See page 140.]

GASOLINE-PROPELLED GUNBOATS FOR RIVER SERVICE.

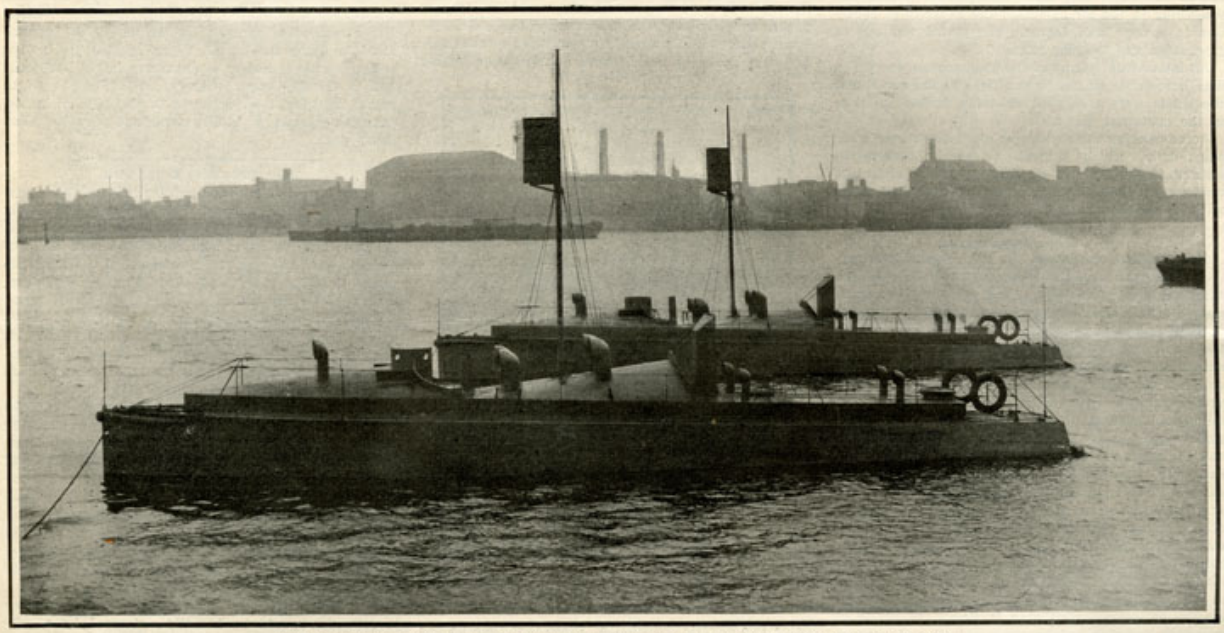
BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The possibilities of applying the small explosion motor to certain light craft for naval duties, such as river patrol work, have been recently advanced by the construction of two gasoline-propelled shallow-draft gunboats for service on the river Danube. These craft were built by the British naval shipbuilding firm of Yarrow & Co. for the Austro-Hungarian government. Each vessel has a length of 60 feet with a beam of 9 feet and a draft of 32 inches. They are built on the Yarrow shallow-draft system, having three screws revolving in tunnels and fitted with twin rudders. The hulls are built of galvanized steel.

The propelling machinery aggregates 350 horse-power distributed in five sets. Each wing screw has two sets of four-cylinder vertical Yarrow-Napier motors having a bore of 6½ inches by a 6-inch stroke, mounted in tandem and each developing 70-brake-horse-power. Thus each wing has eight cylinders representing 140 horse-power. The central screw has only one four-cylinder set and the reversing gear is coupled only to this middle set.

A small conning tower is fitted forward, while right aft is a revolving gun platform. A light gun will be mounted on the platform in Austria. The machinery space as well as fuel reservoirs, conning tower, and gun mounting are protected by 3/16-inch chrome steel armor plates affording complete protection to point-blank rifle fire at short range. Amidships is a short detachable mast fitted with a crow's nest for look-out purposes and to provide an elevated rifle firing position. Special attention has been devoted to the ventilation of the machinery space so as to avoid the accumulation of any noxious gases.

In the official speed trials carried out on the Thames measured mile by the Hungarian naval officers the vessels attained a mean speed of 22.25 knots with a load of three tons during a run of one hour's duration. A consumption trial was then carried out to ascertain the radius of action at an average speed of about 11 knots per hour and it was found that the vessels carried sufficient fuel for a continuous run of some 500 nautical miles. This represented a radius of action three times in excess of what would be possible with craft of the same size propelled by steam. A distinguishing feature during the high-speed trials was the absence of any vibration. Accommodation is provided for a crew of six men, the sleeping appointments for which are placed fore and aft respectively.



TWO 350-HORSE-POWER GASOLINE-PROPELLED GUNBOATS FOR PATROL DUTY ON THE DANUBE.

Note the conning tower, the crow's nest, and the revolving gun platform aft.

The evil repute of the bedbug has acquired fresh justification. It is well known that most contagious diseases are disseminated by blood-sucking insects—malaria and yellow fever by mosquitoes, plague by fleas, the African sleeping sickness by *Glossina palpalis* (a near relative of the tsetse fly), anthrax, tuberculosis, smallpox, scarlet fever, typhoid fever, etc., by the common house fly. Now Jordansky and Klodentzky have proved by very delicate experiments, that bedbugs are the worst of all, at least in the dissemination of plague. Not only do they draw contagion from the bodies of men and animals stricken with plague but the germs live and multiply within the bodies of the insects, retaining their full virulence for many days. The bedbugs do not appear to suffer any inconvenience, for they live and remain active for months after they have absorbed the germs. Hence a few bedbugs might easily infect a regiment with plague and it is to be feared that they possess equal power to spread other diseases.

THE WRIGHT BROTHERS' AEROPLANE IN FRANCE AND THE UNITED STATES.

In view of the fine performances of Wilbur Wright with his aeroplane in France, and also of the flights about to be made by Orville Wright near Washington, at Fort Meyer, we are glad to be able to present to our readers, in this issue, the first actual detail photographs of this world-renowned aeroplane which the Wright brothers have heretofore kept closely veiled from public view. These photographs show that, as had been supposed from the descriptions of eye witnesses and also from the minute photographs taken at long range of the machine in flight at Kitty Hawk, their motor-driven aeroplane is of the greatest simplicity and is, in fact, merely their gliding machine with a motor and propellers added. In the photographs which we reproduce the reader can see that the machine is fitted with a double-surface horizontal rudder mounted in front and having a small vertical rudder at its center point, while twin vertical rudders are used at the rear for side steering. The two propellers are located at the rear of the main planes, and are driven in opposite directions by chains from the motor located on the lower plane a short distance to one side of the center line of the machine. A vertical surface seen at the front end of the motor is the radiator, which consists of a number of small tubes closely assembled. The machine is carried on wood skids placed a short distance below the lower plane and which project forward and upward to form a support for the front horizontal rudder. Suitable stays extend downward from the front edge of the upper plane to these skids and also upward from the front edge of the lower plane to their vertical uprights. Practically all of these features could be made out in the small photographs taken at Kitty Hawk and published and described by us several months ago.

The main planes are 40 feet long by 6½ feet wide, and spaced 6 feet apart. Their supporting surface is 500 square feet. The horizontal rudder planes are 16 feet long by about 2½ feet wide, their total surface being 75 square feet. The weight of the aeroplane without operator or supplies is about 800 pounds. With two men and a supply of fuel and water, it weighs about 1,150 pounds, which, if the area of the horizontal rudder is added to that of the main planes, gives a loading of the surfaces of but 2 pounds per square foot. As some of the recent French monoplanes carry from 3 to 3½ pounds per square foot of supporting surface, it can be seen that the Wright machine is not heavily loaded, the consequence being that it can rise in the air and fly at a speed of 26 miles an hour, although it is capable of traveling at the rate of 40. The machine in use in France has but two control levers, while the new one to be flown here has three. Two of these, which control the warping of the planes and the vertical rudders, can be worked in unison, while the third operates the horizontal rudder. The 4-cylinder, vertical, water-cooled gasoline motor (which is the Wright brothers' own design) is run at a constant speed of about 1,400 R. P. M. It drives the propellers in opposite directions at about 500 R. P. M. No carbureter is used, the gasoline being pumped into the cylinders above the inlet valves. According to Mr. Orville Wright, the speed of the aeroplane is varied by manipulating the surfaces and not by varying the speed of the motor. The method of operating the motor without a carbureter by feeding gasoline direct to the cylinders is that used by Farman with his 8-cylinder engine, and it is claimed that this method, although not economical of fuel, produces the best results when a motor is run at constant speed. The motor of the Wright aeroplane is placed in a fore-and-aft direction across the lower plane a short distance to one side of the center line, while the aviator and passenger sit beside the motor on the other side of this line and with their feet upon a cross brace below and in front of the plane. The frame and braces of the aeroplane are constructed of wood (spruce, ash, and pine), while unbleached muslin is used for the surfaces. No special pains have been taken to reduce the resistance of the various braces, with the exception of the uprights connecting the main planes, which are oval. The planes are braced in all directions with piano wire. They are flexibly connected so that they can be warped slightly by cords passing through pulleys and connected to the levers.

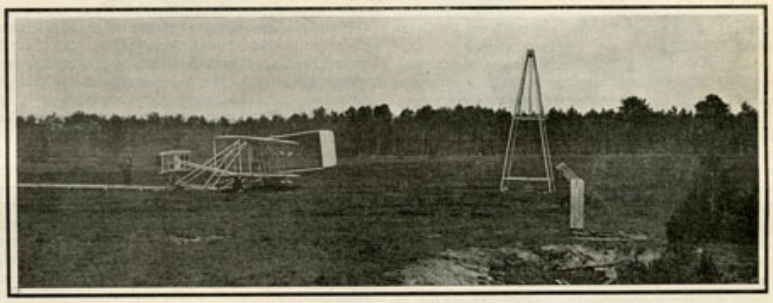
The main points about the Wright machine are its simplicity and efficiency. The former is apparent by a glance at the photographs, which also show some reasons for the latter, such as the lack of a tail and the almost flat surfaces set at a very slight angle of incidence. While there are apparently a good many braces to make head resistance, nevertheless these are chiefly concentrated at one point in the center part of the machine where the resistance of the motor, radiator and men are met with anyway. Besides the ease with which the machine glides through the air for the reasons above mentioned, the Messrs. Wright claim that their screw propellers (which are of wood and about 6 feet in diameter), give very great efficiency. This is another of the chief reasons why they can propel their machine at such high speeds with so little horse-power. The chain drive from the motor to the propeller shaft is also a fairly efficient form of power transmission. As a result of these various causes, they have succeeded in attaining a speed of 44 miles an hour with about 25 horse-power, which shows that their machine is practically 100 per cent more efficient than the best of those made abroad. When the question of stability and safety is considered, however, this machine does not appear to so great an advantage. It is true that the transverse and longitudinal stability can be maintained with great ease by the

warping of the ends of the surfaces and the use of the horizontal rudder, but there is nothing in the least automatic in the way this is done, the aviator being depended upon entirely to control the equilibrium of the machine by moving levers. If anything happened to the man directing the machine, or should he make a false movement of a lever, the aeroplane would either plunge suddenly to the ground, or turn a backward somersault. Should anything happen to the horizontal rudder (as has been known to do with other aeroplanes), the machine would be completely out of control of the aviator and it would probably be dashed to the ground; whereas with the Farman type of machine, which employs a steadying tail, an accident happening to the rudder might be counteracted by the tail, or *vice versa*. Thus, for the sake of simplicity and efficiency, the element of safety has been sacrificed to a considerable extent. In a machine for war purposes, however, speed and efficiency are most desirable and the aviator is willing to sacrifice a large factor of safety in order to be able to fly at high speed.

One of the photographs which we reproduce shows the aeroplane at the beginning of the track along which it runs in making its start. It is mounted on a small two-wheeled carriage, which is jerked forward by a falling weight arranged in the tower at the rear of the machine. This accelerates the speed of the aeroplane more rapidly than the propellers alone can do, and causes it to rise in the air after traveling a distance of barely 100 feet. The carriage is left behind, and the aeroplane, when alighting, lands on its skids. How it seems to start off and make a flight in this machine can best be told by the Wright brothers themselves, from whose article in the current Century Magazine we quote the following:

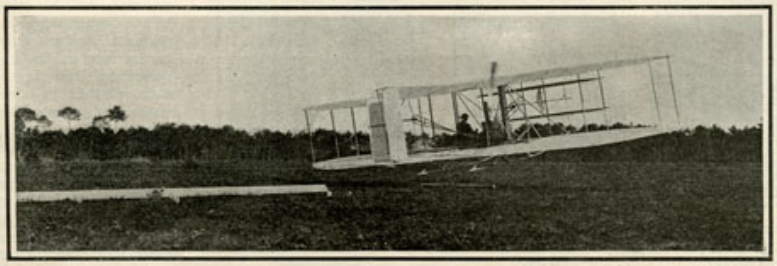
"In order to show the general reader the way in which the machine operates, let us fancy ourselves ready for the start. The machine is placed upon a single rail track facing the wind, and is securely fastened with a cable. The engine is put in motion, and the propellers in the rear whirr. You take your seat at the center of the machine beside the operator. He slips the cable, and you shoot forward. An assistant who has been holding the machine in balance on the rail, starts forward with you, but before you have gone fifty feet the speed is too great for him, and he lets go. Before reaching the end of the track the operator moves the front rudder, and the machine lifts from the rail like a kite supported by the pressure of the air underneath it. The ground under you is at first a perfect blur, but as you rise the objects become clearer. At a height of one hundred feet you feel hardly any motion at all, except for the wind which strikes your face. If you did not take the precaution to fasten your hat before starting, you have probably lost it by this time. The operator moves a lever; the right wing rises, and the machine swings about to the left. You make a very short turn, yet you do not feel the sensation of being thrown from your seat, so often experienced in automobile and railway travel. You find yourself facing toward the point from which you started.

The objects on the ground now seem to be moving at much higher speed, though you perceive no change in the pressure of the wind on your face. You know then that you are traveling with the wind. When you near the starting point, the operator stops the motor while still high in the air. The machine coasts down at an oblique angle to the ground, and after sliding fifty or a hundred feet comes to rest. Although the machine often lands when traveling at a speed of a mile a minute, you feel no shock whatever, and cannot, in fact, tell the exact moment at which it first touched the ground. The motor close beside you kept up an almost deafening roar during the whole flight, yet in your excitement you did not notice it till it stopped."



The Aeroplane Ready to Start, Showing Rail Along Which It Runs.

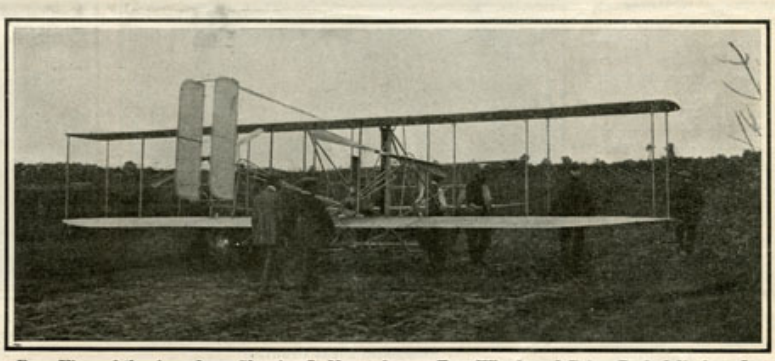
The tower at the right supports a heavy weight which is connected to the small car that carries the aeroplane. At the moment of starting, the weight drops and jerks the machine suddenly forward, thus accelerating quicker than is possible with the propellers alone.



The Aeroplane Leaving the Rail, Showing the Angle of Ascent Produced by the Horizontal Rudder.

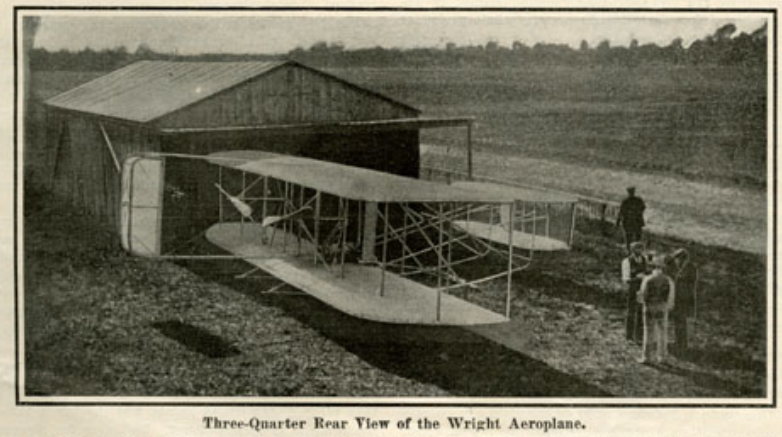
Some of the difficulties met with by experimenters in constructing a machine which will have good stability are also described in the same article:

"The balancing of a flyer may seem, at first thought, to be a very simple matter, yet almost every experimenter had found in this the one point which he could not satisfactorily master. Many different methods were tried. Some experimenters placed the center of gravity far below the wings, in the belief that the weight would naturally seek to remain at the lowest point. It was true, that, like the pendulum, it tended to seek the lowest point; but also, like the pendulum, it tended to oscillate in a manner destructive of all stability. A more satisfactory system, especially for lateral balance, was that of arranging the wings in the shape of a broad V, to form a dihedral angle, with the center low and the wing-tips elevated. In theory this was an automatic system, but in practice it had two serious defects: first, it tended to keep the machine oscillating; and, second, its usefulness was restricted to calm air."



Rear View of the Aeroplane, Showing It Mounted upon Two Wheels and Being Pushed Back to Its Starting Rail.

The 25-30-horse-power, 4-cylinder motor and its twin radiators are distinctly visible, as are also the inclosed chains which drive the propellers in opposite directions.



Three-Quarter Rear View of the Wright Aeroplane.

The aeroplane rests on skids which extend forward and support the horizontal rudder. Note the curved vertical rudder in the center of this, the vertical radiating tubes at front edge of main planes, the motor extending back from them, and the twin propellers and rudders at the rear.

SOME DETAILS OF THE WRIGHT BROTHERS' AEROPLANE.

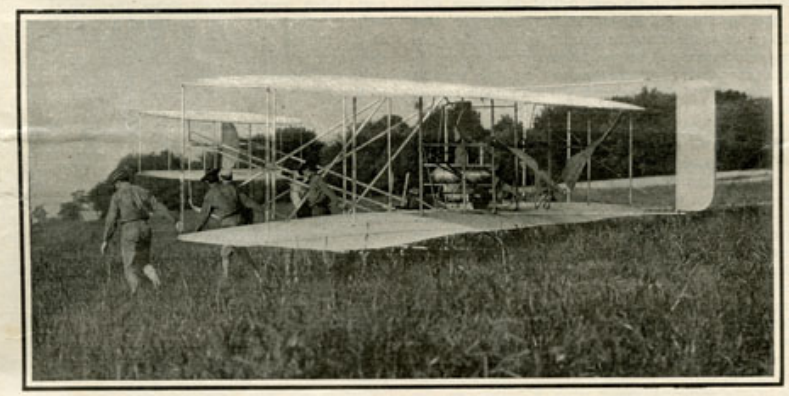
From the above it will be seen that an aeroplane is largely a matter of compromise and that its form and surface must be determined from the uses to which it is to be put, and from whether it is to fly in winds or in calm air alone. The Wright machine has demonstrated that it can fly in a wind as great as 20 miles an hour, while none of the other aeroplanes have ever flown in a wind of half this velocity. In this one point alone it is far superior to all other aeroplanes; and doubtless, in time, the brothers will perfect it so that it will have automatic equilibrium and thus be capable of use by almost any individual. There are great possibilities, too, in the way of reducing the supporting surfaces and all parts of the machine to their minimum size and weight; for one leading experimenter in this line asserts that a two-man motor-driven aeroplane can be built which, complete, will weigh only about 150 pounds. Such a machine could be readily carried to a suitable starting place by the two men using it, and as a means of transport in inaccessible country it would be unsurpassed.

THE FIRST FLIGHT OF THE WRIGHT AEROPLANE AT FORT MYER.

BY OUR WASHINGTON CORRESPONDENT.

After several days of waiting, consumed in assembling and testing its various parts, Wilbur Wright's machine flew at its first attempt on the 3d instant, remaining in the air 1 minute and 10 seconds, and covering a distance of about a mile.

The aeroplane was launched from the starting rail shortly after 6 P. M., by the dropping of some heavy weights that were suspended from the tower and connected by a rope to the two-wheeled starting car.



Transporting the Machine to the Testing Grounds.

The aeroplane was placed upon this car, and as soon as it was jerked forward (the propellers having first been started) it left the car and ascended gracefully. The starting device is calculated to give the 1,000-pound machine a speed of 28 miles an hour in a distance of 50 feet. This speed is sufficient to cause it to rise readily in still air; but if there is a wind blowing from behind, no ascension can be made. This mode of starting, modeled somewhat after that devised by Langley, is peculiar to the Wright aeroplane, and while it enables the aeroplane to take the air in a short preliminary run, on the whole it does not appear to be so good a scheme as running on wheels on the ground. The use of runners or skids for alighting seems to be an excellent idea, however, and the combination of these with some arrangement of foldable wheels would seem to be a very good plan.

In its initial flight on September 3, the aeroplane went one and one-half times around the parade ground at Fort Myer, thereby covering a distance of approximately a mile. The speed varied somewhat, but it may be roughly averaged at 30 miles an hour. The flight was noticeable for its undulatory character in a vertical plane (which was occasioned by the aviator —Mr. Orville Wright—devoting himself chiefly to the side-steering lever), while the sharp turns that were made and the steep inward inclination of the planes in making them were other interesting points. In attempting to make the turn the second time at the opposite end of the field to that from which he started, Mr. Wright pulled his steering lever a little the wrong way, after which he made a quick descent to avoid hitting a new shed that was in process of construction. The machine was being turned quickly as it struck the ground, and one of the runners, owing to faulty assembling, was slightly broken. The demonstration convinced the spectators that the machine was capable of repeating the performance of the old machine.

A close scrutiny of the Wright aeroplane astonishes one by its great simplicity. The main planes are slightly arched downward at their ends. Their front edges are perfectly rigid, only their ends and rear edges being flexible. The outer ends of the lower plane, at the end and second uprights, are connected by a wire that runs through pulleys attached to the upper plane; while the corresponding ends of the upper plane are attached in a similar manner, with the exception that the connecting wire, in the form of a chain, is carried forward through pulleys and around the hub of one of the three vertical levers, so that a fore-and-aft movement of this lever causes the rear edges of the planes to dip down at one end and to rise a corresponding amount at the other. Close beside this lever, and in reality forming part of it, is another vertical lever that moves the twin vertical rudder. In making a turn, the angle of incidence of the outside end of the planes is at first increased, which causes the machine to rise at this end. The tendency which it has to turn in the opposite direction as a result of the increased resistance resulting from the greater angle, is overcome by means of the vertical rudder. As soon as the machine has tipped inward and started to make the curve the positions of the wing ends are reversed, the greater angle then being given to the inner end. If this procedure is not followed, the aviator cannot turn the aeroplane; and it is for this very reason that a wind fails to upset it. The horizontal rudder is operated by a straight inclined rod running directly from the lever to the two superposed surfaces in front. This rudder is used to maintain the longitudinal equilibrium and also for varying the height. It is operated by the left hand of the aviator, and until his hand becomes used to working it, the aeroplane is bound to do considerable bobbing up and down.

From this account one can see that the Wright brothers have followed closely the soaring birds in the method of steering and maintaining their transverse equilibrium; and that this method works well in practice goes without saying.

A South Pole Trip.

Upon his return from his present expedition in search of the north pole Commander Robert E. Peary plans to organize a national American antarctic expedition to explore the southern polar regions, a project which, he says, has the approval of President Roosevelt. Mr. Peary, however, does not intend to accompany the party. Herbert L. Bridgman, secretary of the Peary Arctic Club, was a delegate to the International Polar Congress held in Brussels in May. At that time Mr. Bridgman presented to the congress the following communication from Commander Peary, the text of which he has made public:

"I beg to state that on my return from my coming arctic expedition I shall endeavor in every possible way, consistent with my other duties, to promote and organize a national American antarctic expedition, to secure for this country its share of the honors and valuable scientific information still awaiting the explorer in that region.

"The project would include the building of another special ship on the same general lines and in the light of the experience gained in building and using the 'Roosevelt,' and the utilization of the methods and equipment evolved during my past seventeen years of arctic work. It would not contemplate my personal association with the expedition in the field.

"While it is too early now to make any definite statement, it is hoped that the Peary Arctic Club may lend its encouragement to the work. This project, I am happy to state, has the approval of President Roosevelt."

At a subsequent session of the commission it is hoped to offer a more detailed presentation of the matter for such action or suggestions as the commission may see fit.

Commander Peary has long had under consideration such an exploration as outlined in his letter.

Villages Situated at Great Altitudes.

The most elevated permanent human habitations in Europe are found in Switzerland. According to the census of 1900, nearly 12,000 persons live at altitudes exceeding 4,900 feet, and more than 4,000 at altitudes exceeding 5,900 feet.

The most elevated communities are found in Grisons. More than half the inhabitants of this canton live more than 3,300 feet, and two-fifths live more than 3,900 feet above the sea level. In the canton of Valais 66 per cent of the population are found at altitudes exceeding 3,300 feet, and 4 per cent at altitudes above 4,900 feet.

The highest Alpine villages are:

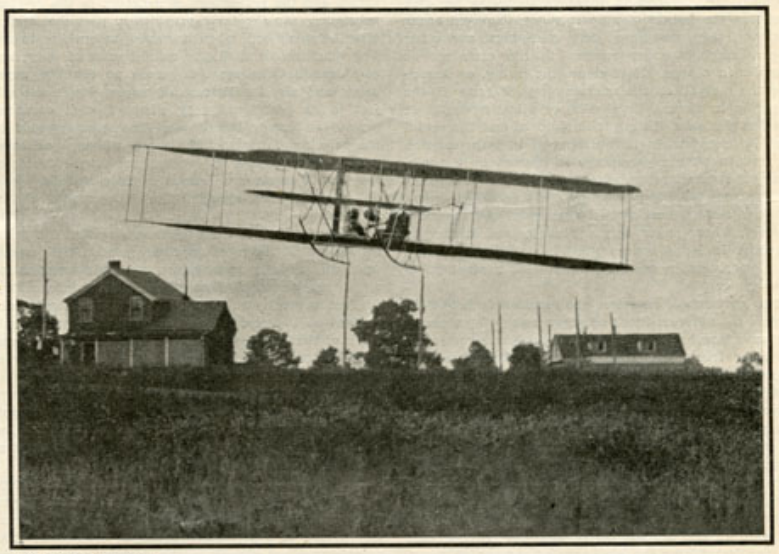
	Altitude.		Inhabitants.
	Meters.	Feet (Approx.).	
Cresta (Grisons)	1,949	6,500	33
Juif (*écart* of Cresta)	2,133	7,100	24
Findelen (Valais)	2,075	6,900	..
Chaudolin (Valais) ..	1,936	6,450	123
Lue (Grisons)	1,918	6,400	59
Arosa (Grisons)	1,892	6,300	1,071
St. Moritz (Grisons) ..	1,856	6,200	..
Pontresina (Grisons)..	1,803	6,000	488

Arosa, which contained only 88 inhabitants twenty years ago, owes its recent increase of population to the establishment of a health resort. All of these villages, with the exception of Findelen, which is inhabited only in summer, are occupied throughout the year. The most elevated shepherds' huts, used only in summer, are those of the Lona Alp in Eringerthal (altitude 2,665 meters or nearly 9,000 feet).

Wilbur Wright in France.

On the 2d instant Mr. Wilbur Wright, after over a week of enforced waiting due to bad weather, again got in the air in France and made a flight in a figure 8 lasting 10 minutes and 40 seconds. He covered a distance of 6 miles in this flight. In a second flight, something went wrong with the starting apparatus.

Manganese steel is now generally recognized as being the only suitable material for street railway track work where any large amount of traffic is to be dealt with, and, as is well known by street railway engineers, this material cannot be dealt with by the ordinary cutting tools, i. e., chisels, saws, files, etc., owing to the extreme hardness of the material.



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The First Public Flight of the Wright Aeroplane in America.

THE FIRST FLIGHT OF THE WRIGHT AEROPLANE AT FORT MYER.

SCIENTIFIC AMERICAN

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

LESSONS OF THE WRIGHT AEROPLANE DISASTER.

Seldom has there occurred a more pitifully tragic disaster than the sudden fall of the Wright aeroplane, involving the death of that promising young officer Lieut. Thomas E. Selfridge, and inflicting shocking injuries on the talented inventor, Orville Wright. That the disaster should have occurred at the culmination of a series of brilliant flights, and on the eve of winning that prize of government recognition for which the Wright brothers had striven, unaided, through long years of patient toil, renders the disaster extremely pathetic, and accentuates that world-wide sympathy in which the SCIENTIFIC AMERICAN so sincerely shares.

But although the accident is deplorable, it should not be allowed to discredit the art of aeroplane navigation. If it emphasizes the risks, there is nothing in the mishap to shake our faith in the principles upon which the Wright brothers built their machine, and achieved such brilliant success. The defect was purely one of structural detail. The breaking off of the blades of the propeller of an airship is comparable to the bursting of a tire on an automobile. In each case there is the danger of an upset; but in neither should the accident be taken to indicate that the principles and design of the whole machine are at fault.

Nevertheless, it must be admitted that if the demand for absolutely first-class design and materials is strong in the automobile, it is doubly so in the aeroplane. Judged by the nature of the work it has to do, and in view of the tragic penalties which may attach to the breakage of any one of its delicate and nicely calculated parts, it would seem that a broader margin of safety should be allowed in cutting down the size and weight to secure the necessary lightness. The supporting planes, with their fragile wooden struts and hair-like wires, constitute a trussed bridge, whose strength, like that of a chain, is no greater than the strength of its weakest link. Should a single strut or wire snap, the whole fabric must collapse. Similarly, the equilibrium of the whole structure is so sensitive to disturbance, that any sudden change in the opposed forces, such as was occasioned by the snapping of one of the two propellers, must instantly upset the delicate poise, and change the aeroplane, suddenly, from a self-sustaining machine to an inert mass, subject only to the destructive force of gravity.

The lessons of this particular case are, first, that wood is too uncertain a material to safely endure the complicated stresses due to thrust, high centrifugal force, excessive vibration, or the possibility of contact with the machine to which a propeller is subjected; and, secondly, that the distribution of the thrust between two propellers, placed on either side of the center of gravity, constitutes, as this terrible accident has too clearly shown, a constant invitation to disaster. Should one propeller break, become loose, or be disconnected from its chain drive, the whole power of the engine becomes concentrated at a point several feet to one side of the center of resistance of the machine, with the result that it becomes immediately unmanageable, and is driven violently from its path; whereas the breaking of a single, centrally-placed propeller would have no greater effect upon the control than would the simple stopping of the motor.

Undoubtedly, it was the inevitable confusion created by the breaking of the propeller on the vertical rudder wire that caused the disaster; for although Wright made a gallant effort to bring the machine back to control, stopping his motor, etc., the horizontal rudders appear either to have failed or to have been pulled in the wrong direction; the aeroplane, after partially righting, taking a sudden and steep plunge to the ground.

Perhaps the most important lesson of all, however, is, that, to render the aeroplane thoroughly reliable, some method of automatic control of both lateral and horizontal stability must be devised. This control should automatically hold the rudders and plane tips in the requisite position for equilibrium, any deviation therefrom being made by separate manual control.

SOME SUBMARINE SUCCESSES.

The increase in size, power, and endurance of the submarine, and the accumulated knowledge and confidence which are being acquired by officers and men in the handling of this sensitive and capricious type of boat, are rapidly winning for the submarine a position as a well-tried and efficient type of fighting craft. On the return of the submarine flotilla to Newport after its last series of maneuvers carried out in Buzzards Bay, it was made known that the five submarines, "Octopus." "Viper," "Cuttlefish," "Tarantula," and "Plunger," representing the latest additions to our fleet, had made a most successful attack upon the United States cruiser "Yankee." The significance of the result, all five of the boats making a hit, is emphasized by the fact that the attack was made in broad daylight, and that it was expected by the "Yankee," whose officers and crew were keenly on the watch for the submerged enemy. In carrying out the maneuver, the submarines first steamed away from the "Yankee" on the surface of the water, closely observed by the glasses of the officers on board, until they disappeared from view. At twenty miles distance they submerged and proceeded to the attack under water, making observations at intervals by means of the periscope, until they came within hitting distance, when each boat discharged its torpedo and found the mark. Although the "Yankee" searched closely for surface indications of the boats, there was no notification of their presence until the five torpedoes got home against the hull. A second attack, made from a less distant point, met with equal success. This exploit is certainly a strong demonstration of the efficiency of the submarine under the conditions existing; and it may fairly well be claimed that the fact that the "Yankee" was stationary was offset by the other fact that the time and direction of the attack was known to those on board the ship.

Another notable success was that achieved by a flotilla of Italian submarines, or to speak more strictly, submersibles, consisting of four boats, which recently made the trip of 1300 miles from Venice to Spezia under their own power and without any assistance from auxiliary boats. These craft can steam 7 knots submerged, and 14 knots in the light condition. They carry two torpedo tubes below the bow, and embody the principle which is adopted in the Lake boats in this country of carrying a heavy false keel, which may be detached should the submarine, through accident, sink to the bottom. Comparable with this 1300-mile trip, in a semi-submerged condition, of the submersibles is the recent cruise, under war conditions, of the British submarine flotilla for a distance of 300 miles, during which they stayed for forty consecutive hours under water.

The three performances above recorded are very encouraging, since they foreshadow the ultimate mastery of two difficult problems in the submarine: radius of action and certainty of attack. The submarine of the future will grow in size, and as it does so its speed and radius of action will steadily increase—possibly even to the point at which the largest type will be capable of accompanying a fleet in its operation on the high seas.

OUR PONDEROUS PASSENGER CARS.

Does it ever occur to the passenger, when he is sweeping through the country in the luxurious comfort of his heavily upholstered seat in a Pullman car, that, in order to give him that accommodation, the railroad company must haul over the tracks, not merely his individual 150 pounds of weight, but an additional two tons of weight of the car? The largest modern Pullmans will weigh over 60 tons; and, since they provide only sixteen sections, it follows that for every passenger carried, even when the car is full, two tons of dead weight must also be moved. In respect of the weight hauled per passenger, therefore, a Pullman train is the most extravagant and costly method of transportation in the world, as the following comparative facts will show. A touring car capable, when running on a good road, and if, like the railroad train, unhindered by speed restrictions, will carry seven people at the same speed as a Pullman train. The machine will weigh about 3500 pounds, or 500 pounds to the passenger. A 7-horse-power motorcycle, weighing 150 pounds and running on a good road without speed restrictions, will transport two people on the level at a speed of 40 miles per hour; while a bicycle, weighing only 25 pounds, can be driven by an ordinary rider on a good road at from 12 to 15 miles per hour, and by a racing man at from 20 to 25 miles an hour. Even that good old standby, the two-seated buggy, weighing, let us say, 320 pounds, will convey its two passengers in comfort and safety at a speed of from 15 to 20 miles an hour. Summing up our comparative results, then, we find that the dead weight necessary to carry a passenger in a touring car is 500 pounds, on a motorcycle 75 pounds, on a bicycle 25 pounds, and in a horse-drawn buggy 160 pounds, as against the enormous load of two tons of dead weight necessary for the transportation of a Pullman passenger. It may be objected that the Pullman car represents an extreme case, and that much of the weight is due to the provision of sleeping accommodations; but we find that, even in the first-class day coach, the dead weight per passenger is very high, being, in the case of coaches accommodating, according to size, from seventy to eighty-four people, about 1 1/3 tons of dead weight per passenger.

It does not require any elaborate mathematics to show that the hauling of this enormous dead weight over the track is very costly, involving heavy maintenance expenses on the part of the railroads and proportionately higher rates for the traveling public. Apart from the large expenditure of fuel, the excess weight causes a rapid deterioration not only of the tracks and roadbed, but also of the rolling stock itself. Rails are broken, or battered down at the rail joints; rails and tie-plates are crushed down into the ties; the heads of the rails and the flanges of the wheels are rapidly ground away on the curves; and, because of the heavy impacts due to the great deadweight, there is not only a more rapid deterioration of the rolling stock, but of every part of the system that comes into physical contact with it.

The great weight of passenger cars is due in no small measure to the great length to which these cars have grown in recent years. The body of a modern Pullman, over 70 feet in length, supported on a truck at each end, may be regarded structurally as a bridge carried upon two end piers; and, in the case of the car, as of the bridge, the bending stresses tending to break it in two, and, therefore, the weight of material necessary to resist those stresses, increases in a much more rapid ratio than the length. Moreover, the concentration of weight on the two trucks calls for heavy construction in the trucks themselves; and it is a question worthy of the consideration of the car builder whether a great saving in weight would not be effected by reducing the length of the cars and substituting lighter four-wheeled trucks for the ponderous six-wheeled trucks now in use. Furthermore, the roof construction could be considerably lightened by abolishing the present ventilator and substituting a plain curved roof. Considerable weight might also be saved by abolishing the end platforms, vestibuling the car bodies directly against one another, and substituting entrances at the center of the cars.

The greatest reduction of weight, however, would come from the introduction of steel in place of wood and the application to the design of the cars of those principles of bridge construction which have rendered the modern steel bridge such a marvel of lightness in proportion to its strength and the load it can carry. We believe that the weight of our present railroad cars is due not a little to the fact that too much of the coach builder's and too little of the bridge engineer's art has been employed in their design and construction. It is one of the curious anomalies of railroading, that at this late day, when so many steels and alloys offering great strength in proportion to their weight are available, we should still be building our cars of wood and building them on such massive lines. We note that in a recent discussion of this question, as applied to street railway and interurban cars, Mr. M. V. Ayers, of the Boston and Worcester Street Railway, estimates that the weight of a 60-passenger, 31-ton car could be so greatly reduced by careful design and the use of steel, that there would be a saving of $1100 per year in power cost alone, in favor of the lighter car—an economy which would more than offset the increased cost due to special design and the use of a high-grade steel. The SCIENTIFIC AMERICAN has more than once drawn attention to this important question during the past few years, and we heartily indorse Mr. Ayers's statement that more actual saving of money can be effected by reducing the weight of cars than by any other change that can take place in the art of railroading.

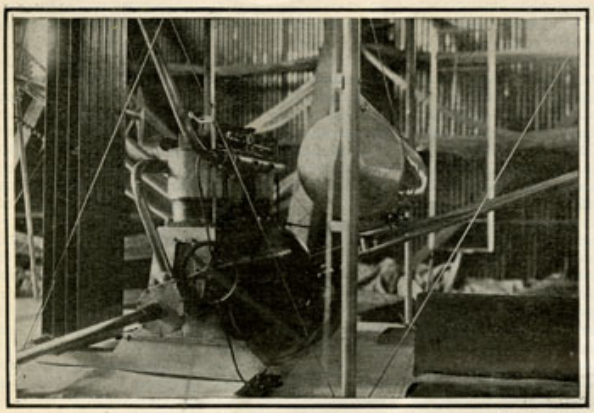

Fig. 1.—Detail Front View of Center of Aeroplane, Showing the Motor, Radiator, Gasoline Tank, and Seat.

The driving chain and sprocket of one propeller are visible at upper left-hand corner, and the crossed tubes carrying the other propeller chain can be seen on the right. The twin vertical rudder is also seen on the right at the rear.

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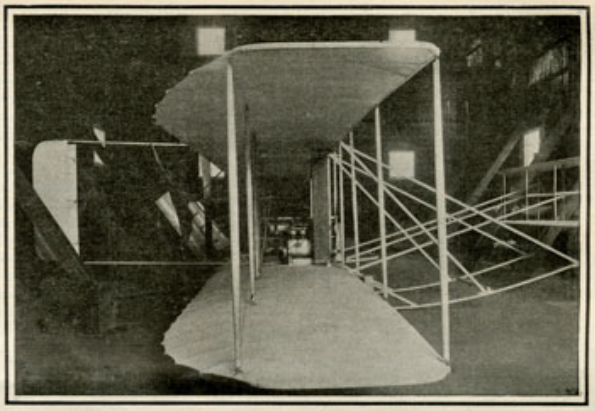

Fig. 2.—End View of the Aeroplane, Showing the Vertical and Horizontal Rudders, Propellers, Gasoline Tank, Motor, and Radiator.

This photograph gives a good idea of the slight curve of the planes as well as of their construction.

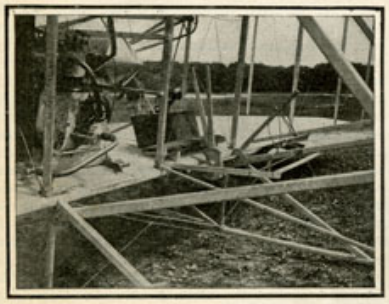

Fig. 5.—Front View of Lower Plane.

The radiator, motor, fuel tank, seat, and levers are visible. The aviator sits farthest from the motor and holds the horizontal-rudder lever in his left hand and the vertical-rudder and wing-warping levers in his right. Note foot-rest in front of levers.

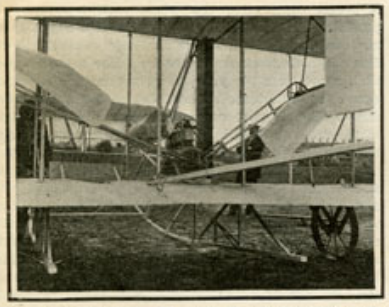

Fig. 7.—Rear View, Showing Motor, Propellers, and Driving Chains.

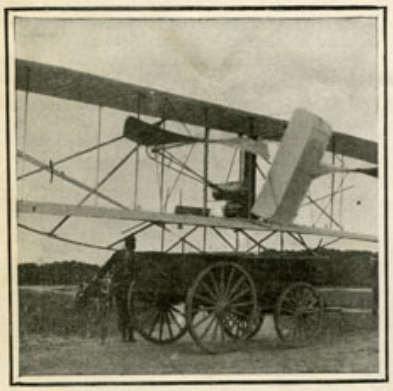

Fig. 8.—The Aeroplane on an Army Wagon.

The runners are folded back against the front edges of the planes and the rudder is placed against their rear edges.

Fig. 9.—The Aeroplane Flying at a Great Height.

In some of its flights the machine is estimated to have reached an elevation of 200 feet.

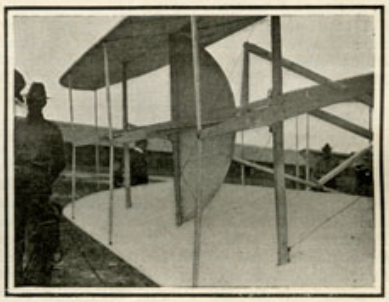

Fig. 6.—Detail View of Front Horizontal Rudder.

In this photograph the rudder is shown tipped downward. The operating lever and wood rod connecting to lever on aeroplane are visible. Also note semi-circular vertical surface which is loosely mounted at the center.

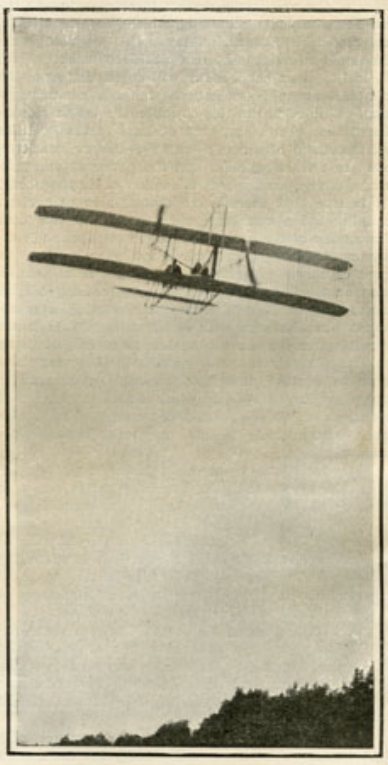

Fig. 10.—Rear View of the Aeroplane Making a Turn.

The machine can make a much sharper turn than this, and in so doing dips downward much more.

THE CONSTRUCTION OF THE WRIGHT AEROPLANE.

THE CONSTRUCTION OF THE WRIGHT AEROPLANE.

In view of the record-breaking flights made by the Wright brothers here and in France during the past few weeks prior to the accident to Orville Wright's machine, we believe that our readers will be interested in some of the constructional details of this, the simplest and, so far, the most successful aeroplane flying machine that has been built. In our issue of August 29 we gave a brief description of the Wright aeroplane, and in this issue we show some detailed photographs of its various parts.

The machine consists of two rectangular planes, rounded slightly at the rear corners and superposed, one above the other, at a distance of 6 feet apart. These planes are 40 feet long by 6½ feet wide, and have a supporting surface of about 500 square feet. They are made of unbleached muslin tightly stretched on rectangular frames provided with curved ribs extending across the frames and beyond their rear edges for about 18 inches. A wire is stretched tightly through the forked rear ends of the ribs, and to this wire the cloth is attached, while it also passes around the front edge of the rectangular frame and back under the ribs, completely covering them. The two frames are fastened together by sixteen tapered uprights, properly spaced apart along their front and rear edges. Four of these uprights on each end are secured to the frames of the planes by the hook-and-eye connection shown in Fig. 3, which makes a flexible joint. The aeroplane is mounted upon runners, which are secured beneath its center part and which extend forward and curve upward to support the horizontal rudder. This is formed of two superposed surfaces very similar to the main planes. These surfaces pivot upon a rod that runs through each of them lengthwise, a little forward of their center point. The uprights (Fig. 6) also carry a rod about half way between the two planes, and on this rod, at suitable intervals, are fastened horizontal crosspieces, which connect with vertical tie-strips that unite the upper and lower planes. A lever projects upward from one end of the rod, and is connected by means of a wooden rod to the operating lever on the front edge of the aeroplane, and which is shown projecting forward in Fig. 5. On the base of this lever is a drum with a friction band which holds the lever, and, consequently, the rudder in the position in which it is set by the aviator, and thus relieves his hand of much of the strain. In the middle of the horizontal rudder there is a semicircular vertical surface, which is allowed to flap a short distance from one side to the other. This has a steadying effect upon the steering of the machine. The vertical rudder is also a twin affair. It is mounted upon two horizontal sticks that project back of the machine at its center point, and is operated by one of the two levers (the vertical one) seen projecting upward close together in Fig. 5. The manner in which this is connected to the operating lever is shown in Diagram 3, Fig. 4, where *F* is the rudder and *B* the main planes. The third lever (the other one of the two just mentioned) has connected to it two wires in a similar manner to those which operate the vertical rudder. These wires run through pulleys at the rear of the lower main plane, and extend to the top of the outermost rear connecting post, as shown in 1, Fig. 4. The lower ends of the lower plane are connected together by a wire passing upward through pulleys and downward again, as is also shown in this diagram. When the lever is pulled, as shown, it draws down the upper rear edge of the uppermost plane. The lower plane, being connected to it by the upright, is also forced downward, exerting a pull upon the wire attached to it, thus raising its opposite end, which also forces upward the corresponding end of the upper plane. The ends of the planes are warped in this manner, and thus when a greater angle of incidence is obtained at one end, the angle is correspondingly lessened at the other. As the device is constructed, there are additional wires running from the tops and bottoms of the posts next to the end ones, and joining the wires just before they pass through the pulleys. This feature of the Wright aeroplane is patented, and is the one to which they lay the success of the machine; for by twisting the planes they are able to tip the machine readily and make sharp turns, and also to quickly counteract the effect of wind gusts. They expect to warp the surfaces and control the rudders automatically in the future, but for the present they depend upon manual control, which, of course, does not eliminate the personal equation. It may be due to this that their aeroplane made its fatal downward plunge, as a similar accident occurred during their practice flights in North Carolina last spring, when Wilbur Wright very likely would have been killed had it not been for the fact that the machine landed in the soft sand. He made a false move of the lever which operates the horizontal rudder and, instead of rising and passing over a sand dune, the machine dove suddenly downward into it. In the recent accident, however, Orville Wright stopped his motor, and he should have been able to glide safely to the ground. In stopping the motor, he was obliged to take his hand off the twin levers that warped the surfaces and worked the vertical tail, and it is possible that during this moment the machine may have tipped too much to one side, and that the aviator was unable to correct this tipping during its downward plunge.

Experts believe that after the motor was stopped the machine, which had already lost speed on the end having the broken propeller, quickly lost its momentum, and that although Mr. Wright was able to regain his equilibrium momentarily, its final downward plunge was due to the loss of speed and the forward location of the center of gravity. The height of the machine above the ground was not sufficient for it to descend properly in gliding flight, as a machine of this size and type, if dropped from a height, must plunge downward 50 or 60 feet before it can obtain sufficient speed to glide successfully in a more or less horizontal position. The instability of this type of aeroplane was demonstrated by the accident, and it seems certain that some type of machine which has more inherent stability, both in a longitudinal and a transverse direction, will have to be devised.

Regarding the mechanical features of the aeroplane, its 4-cylinder, vertical, water-cooled motor and the method of driving the propellers are illustrated in Fig. 1. This engine was designed by the Wright brothers and, like the machine itself, is of great simplicity. Its total weight is 170 pounds. It is mounted in a fore-and-aft direction in the aeroplane, a little to the right of the center line of the machine as one sits in it and faces forward. The four cylinders are bolted to an aluminium crankcase; they are fitted with aluminium water jackets and the valves are located in their heads. The inlet valves are automatic, and are connected together by a suitable inlet pipe. Gasoline is pumped into this inlet pipe by a small pump in the crankcase, which is driven from the crankshaft. There is also an oil circulating pump which raises the oil from a reservoir attached to the under side of the crankcase, and distributes it to the bearings of the crankshaft. The motor is oiled chiefly by splash lubrication. The water-circulating pump is on the outside of the motor at its forward end, and is distinctly visible in the photograph, as is also the large gear of the camshaft. The flywheel is to be seen at the rear end of the motor. The cooling water is pumped through four rows of vertical radiating tubes, each consisting of six flattened brass pipes, which make a light form of radiator having considerable surface and but little air resistance. The

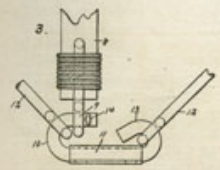

Fig. 3.—Joint Used in Connecting Uprights to Planes.

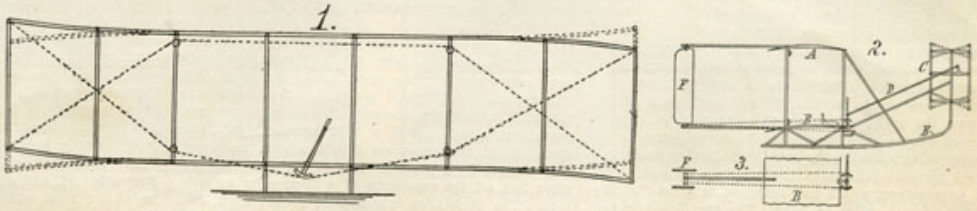

Fig. 4.—Diagrams Showing How the Surfaces Are Warped and How the Rudders Are Operated.

1. Diagram showing connections for warping the planes. 2. Side view showing connection, *D*, for operating horizontal rudder, *C*, which is carried on an upward projection of runners, *E*. 3. Plan view showing connections for operating vertical rudder *F*.

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Figs. 11 and 12.—Through the Breaking of a Propeller While the Aeroplane Was Traveling at a Height of 75 Feet, with Orville Wright and Lieutenant Selfridge on Board, the Machine Became Unmanageable and Plunged to the Ground, With the Result That Lieutenant Selfridge Was Killed and Mr. Wright Seriously Injured.

THE CONSTRUCTION OF THE WRIGHT AEROPLANE.

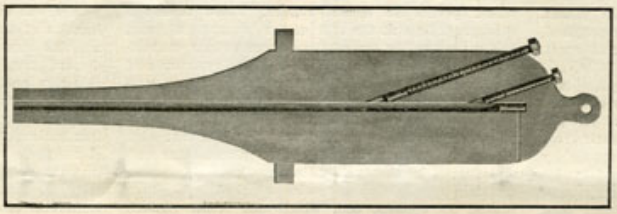
ignition is of the make-and-break type, the igniters being operated from a horizontal camshaft running across the top of the motor, and driven by bevel gears from a vertical shaft extending into the crankcase. A magneto, driven off the flywheel, supplies current. The switch is visible in the photograph at the lower front edge of the motor. The chains which drive the propellers pass through tubular guides on their way from the sprockets on the motor crankshaft to the sprockets on the propeller shafts. One of the latter of these is visible at the left-hand upper edge of Fig. 1. The crossed tubes carrying the chain of the other propeller are also distinctly visible in this illustration. The method of reversing the direction of rotation of the propeller by crossing the chain does not seem to be an extra good one, despite the statement of Mr. Orville Wright that he has never had any trouble with this arrangement. Whether this had anything to do with the breaking of the propeller, or not, will probably never be known. The propellers which were used on the day of the accident were new ones about 9 feet in diameter and of a somewhat less pitch. The propellers which were used previously, and which were about 8½ feet in diameter and of the same pitch, are those illustrated in our photographs. They ran at a speed of about 400 revolutions a minute. Mr. Wright had hoped to increase the speed of the aeroplane by the use of new propellers, as their flatter pitch should enable the motor to obtain a higher speed and develop somewhat more power. Ordinarily, the motor developed about 25 horse-power, which was sufficient to drive the machine over 40 miles an hour. The specifications put out by the government required a speed of 40 miles an hour with two men on board, and Mr. Wright hoped to surpass that considerably. As far as endurance was concerned, he had already, on September 12, made a flight of 1 hour, 14 minutes, 24 seconds, which was practically a quarter of an hour longer than was required by the specifications. These required that he should carry a passenger, however, and it was in a second effort to see what he could do in this direction that he took Lieut. Selfridge with him on the 17th instant.

In one of our illustrations, Fig. 8, the aeroplane is seen upon an army wagon. This photograph shows it as it is being transported from the shed where it was put together to the tent where it was housed during the first few days of its stay at the Fort Myer parade ground. In this picture the vertical rudder is shown folded up against the rear of the plane, and the runners are also folded back against the front edge. When it is desired to take the machine apart, the outer quarters of the main planes can be folded back upon the central halves, and the whole machine can be quickly disassembled. Great ingenuity was displayed by the Wright brothers in constructing their aeroplane so that it would fulfill the condition of being readily dismounted and packed upon an army wagon, but the great simplicity of the entire machine is the most striking point about it, and the one which most strongly evidences a real stroke of genius. The result of the accident will be a greater striving of inventors to produce a machine having automatic stability, and which will only require sufficient attention on the part of the aviator to steer it sidewise and up and down, and to keep the motor running. It would also seem that a new impetus should be given to Langley's idea of experimenting over water where, if a machine took a sudden plunge, the aviator would at least have a chance of escaping. The accident to the Langley machine some years ago, when it plunged into the Potomac while Mr. C. M. Manly acted as aviator, illustrates this point; for, although the machine was injured, and Mr. Manly had a very narrow escape, nevertheless he is alive to-day and is one of our most enthusiastic aviators.

In the Electrical World C. E. Lord describes a method of ventilating a high-speed machine so that the noise is reduced to a minimum. The air which cools the rotor does not pass directly to the stator, but follows a restricted path through the stationary member. The ventilating passageways in the stator are arranged concentrically about the axis of the rotor, and means are provided for cutting off direct communication between the ventilating passageways and the air gap of the machine.

AN EARLY ARMOR-PIERCING GUN.

The following sketch and description of an early and decidedly novel design for an armor-piercing gun have been furnished us by Mr. W. B. Williamson, of Ames, Okla., who was on special service in Washington from 1862 to 1865, and was in a favorable position to observe the construction and test of the gun. The drawing, it should be understood, is only approximately correct, the sketch on which it is based having been made from memory after a lapse of forty years. The gun was cast at the Washington navy yard and placed in the experimental water battery (then used for drill and practice). Its length was about 11 feet, and its bore only 2¼ inches. Its weight was about equal to that of a 32-pounder iron Dahlgren. From the trunnions to the muzzle the taper was abrupt; from the trunnions to the neck ring the piece had all the ear-marks of a 68-pounder smooth-bore. The projectiles, which were forged from tool steel and turned down to caliber, were about 12 inches long. The gun was rifled, and soft metal rims were swaged on the projectile to enable it to take the rifling. The first powder charge and the projectile were loaded from the muzzle. On the right side of the breech were two holes bored at acute angles to the longitudinal axis of the gun, the first entering the bore a little ahead of the projectile, the second farther ahead, nearer the trunnions, in the position shown in the engraving. Each hole was fitted with a long, coarse-threaded breech-pin. A charge of powder, somewhat smaller than the main charge, was inserted in each chamber, and the breech-pin screwed home. Each of these auxiliary chambers was of about 2 inches bore. The gun easily pierced a 9-inch iron plate at 500 yards, and it required a 12-inch plate to stop the projectile.



Length, 11 feet. Bore, 2¼ inches. Penetrated a 9-inch iron plate. The gun had three powder chambers in which the charges were ignited successively as the projectile passed down the bore.

AN EARLY BREECHLOADING GUN.

It will be seen that, in a certain sense, the designer of this gun anticipated the theories of our modern smokeless powder; for the charge was burned progressively, part of it at the breech, and two other portions at succeeding intervals during the travel of the projectile down the bore.

President Lincoln, visiting the yard one day in 1862, requested to have the gun loaded, sighted the piece, and fired, making a center. Thereupon the piece was dubbed "Abe Lincoln's pocket piece."

According to a contemporary, there is manufactured in Holland a substance called liconite. It is similar to rubber in appearance and in many of its qualities. It is a compound of bitumen and various oils, has neither rubber nor gutta-percha in its composition, is elastic and tough, and is said to be non-hygroscopic, unaffected by water, dilute acids, or alkalis, and capable of withstanding all ordinary temperatures without flowing or cracking.

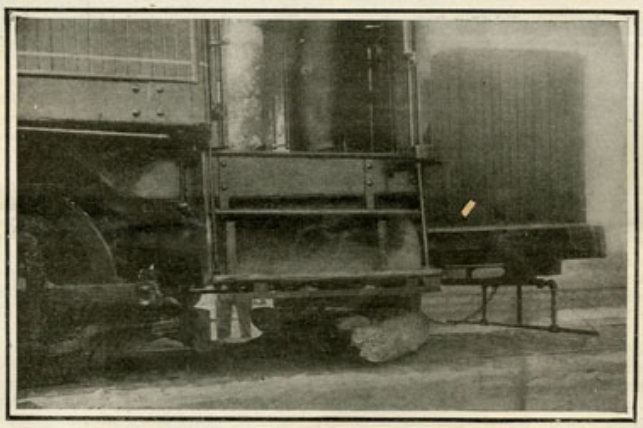
CAR FENDER TESTS BY THE PUBLIC SERVICE COMMISSION

The Public Service Commission of the city of New York never inaugurated a more commendable movement that when it arranged for a series of public competitive trials of street-car fenders, with a view to selecting the most efficient type for use on the street railways in this city. It has been moved to take this step as the result of the statistics of street-railway accidents which have been gathered under its administration. These were of such an appalling character, both in number of fatalities and the shocking character of the injuries, that the Commission at once took steps to institute the present inquiry and select a really effective car fender. The tests are to be carried out partly at Schenectady and partly at Pittsburg; the first on tracks provided by the General Electric Company, and the later series on tracks near the works of the Westinghouse Company. Neither of these concerns has the least financial interest in the competition; they merely place the excellent facilities of their respective plants at the service of the Commission. The tests, of which we present several illustrations, were held upon a stretch of track running along the banks of the Erie Canal in the presence of the Commissioners and their engineering staff, eminent traction engineers from various parts of the country, and several members of the General Electric Company's own engineering force.

The first series of tests took place on Wednesday, September 16, and evidence that the competition will be of the most widespread character was shown by the fact that up to noon of the previous day, 112 men had registered for competition at the office of the Commission. The character of the tests and the conditions of the competition were given in full detail in our issue of September 19. The first fender tried was of the projecting automatic type, and was manufactured by John O'Leary, 25 Congress Street, Cohoes, N. Y. It consists of a square section of metallic latticework which, when in use, extends in front of the car close to the track, and, when not in use, can be raised and tied up to the dash board. One of these fenders was attached to a trolley car weighing 25 tons, provided by the General Electric Company. Dummies representing boys weighing 50 to 60 pounds and others representing women weighing 120 pounds were placed upon the track in various attitudes, and run into by this car with the fender in position. The tests were made with the car going 15 miles an hour and also at a speed of 6 miles an hour. There were two series of tests, one on cobblestone pavement and the other on asphalt pavement, this being done to reproduce as nearly as possible street conditions in New York city.

The dummies were placed on the track standing up, lying on their side, or stretched along the rail, and the effect of the contact with the fender in all such positions was noted. In most instances the fender made a clean pick-up of the dummy and carried it, as if in a basket, until the car was brought to a standstill by the brakes. In some instances the dummy was scarcely injured by the impact; in others it was deprived of one or two legs; and in cases where the fender failed to pick it up, it was rolled along over the roadbed and badly mangled. The credit marks used in each test to keep the official record were as follows: A counted 4 points for a complete pick-up or removal from the track; B counted 3 points for a partial pick-up or removal from the track, with any part of dummy remaining under fender; C counted 2 points for a partial pick-up or removal from the track, but with the dummy for the most part under the fender; D counted 1 point where no pick-up is made and when the dummy is entirely under the fender, but dragged sufficiently to prevent its going under the car. In the first series of runs made on cobblestones at 15 miles an hour, the O'Leary fender received four A's, one C, and one D. In the same series on cobblestones at 6 miles an hour it received three A's, one B, and two D's.

The dummies, as will be seen from our photographs, were constructed so as to closely approximate the forms of living persons; and the distributing of the weight, center of gravity (most important point), etc., were carefully considered. It will be noticed



Shows Manner in Which Defective Fender Allowed Body to Pass and Be Mangled.

CAR FENDER TESTS BY THE PUBLIC SERVICE COMMISSION.

TRINITY COLLEGE
NC. CAROLINA

SCIENTIFIC AMERICAN

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Henry Farman making the first cross-country flight that has ever been accomplished with an aeroplane. The 17 miles between the military camp at Chalons and the city of Rheims, France, were covered in about 20 minutes.

A NEW ERA IN AERIAL NAVIGATION.—[See pages 350 and 357.]

AN AEROPLANE FACTORY.

BY JACQUES BOYER.

The construction of aeroplanes is the latest new industry to be started in France; and the exploits of Santos Dumont, Bleriot, Farman, Delagrange, and the Wright brothers, by focusing public attention upon aviation, have aided in its development. As a result, there are to-day several factories especially fitted up for this purpose near Paris. The most important of these, that of Voisin brothers at Billancourt, has a capacity of four machines a month.

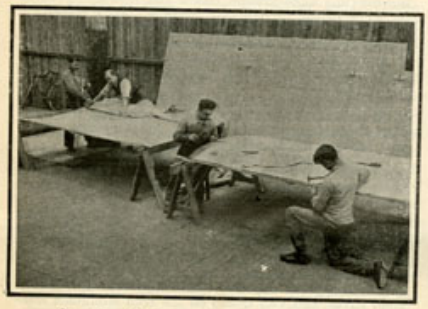
In the principal room of this original factory are found scattered about the various parts of aeroplanes in course of construction. In one corner is to be seen the body framework or skeleton of a future aerial vehicle, some 36 feet in length by about 2½ feet in width, while a little farther on are placed the cells, or enormous wings, having a spread of some 32 feet, and intended to be mounted on monoplane, double or triple-surface machines.

The tools used in the aeroplane factory are of the simplest sort. They consist of mallets, saws, chisels, and such other tools as are used by carpenters. The wood used in making the body framework is generally ash, while the uprights that connect the main planes are of the same material or of poplar. The main longitudinal pieces are cut from very dry wood. They are about 32 feet long, and are selected so that the grain runs from one end to the other, in order to give a maximum resistance for a given section. They are planed down and grooved in certain places, and then fitted together by means of uprights that are mounted in aluminium sockets attached to them. The framework thus formed is suitably braced by means of steel piano wire, drawn taut and fastened to eyelets in the aluminium sockets. In the aeroplanes of the Farman type constructed by Voisin, the finished body framework has a total length of 9½ meters (31.16 feet), weighs 55 kilogrammes (121¼ pounds), and is so rigid that it will support a weight of over 1,000 pounds at its front end.

The body framework tapers at the front and terminates in a steel and aluminium plate, in the center of which is fastened the bearing for the propeller shaft. The motor is mounted on a metal frame, and the seat of the aviator consists of a board with a back attached.

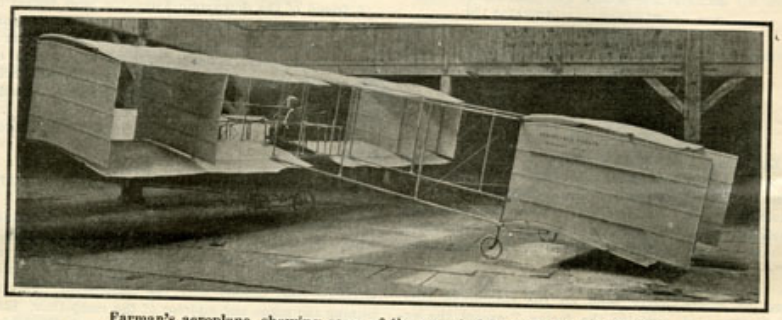
The cells or wings, which are attached to each side of the body framework, consist, in the case of a double or a triple-surface machine, of two or three superposed surfaces, connected together by poplar uprights mounted in the aluminium sockets, and braced by steel wires in order to make them sufficiently rigid. These surfaces are made up of a frame consisting of two strips of wood (one in front and one at the back) connected by curved ribs of poplar, and covered with rubber-impregnated cloth, which is nailed to the strips

(Concluded on page 358.)



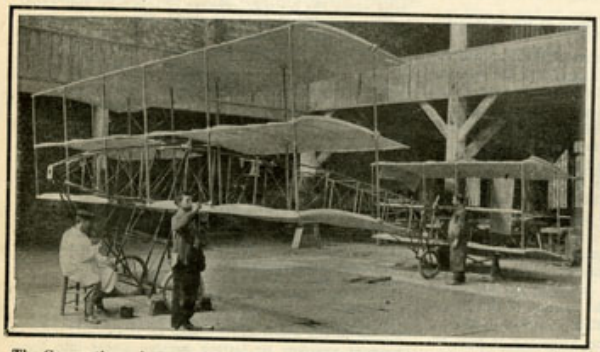
Covering the frame of a plane with cloth.

A waterproof cloth having pockets for the ribs is used to form the planes.



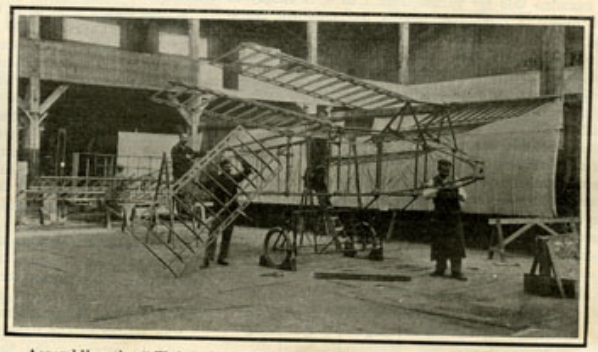
Farman's aeroplane, showing some of the recent changes in its construction.

Vertical partitions have been placed half way between the center and ends, and also at the ends of the main planes. They prevent the machine from skidding sideways when turning a corner.



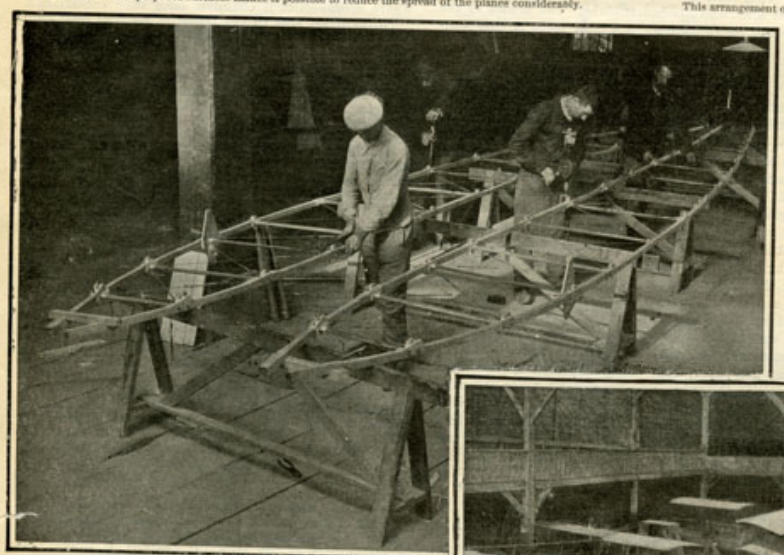
The Goupy three-decker. This machine was tried without encouraging results.

The use of three superposed surfaces makes it possible to reduce the spread of the planes considerably.

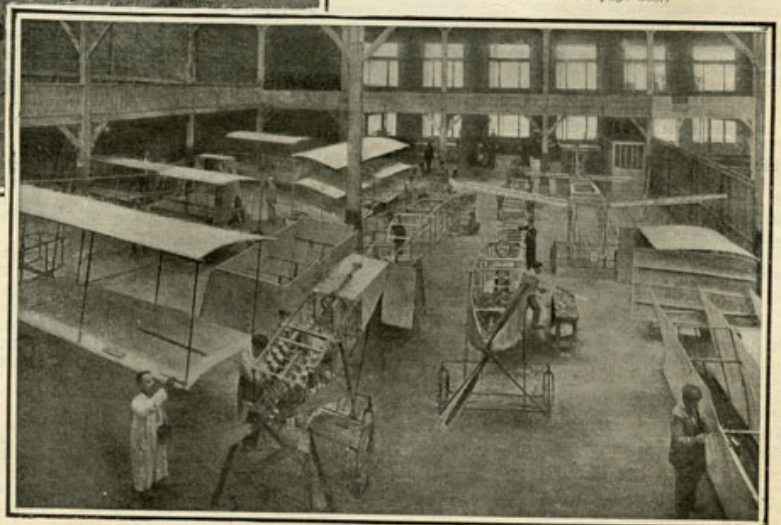


Assembling the "Flying Fish," Farman's untried following-plane machine.

This arrangement of following planes also makes possible the reduction of the wing spread.



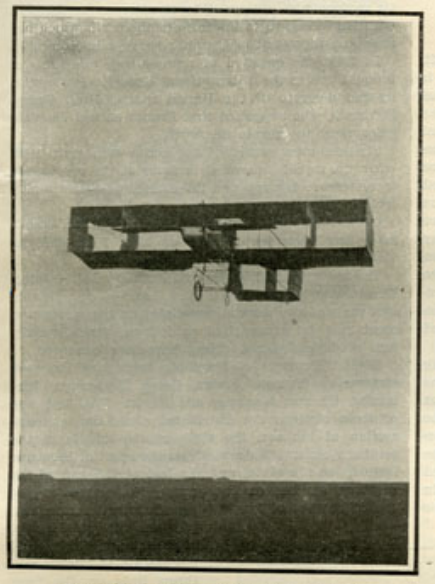
Side members of the main body frame of an aeroplane.



Interior of the Voisin factory, showing finished aeroplanes and others in course of construction.

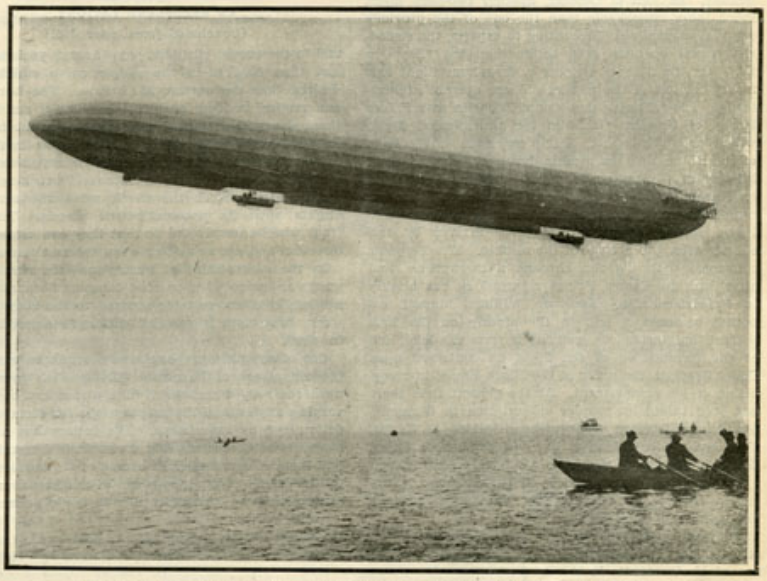
THE LATEST EUROPEAN AIRSHIPS AND AEROPLANES AND THEIR PERFORMANCES.

As noted in our issue of October 31, Count Zeppelin, on the 23d ultimo, brought out his fifth airship for its first trial. One of our illustrations shows this huge air craft undergoing its first trial. The new airship is the remodeled "Zeppelin III." of 1906, which, before the building and operation of the fourth airship last year, had shown remarkable results. It has been lengthened out 8 meters (26¼ feet), and, because of its smaller diameter than the No. 4, Count Zeppelin has used two 85-horse-power motors in place of the 110-horse-power engines that were on the later airship. The remodeled No. 3 has the same inclined stabilizing planes attached to its sides at the rear that were first tried out upon it and afterward used in a modified form upon the No. 4, but in place of the very large vertical rudder the latter had at its rear end, small triple vertical rudders only appear to be used between the stabilizing planes on each side. A three-surface horizontal rudder is used on each side



Farman's aeroplane flying across country.

Note the vertical partitions connecting the planes. These have been added recently.

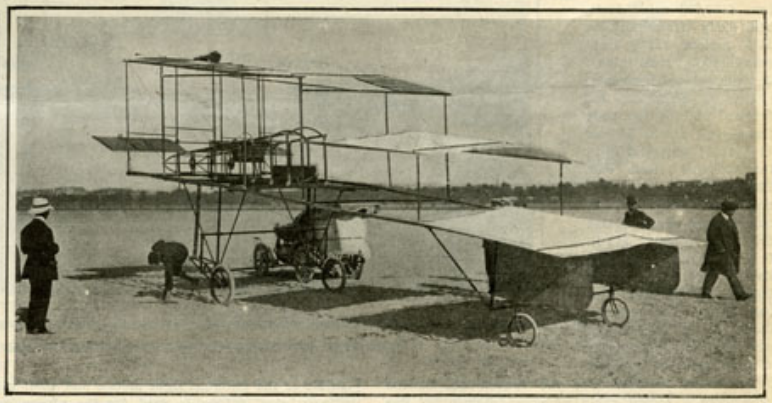


The latest Zeppelin airship—the remodeled No. 3—in flight above Lake Constance.

The large vertical rudder at the rear has been dispensed with and replaced by small triple rudders on each side.

Blériot's monoplane on its nine-mile cross-country flight.

Despite numerous accidents, this machine has proved its worth by its flights across country and in a strong wind.

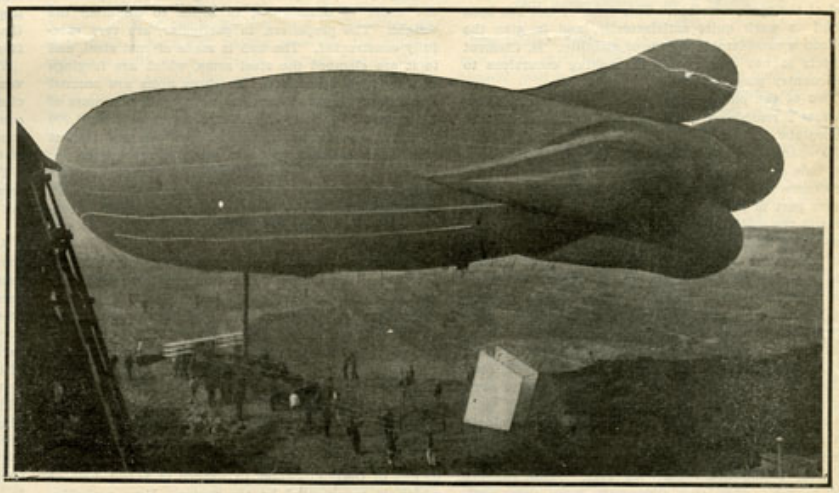


Three-quarter rear view of the Witzig-Lioré-Dutilleul aeroplane.

Note the step-like arrangement of the surfaces, with the horizontal rudder in front and the twin vertical rudders at the rear.

The Clement dirigible sailing over the Madeleine in Paris on its initial trip.

Note the aluminium cabin in the body framework.



The new Clement airship, showing the peculiar tail, the propeller, and the horizontal and vertical rudders.

During its maiden voyage on October 29, this new airship, piloted by M. Kapferer, carried seven people from Sartrouville to Paris and back at a speed of between 25 and 30 miles an hour.

SOME NEW AND IMPROVED FOREIGN AEROPLANES AND AIRSHIPS.

of the bow also. Among the new features is a telegraph line connecting the two cars.

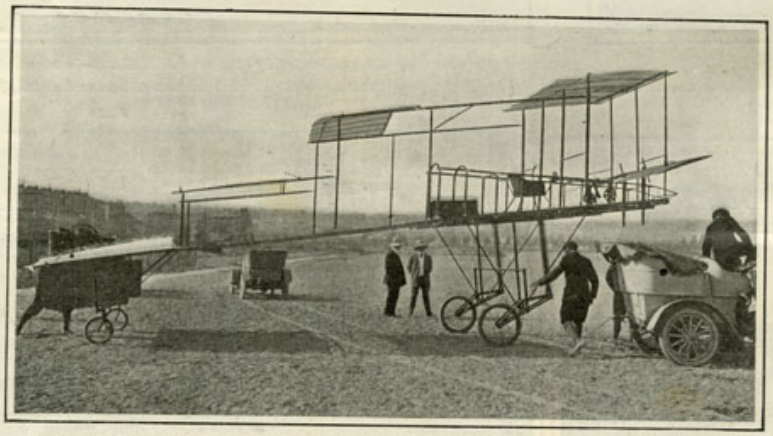
A few of the recent flights of the remodeled airship are enumerated below. The first was made on October 23, when the airship flew over Lake Constance and the city of the same name about four hours. On the next day a flight of two hours was made, and on Sunday, the 25th of October, another two-hour flight much more remarkable than the one of the previous day was carried out. According to experts, the remodeled vessel operates even better than the "Zeppelin IV." On the 26th of October a three-hour flight was made, but one of the motors did not operate satisfactorily. The following day, Count Zeppelin took Prince Henry of Prussia with him for an extended flight, which lasted six hours. A trip was made to the Falls of the Rhine, and the airship developed a speed of 50 kilometers (31 miles) an hour. Several days after, on November 7, Crown Prince Frederick William accompanied the Count, and made a trip to Donaueschingen, Baden, where the Emperor arrived by rail shortly after the arrival of the airship. The Emperor conversed with his son through a megaphone, and afterward the Crown Prince returned in the airship to Friedrichshafen. Emperor William himself expected to make a trip in the airship on the 10th instant, but instead he watched it from the lake, and at the termination of the flight he conferred upon Count Zeppelin the order of the Black Eagle, in recognition of his achievement. At the present time there has been raised by popular subscription in Germany, for the construction of Zeppelin dirigibles, $1,378,334. This gives a good idea of the decided success Count Zeppelin has finally met with among his countrymen.

The other dirigible which we illustrate is the "Clement-Bayard" of M. Clement, the well-known automobile manufacturer of Paris. This airship has been constructed for the personal use of M. Clement. It is 56 meters long (183.6 feet) by 10.58 meters (34.7 feet) in diameter, and it has a capacity of 3,500 cubic meters (123,602 cubic feet). The body framework is 28½ meters (93½ feet) long, made of steel tubing. A triple-surface horizontal rudder is placed at the forward end of the body framework, and a 5-meter (16½-foot) propeller is at the extreme front end. The 120-horse-power Bayard-Clement motor is mounted on springs, and drives the propeller 380 R. P. M. by reduction gearing. Every conceivable kind of indicating apparatus has been fitted. For example, there is a tachometer which gives the number of revolutions of the motor at every instant. For the convenience of the passengers a closed cabin of sheet aluminium has been provided. A specially noticeable feature of this dirigible is the peculiar tail, which consists of four club-shaped gasbags placed beside the reduced rear end of the main envelope. This form of tail has been found to work quite satisfactorily, and to give the balloon a considerable degree of stability. M. Clement expects to use this airship in making excursions to his country place.

Two of the photographs reproduced herewith show Farman's remodeled aeroplane and the latest Bleriot monoplane in full flight. The Farman machine has been changed by the placing of vertical partitions at the ends of the main planes and by the moving of the partitions that were formerly on each side of the center part to points about half way between the center and the ends of the main planes. M. Farman has also fitted horizontal auxiliary planes or shutters to the rear edges of both the upper and lower planes. The angle of these shutters can be varied to tilt up the machine when turning a corner. After making the sensational cross-country flight mentioned elsewhere, Farman, on October 31, won the "Prix de la Hauteur" of the Aero Club of France by flying over a line of captive balloons placed at a height of 82 feet.

The Bleriot monoplane has not been changed very much of late. The movable wing tips are still used on the ends of the plane, and there is but a single horizontal rudder below the rear end of the body framework. A small additional plane is fitted above the body framework toward the rear. These rudders and movable wing tips apparently work very well, since M. Bleriot was able, on October 22, to drive his machine against a strong wind of between 25 and 30 miles an hour. The speed of the machine itself is about 37 miles an hour.

The other aeroplane we illustrate is a new type, in which the surfaces are arranged in a series of steps. This aeroplane is known as the Witzig-Dutilleul. It has a total surface of 50½ square feet, and is to have a 50-horse-power Antoinette motor. No experiments of any account have as yet been made with it.



Side view of Witzig-Lioré-Dutilleul aeroplane, showing step-like arrangement of the following planes.

SOME NEW AND IMPROVED FOREIGN AEROPLANES AND AIRSHIPS.

AN AEROPLANE FACTORY.

(*Concluded from page 356.*)

and to the curved ribs that pass through pockets in it, and thus hold it in the proper curve which it is desired that the surface shall have. The horizontal and vertical rudders are fitted in front of and behind these planes, the former being mounted at the forward end of the body framework, and the latter in the box tail at the rear.. The main frame is supported upon a chassis of steel tubing by means of two long coiled springs that absorb the shock when the aeroplane alights upon its pneumatic-tired wheels. The two front wheels are pivoted so that they can assume any direction and act as casters when the machine alights.

In the construction of monoplanes the ribs of the wings are mounted upon steel tubes or I-beams of aluminium that are suitably secured to the body framework. The cloth is provided with eyelets and is laced in place.

One of our photographs shows a workman mounting the six planes of Farman's "Flying Fish" aeroplane upon the body framework. The planes can be set at varying angles, and the proper angle for them will be determined by experiment. The factory has a laboratory, in which experiments are made to determine the best form of aeroplane, the curves of the surfaces, and the resistance of the planes and of the framework. In constructing an aeroplane, use is made as much as possible of the different light metals and their alloys. Ordinary steel tubing is used for the planes, while for the propeller shafts and the blades nickel steel, offering the greatest resistance for the least weight, is employed. All pieces working under compression are made of aluminium, in order to diminish the weight. The propellers, in particular, are very carefully constructed. The hub is made of cast steel, and to it are clamped the steel arms, which are forgings of very high resistance. To these arms are secured aluminium blades. When one notes that this mass of 2.3 meters (7½ feet) diameter revolves at from 1,000 to 1,400 revolutions a minute, one can see that it must be exceptionally strong. At 1,335 revolutions per minute the end of one of the blades travels through space at the rate of 525 feet a second (350 miles an hour) and the blade itself is constantly under a centrifugal force of nearly 9,000 pounds, tending to project it outward.

The motor is one of the most important parts of the aeroplane. Heretofore Voisin brothers have used only the Antoinette motors of the 8-cylinder V type; but lately they have adopted the "Vivinus," or the motor of the Belgian Société Metallurgique. This latter motor, which is the one used on the Goupy, Florio, Moore-Brabazon, Farman ("Flying Fish" for two passengers), and De Caters aeroplanes, is a 50-horse-power, light-weight, automobile motor weighing about 300 pounds. Whatever motor is adopted, the installation of it requires only a few days. In fact, a complete aeroplane can be constructed in about a week's time. The cost of one of these machines in France is $4,000, half of which is represented by the motor. Very probably, however, the cost will be reduced as the machines come into more general use, for in reality, the materials used and the work necessitated in their construction are less than in the case of an automobile.

The Arc of Peru.

The committee of the French Academy of Sciences having scientific control of the French geodetic operations on the equator has reported the completion of the remeasurement of the historic arc of Peru.

This arc was measured by the French (1736-1743) and used in connection with a similar arc in the Arctic regions, also measured by the French, to decide a question in regard to the form of the earth which had arisen as the result of Cassini's surveys in France.

In 1889, the question of remeasuring this arc was brought before the International Geodetic Association by the delegate of the United States, Prof. George Davidson, who suggested that France should have the prior right to execute the work.

Circumstances prevented any active work until 1898, when the association voted in favor of the proposition to remeasure the arc, and the French delegates undertook to have the work done.

Officers of the Geographic Service of the French army left Paris for Ecuador in May, 1899, and the work was continued until completed.

The arc extends from Tulcan, Ecuador, Lat. +0 deg. 48 min. 25.6 sec., to Payta, Peru, Lat. —5 deg. 05 min. 08.6 sec. and the work accomplished in the remeasurement may be summarized as follows, viz.: Seventy-four geodetic stations. Three base lines measured.

Eight differences of longitude determined between stations at Tulcan, Piular, Quito, Latacunga, Riobamba, Cuenca, Machala, and Payta. The first five of these stations are distributed along the northern section of the arc, the sixth at the middle of the southern section, the seventh on the coast at the same latitude as the sixth, and the last at the end of the southern section, on the coast. The comparison of the differences of longitude, geodetic and astronomic, between the stations at Machala and Payta and the station at Cuenca will throw light on the form of the geoid, as the first two stations are on the coast and the third is in the inter-andine region.

Six azimuths were determined, namely, at Tulcan, Piular, Quito, Riobamba, Cuenca, and Payta.

Sixty-four determinations of latitude were made.

The forty-eight magnetic stations were distributed all along the arc.

Of the six pendulum stations, one is at Machala, on the coast, at the point where observations for longitude were made; one at the foot of the western Cordillera, near Chimborazo; one, at an elevation of 4,150 meters in the western Cordillera; two, in the inter-andine region at Riobamba and Quito; and one at an altitude of 1,800 meters in the plain of the Amazon on the eastern slope of the eastern Cordillera.

Of the two lines of levels of precision, one runs from the Riobamba base line to Guayaquil and to the tide gage at Salinas on the Pacific coast and the other from the southern base line to the tide gage at Payta, the two lines covering a distance of 410 kilometers.

The preliminary computations are far enough advanced to assure the value of the observations. The closure of the triangles and the agreement of the computed and the measured lengths of the base lines compare well with the results obtained in the revision of the meridian of France.

The publication of the results of the work will be regarded as an important event by geodesists throughout the world.—Abstract from Science.

A new and peculiar use for electricity has been found. The city of Zittau possesses extensive and beautiful forests, in which such depredations have been made by the larvæ of the "nun" moth that it has been found necessary to cut down all the trees over large tracts. Last summer the electric light was enlisted in the warfare against the insects. On the roof of the city electrical station were mounted an exhaust blower and two powerful searchlights, the beams of which were directed to the forest five miles away. The hoped-for result followed. The moths flew by the thousand toward the searchlights but, before they could reach these, they came within the field of action of the blower and were carried away to destruction. In one night 66 pounds of moths were destroyed in this way, in addition to the great numbers of moths which found death in the electric arcs of the street lamps, from which the globes had been purposely removed.

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.

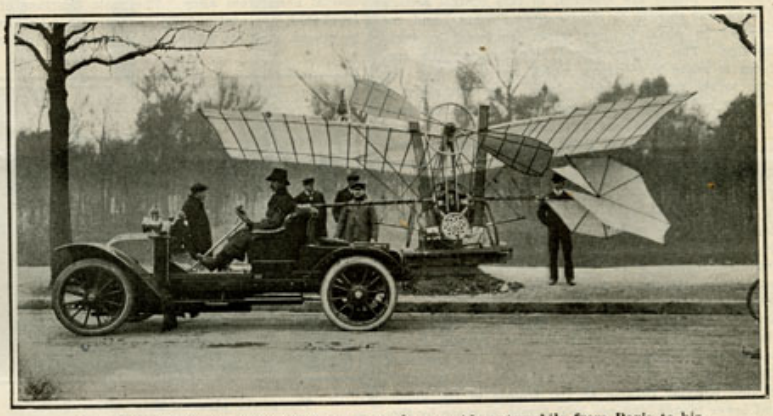
Two experimental dams, with dimensions corresponding to the dam as it is to be built, were made, on the scale of 1 inch to the foot, and these experiments show not only the suitability of the available material, but that a stable and water-tight dam can be built by hydraulic methods. Construction work 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 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.

SANTOS DUMONT'S LATEST AEROPLANE.

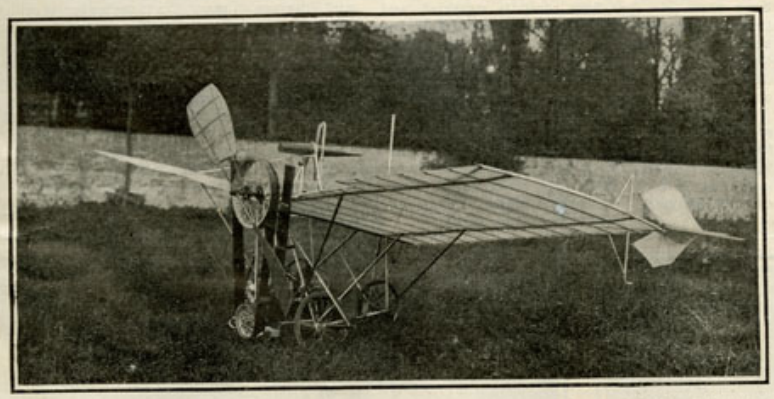
The tiny aeroplane illustrated on this page is the latest one to be produced by Santos Dumont. The noted Brazilian experimenter has not been actively engaged in continuing his experiments in aviation for the past few months, but he has now taken up the subject again, and has brought out once more the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

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 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."

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.

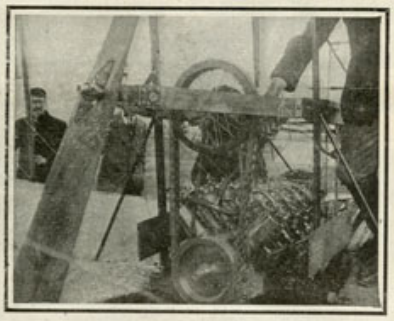
The central part of the machine, which contains the power plant, steering wheel, and control mechanism, is very substantially built, and is complete in itself. The four planes are attached to this central section (which has sockets to receive their frames), and are secured in place by guy wires tightened 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 3⅝ 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 1⅝ 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.

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SCIENTIFIC AMERICAN

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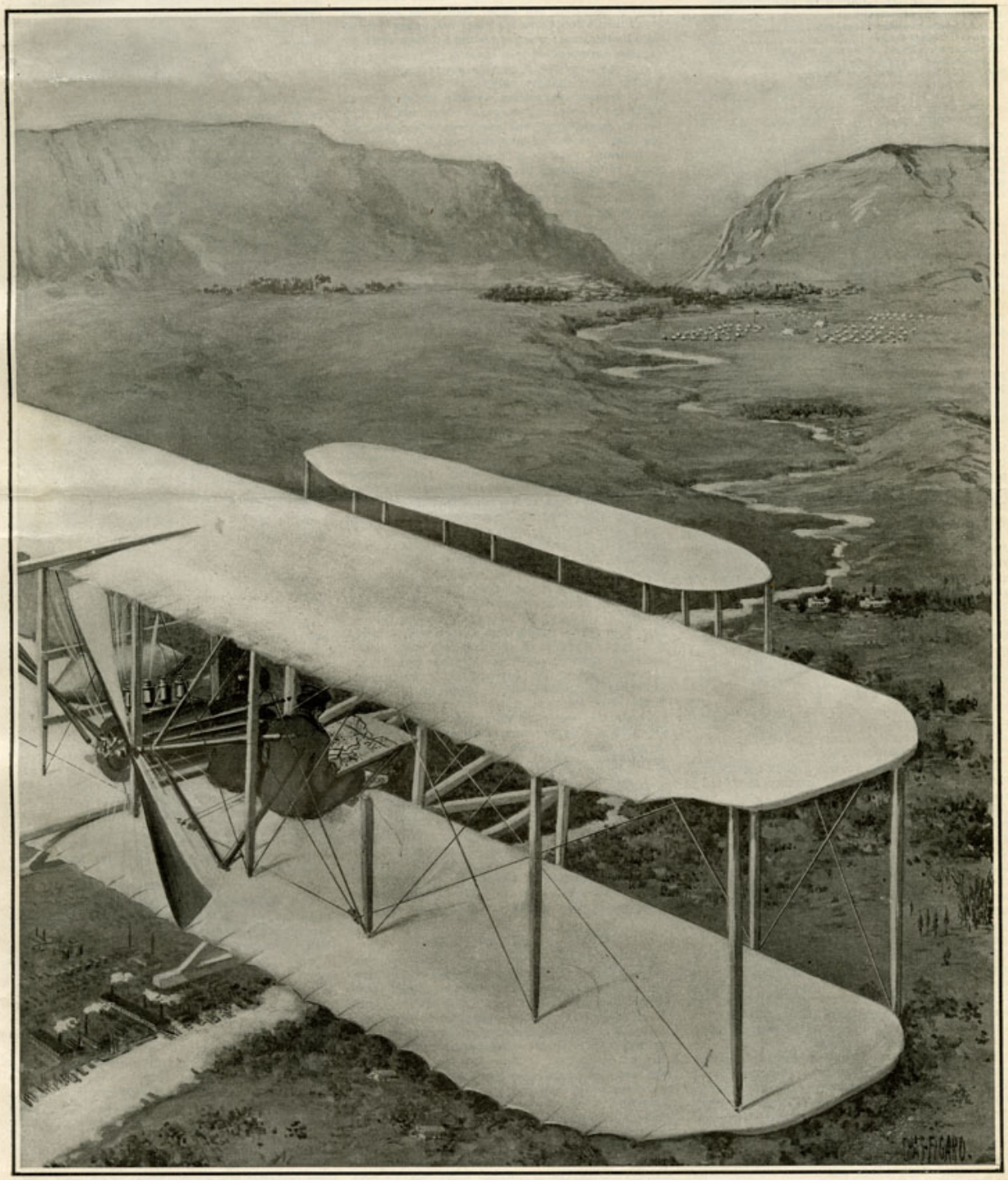

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The aeroplane will find its principal field of usefulness as a scout. At an elevation of from 1,500 to 2,000 feet, it will be possible to make an accurate map of the country occupied by the enemy, and note the strength and disposition of his forces.

THE AEROPLANE MILITARY SCOUT.—[See page 450.]

THE AEROPLANE MILITARY SCOUT.

The astonishing advances which have been made during the past year in the development of the aeroplane and the dirigible balloon, have encouraged our War Department to ask Congress for an appropriation of $500,000, for the purpose of building dirigibles and aeroplanes and carrying on the general work of military aeronautics. We consider that the Department is fully justified in requesting this appropriation. The work done by the Wright brothers, both in this country and in France, to say nothing of the successful flights accomplished by Farman, Bleriot, and Delagrange, and the sensational journey by the monster dirigible of Count Zeppelin, is a fact of profound significance. These flights prove that the problem of mechanical flight is passing, if it has not already passed, out of the domain of theory and academics into that of the practical and useful. At the present writing it cannot be disputed that as compared with the dirigible the aeroplane holds the first place in popular, if it does not in official favor. The flight by Wilbur Wright of over an hour, the straightaway journey of Farman across country for seventeen miles, and the round-trip flight of Bleriot of eighteen miles across country, are feats which exceed the most optimistic expectations of the early months of the present year. Wright, with a 25-horse-power engine, has shown that he can maintain a speed of 35 miles an hour, and Farman and Bleriot, in their cross-country flights, averaged about 50 miles an hour.

It may as well be recognized at once that the aeroplane can never be seriously considered as a means of transportation on any extended scale. The present indications are that a single machine can never hope to carry more than two or three passengers. For the carriage of heavy freight it is altogether out of the question; although it is possible that it may have a field of usefulness in the post office and express service, for the transmission of important mail and light packages with the least possible delay.

Undoubtedly the greatest field of usefulness of the aeroplane will be in military operations; although even in this field its work will be of a limited character. Its small carrying capacity will prevent its being used on any extensive scale for the carrying and dropping of high explosives. The amount of explosive which it could take up would be so insignificant as to have no particular value for this purpose. The attack on fortifications, arsenals, dockyards, fortified camps, and cities by landing within them high-explosive shells, can only have any decisive effect upon the outcome of a war, if the high explosives can be thrown in enormous quantities. The dropping of a few isolated shells could work only a limited amount of damage, and unless they could be accurately aimed, they would represent so much time and money thrown away. Experience in bombardments has proved this fact conclusively. It was only after the capture of 203-Meter Hill outside Port Arthur, when the fire of the guns could be accurately directed, that the heavy mortar batteries were able to do any very effective work. Now to aim the one or two high-explosive shells which an aeroplane could carry so that they would unerringly hit some particular point below, would be a practical impossibility, for reasons which it is not necessary here to enter into.

The military aeroplane of the future will find its greatest field of usefulness in the important work of scouting. The military scout will carry two men; one to operate the machine, and the other to take photographs and make reconnaissance sketches of the country. The striking picture shown on the front page of this issue, is no mere dream of the enthusiast. It would be entirely possible for Wilbur Wright to take up with him an officer, rise to a height of 1,000 or 1,500 feet, sweep over 25 or 30 miles of an enemy's country, and secure a thoroughly accurate sketch of the lay of the land, the disposition and strength of the enemy, the various roads by which he might attack or be attacked, and all the other information which it would be the duty of the reconnoitering officer to secure. Because of the height at which the aeroplane would travel, and the uncertainty as to its speed and direction of flight, it would be an extremely difficult object to hit; and it would be possible for several shells of the small caliber which would be used in an attack to pass through the canvas of the aeroplane without impairing its stability.

Restoring Burnt Carbon-Steel Machine Tools.—When lathe or planer tools of carbon-steel have been overheated or burnt by being heated up to a temperature of say 2,100 deg. F., near the melting point, they may be restored, according to Mr. George T. Coles, in a recent article in the American Machinist, by reheating to 1,100 deg. F., or a very dark red, and then quenching in boiled linseed oil. This treatment is very simple and inexpensive, with no nostrums or chemicals to be used, and may be the means of saving a good tool, so that it can be used with satisfactory results.

The Vacuum Airship.

BY O. J. DEER.

Count Zeppelin's successful flights have proved that the rigid system of dirigible construction is the correct one, but the accident which terminated his flight of last summer illustrates the danger of using hydrogen and other inflammable gases. Although men willingly risk their lives for great objects, and although we have so mastered steam and electricity that we are no longer afraid of steam boilers, high voltage dynamos and transformers, it is nevertheless desirable to reduce the elements of danger to a minimum.

It is said that explosions by lightning will henceforth be prevented by the employment of earth connections, wire netting and other protective devices, but everybody who is familiar with the vagaries of inflammable gases knows how easily explosive mixtures with air are produced by slight defects in the gas bag and how often explosions are brought about by various causes. For example, sparks may be produced by impact, some metals spontaneously become very hot in explosive gaseous mixtures, particularly if the metals have been previously heated by the sun's rays, etc. Wireless telegraphy is another possible source of danger.

There are other objections to the use of hydrogen. It is still a comparatively costly gas and it cannot be obtained everywhere in large quantities. At present it is produced chiefly by electrolysis, as a by-product of the electrolytic manufacture of chlorine and alkalies. The cost of compression, containers and transportation, however, makes the gas, when delivered, very expensive, and the cost is still greater if the hydrogen is generated on the spot expressly for the purpose of filling the balloon. Although methods of producing hydrogen directly from water and coal, without electrolysis, are being developed, and although we are told that Zeppelin's balloon sheds and landing stations will soon be equipped with hydrogen generators, presumably electrolytic, the danger and inconvenience attending the employment of hydrogen will still remain.

In view of these facts the writer desires to call attention to a possible method of dispensing with hydrogen. The valuable property of hydrogen is its lightness. Now, a balloon filled with air may be made even lighter than the same balloon filled with hydrogen at atmospheric pressure if the air is sufficiently rarefied. Francisco Lana called attention to this principle, in connection with aeronautics, in 1670, but at that time it was impossible to construct a vacuum balloon light enough to rise in the air and yet strong enough to withstand the crushing pressure of the external atmosphere. Now, however, when we have at our disposal so light and strong a metal as aluminium, and perhaps other equally suitable materials, the vacuum airship seems at least worthy of discussion.

Retaining, approximately, the dimensions of Zeppelin's airship, suppose that 10 hollow globes of aluminium, each 20 meters (65.6 feet) in diameter and with walls 1 millimeter (1/25 inch) thick, are joined in a straight line, forming a vessel 200 meters (656 feet) long. The lifting power of the 10 globes, when completely evacuated, will be about 16 tons. Aluminium walls only one millimeter thick would be far too weak to resist, unaided, the external atmospheric pressure of about 15 pounds per square inch, the force of the wind, and the weight of the suspended parts, but half of the buoyancy, or eight tons, may be used to compensate the weight of an internal skeleton. Motors capable of furnishing 400 horse-power would weigh about 2 tons, leaving about 6 tons for the car, propellers and other mechanism, crew, supplies, etc. If the globes were evacuated only to a residual pressure of 53 millimeters (2.1 inches), in which condition they would have the same weight and buoyancy as if they were filled with hydrogen at ordinary atmospheric pressure, their aggregate lifting power would be about 13 tons, and they would not require so much stiffening, so that more than 3 tons would still be left for the car, passengers, etc. Besides, it may be possible to make both the skeleton and the shell of substances lighter than aluminium, such as paraffined wood and India rubber strengthened by imbedded wires. Air pumps that produce a partial vacuum as low as 53 millimeters are already in practical commercial use, and it should not be difficult to construct pumps of great capacity and rapid action, by which the balloons could be exhausted to the required degree very speedily.

Every balloon station would be provided with great pumps of this character, but the vacuum airship would possess a peculiar advantage in carrying with it a portable air pump by which the necessary degree of exhaustion could be maintained or restored in the event of leakage or slight accidents. In a hydrogen airship, on the contrary, losses of gas cannot be supplied during the flight, but can only be compensated by throwing out ballast carried for that purpose.

The vacuum airship could also be made to sink and rise by admitting and extracting air, and could be steered in a vertical plane by operating on the air chambers individually. Its flight would not be stopped by lack of gas and, on reaching its station, it would be quickly restored to its original efficiency.

Several problems must be solved before the vacuum airship, here suggested as a possibility, can become a reality. It is for the mechanical engineer to decide whether or not a sufficiently light and strong vacuum airship, stationary air pumps of the necessary capacity and rapidity of operation, and perhaps also portable air pumps of the required lightness and efficiency can be constructed with the materials now known to technical science.—Illustrirte Aeronautische Mitteilungen.

To Detect and Estimate Boric, Salicylic, and Benzoic Acids in Foodstuffs.

Boric Acid.—The substance, mixed with lime or magnesia, is incinerated, and the ashes are leached with warm water containing a little hydrochloric acid. A measured portion of the solution is neutralized until it fails to bleach phenol phthalein and, after the addition of a measured quantity of a 10 per cent solution of mannite, is titrated with an alcoholic solution of soda.

Salicylic Acid.—The best method is Freyer's, in which the salicylic acid is converted, by excess of bromine, into tribromophenyl bromide, which is estimated iodometrically.

Benzoic Acid.—The benzoic acid is extracted by means of a volatile solvent, a few drops of ammonia are added and the mixture is evaporated until nothing is left but an aqueous solution of ammonium benzoate. The addition of a dilute solution of lead acetate precipitates lead benzoate, which is washed, dried, and weighed.

The Supposed Inheritance of Acquired Characters.

Dr. Francis Darwin, in his presidential address before the British Association, spoke as follows:

"Fischer showed that when chrysalids of *Arctia caja* are subject to a low temperature a certain number of them produce dark-colored insects; and further that these moths mated together yield dark-colored offspring. This has been held to prove somatic inheritance, but Weismann points out that it is explicable by the low temperature having an identical effect on the color-determinants existing in the wing-rudiments of the pupa, and on the same determinants occurring in the germ-cells."

T. D. A. Cockerell suggests in Nature that still another explanation is possible to cover at least some such cases. In discussing various types of latency, Dr. Shull (American Naturalist, July) has recently defined as "latency due to fluctuation" those cases (of which many are known) in which the special characters of a race do not appear except under suitable conditions. Following this idea, it is possible to think of the dark *Arctia caja* appearing after exposure to cold as representing a variation which possessed an inherent tendency to darkness not exhibited under more ordinary conditions. Indeed, this must have been the case, since only "a certain number" were affected. Given such a variation, it is not unreasonable to suppose that when examples were mated together the tendency would be so emphasized as to appear under normal temperatures, thus producing an apparent case of the inheritance of acquired characters.

The Current Supplement.

The current Supplement, No. 1720, opens with an illustrated article on the steamship "George Washington," which is the latest type of passenger and freight-carrying vessel, embodying as it does every innovation known to the shipbuilding industry. Mr. James Denny writes on marine engineering, past, present, and future. Sidney H. Hollands contributes an article on "A New Departure in Aerial Propellers." W. W. Massie has prepared a diagram on electric wave lengths, whereby he eliminates the necessity of repeated calculations. The question whether explosion gas turbines or combustion gas turbines offer the greater practical possibilities is discussed. A. T. Cameron contributes an article on the number of radio-active elements and their properties. The Concrete Pier at Santa Monica, Cal., is described and illustrated. This is the first reinforced concrete pier to be built in the West, and probably the second in the world. Dr. Armand Billard shows the effect of agitated or moving water on animals. Prof. Meltzer's consideration of an animal as an engineering structure is concluded.

To Frost Window Panes.—The following process can be used for lights of glass already set in the sash. Dissolve 1 part of wax in 10 parts of oil of turpentine and add 1 part each of varnish and siccative. With this mixture the panes are coated on the outside, and before drying, dabbed with a pad of cotton wadding. If desired, small quantities of Paris blue, madder lake, etc., may be mixed with the wax solution.

NEW MECHANICAL TOYS.

BY JACQUES BOYER.

The eighth of the annual competitive exhibitions of toys and mechanical novelties, established by M. Lépine, was recently held in Paris. Many of the exhibits gave evidence of a keen desire to be fully abreast of the times so that the exhibition resembled an illustrated summary of current events and matters of public interest. Single, double, and triple aeroplanes, kites, and other aeronautical devices were shown in great numbers and variety. There were dirigible balloons of metal which merely revolved with fixed posts and others which were suspended by cords and described gradually diminishing circles, under the impulsion of tiny propellers. Some of these airships were really lighter than air, like real dirigibles.

Conspicuous among the aeroplanes were those shown by Mangin, the inventor of the "dragon fly," the "tortoise," and other mechanical toys which have become classic among Parisian children. The operation of these little aeroplanes (Fig. 1) is very simple. The mechanism, which can be started and stopped by moving a catch, is driven by the contraction of stretched rubber bands and is wound up by thirty turns of a crank at the bow. The aeroplane is attached, by means of a ring at the top, to a long cord, the other end of which is fastened to a hook in the ceiling or other elevated support. It is then set on the floor and the mechanism is started. The aeroplane, which is mounted on small wheels, first describes a spiral course on the floor, then rises and circles in the air.

Vallin showed self-propelling kites operated in a similar manner and so constructed that a broken stick is easily replaced. Vallin kites of three sizes were exhibited. The smallest is designed as a child's toy, the intermediate size for sport, and the largest for meteorological and photographic work. The largest kite has been successfully employed, at Havre, in carrying lines between vessels and the shore.

The Guillot automotor (Fig. 2) excited the liveliest interest and received a first prize. Its mysterious action has won for it the name of "perpetual motion." It consists of a disk of ground glass with a central hole, through which a rod passes, but without touching the glass. The rod is held perpendicular to the disk by twenty fine silk cords which are stretched tightly over the ends of the rod and the edge of the disk. The automotor is mounted in a frame with the rod, or axis, horizontal and resting on pivots or ball bearings, so that it can turn freely over a bowl into which the disk and some of the cords dip. When the bowl is filled with water the automotor begins to rotate and it continues turning indefinitely.

The principle of the automotor is illustrated by the diagrams (Fig. 3). The upper diagram represents the apparatus reduced to its simplest form, the disk being replaced by a straight bar *A* which passes loosely through a hole in the axle *B*, and at right angles to the axle, and is kept in position by the cords *D* above and the cords *D*, below. When the lower cords are immersed in water they contract and force the bar upward, so that the bar and cords assume the position indicated by the dotted lines. In this position, however, the center of gravity is above the axis and the equilibrium is consequently unstable. Hence the rod falls over and turns, with the cords and axle, until its longer end is below. Then the wet cords D_1, which have been raised to the top, dry and expand, and the cords *D*, which are now immersed, contract, again pushing the rod upward and causing a second half rotation of the apparatus. This series of operations is repeated indefinitely, but the successive and sudden half turns may be made in the same or in opposite directions, as accidental influences dictate. But when the rod is replaced by a number of spokes or a solid disk, and the cords are correspondingly multiplied, the action becomes more energetic and regular, and the differences in the times during which the various cords have been exposed to the action of the water and the air, respectively, produce a lateral as well as a vertical displacement, as indicated by the dotted line in the lower diagram, so that the apparatus continues to turn in the direction in which it has started.

The automotor exhibited made one revolution in four minutes. Great speed can be obtained by substituting for the water a more volatile liquid such as alcohol or ether. An automotor may be made with metallic wires, instead of silk cords, and arranged to dip into a very cold liquid in a warm room. In this case the lower wires contract because they are cooled by the liquid.

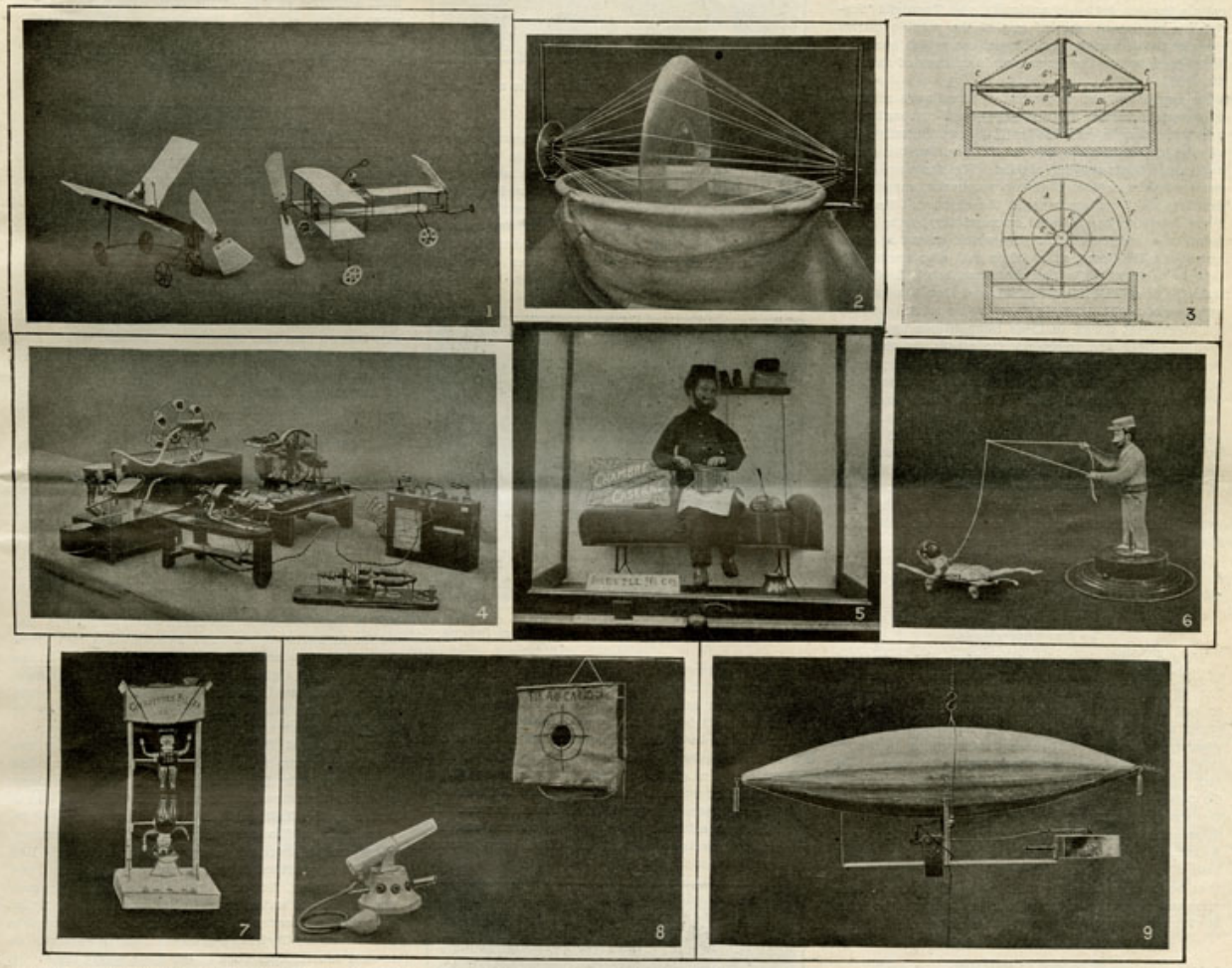
The accumulators which were employed to operate the little Lebrun electric motors (Fig. 4) have electrodes of pure lead, originally very soft, but hardened by hydraulic pressure and cut by machine into the form of a comb. They are enveloped in amianthus, which prevents disintegration and waste. The compression assures a long life of the electrodes, as the lead is attacked very slowly and the freedom from alloy and impurities gives a maximum capacity, 12 or 13 ampere hours per pound of lead.

The largest of the three Lebrun motors shown in the photograph (Fig. 4) operating a little bucket pump, is sufficiently powerful, in spite of its small dimensions, to run a sewing machine. It has eight poles, Niaudeb winding, and a horseshoe iron inductor, and is capable of great variation in speed.

Bressonet's mechanical soldier (Fig. 5) attracted especial attention because it was a caricature of the Socialist deputy Archimbaud, who was recently recalled to the army to complete his term of military service. When a coin is placed in a slot, music is heard and the soldier opens his kit and takes from it a carrot, an onion, and finally a toad.

Gasselin's swimming lesson (Fig. 6) is more interesting. The teacher is only an accessory, the interest attaches to the pupil, who travels on dry land, supported by wheels, but imitates very neatly the movements of a swimmer. Four iron wires, attached to the arms and legs, jointed together to form a parallelogram, and moved by one of the wheels, constitutes the entire mechanism.

The same inventor has introduced an innovation in his acrobats (Fig. 7), which are caused to turn about horizontal bars by the weight and impact of bicycle balls. The balls are stored in a box at the top of the apparatus, and roll, in a row, down an inclined channel until the first ball strikes a cam, which can be retracted by pressing a button. The first ball, having been released by this means, rolls down a series of



1. Aeroplanes. 2. The automotor. 3. Diagrams of the automotor. 4. Accumulators and electric motors. 5. The soldier at dinner. 6. The swimming lesson. 7. The acrobats. 8. Artillery practice. 9. A dirigible balloon.

NEW MECHANICAL TOYS SHOWN AT THE EIGHTH LÉPINE COMPETITION IN PARIS.

inclined planes inside the box and falls into a cavity in the head of the upper acrobat, causing the figure to make a complete turn around the bar and, in passing, drop the ball onto the head of the figure below, which executes a similar movement, dropping the ball into a funnel at the base of the apparatus. The ball, in falling, strikes a lever which, operating through a rod concealed in one of the posts, again retracts the cam and releases a second ball. So the acrobats swing alternately round their bars until all the balls have reached the bottom.

The same inventor exhibited a pneumatic cannon and target (Fig. 8). The cannon is discharged by compressing a rubber bulb and, if it has been correctly aimed, the projectile passes through a hole in the target and is caught in a canvas bag behind. The projectile is tubular and the breech is perforated, so that the piece can be aimed by sighting along the axis.

Among other interesting novelties were Boisard's boat and airship, equipped with practicable rudders (Fig. 9), Mizault and Papin's auto-sphere, which recalls a famous device of antiquity, and Teantet's "flip-flap," a miniature copy of one of the notable attractions of the Franco-British Exposition, which has been fully described in the SCIENTIFIC AMERICAN of October 31, 1908.

In conclusion, let us glance at Blondinat's remarkable repeating gun, in which the usual mechanism of automatic toys is combined with a very ingenious device which enables the gun to advance, fire two shots, and return to its original station. The shots are represented by the explosion of two percussion caps which are fixed on hammers beneath the chassis of the gun. These hammers are released, successively, by the movement of a rod bearing a peg which enters a spiral groove on the front axle. This rod also causes the vehicle to turn while the shots are being fired, sufficiently to reverse its direction, and then allows it to pursue a straight course to the starting point.

The interest shown in these competitions by French manufacturers and inventors (to whom, by the way, the competition is restricted) increases from year to year. Inventors have learned that it is useless to exhibit an undeveloped idea. Every detail must be worked out in practical form if the invention is to find a manufacturer who will take it up. Hence the members of the "*Société des petits fabricants et inventeurs français*," under whose auspices this annual exhibition is held, have learned to combine their efforts and, as a result of this harmonious arrangement, they are every year becoming more formidable competitors of the German toymakers of Nuremberg.

In the current number of the SCIENTIFIC AMERICAN SUPPLEMENT will be found descriptions of other toys which were to be seen at the exhibition.

To Our Subscribers.

We are at the close of another year—the sixty-third of the SCIENTIFIC AMERICAN's life. Since the subscription of many a subscriber expires, it will not be amiss to call attention to the fact that the sending of the paper will be discontinued if the subscription be not renewed. In order to avoid any interruption in the receipt of the paper, subscriptions should be renewed before the publication of the first issue of the new year. To those who are not familiar with the SUPPLEMENT, a word may not be out of place. The SUPPLEMENT contains articles too long for insertion in the SCIENTIFIC AMERICAN, as well as translations from foreign periodicals, the information contained in which would otherwise be inaccessible. By taking the SCIENTIFIC AMERICAN and SUPPLEMENT the subscriber receives the benefit of a reduction in the subscription price.

Detection of Gelatine.

Gelatine can be detected in solution by boiling the liquid with a mixture of equal parts of Nessler's reagent and a solution of tartaric acid. If gelatine is present a lead-colored precipitate is deposited, but no precipitate is produced by gum arabic, dextrine, cane sugar, extract of saponaria, or licorice. Hence this method may be used for the detection of gelatine in solutions of those substances. Nessler's reagent is an alkaline solution of potassium iodide and mercuric chloride, which assumes an orange color in the presence of even a trace of ammonia.

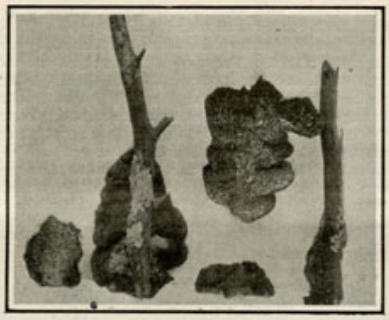
A $500 Prize for a Simple Explanation of the Fourth Dimension.

A friend of the SCIENTIFIC AMERICAN, who desires to remain unknown, has paid into the hands of the publishers the sum of $500, which is to be awarded as a prize for the best popular explanation of the Fourth Dimension, the object being to set forth in an essay the meaning of the term so that the ordinary lay reader can understand it.

Competitors for the prize must comply with the conditions set forth in the current number of the SCIENTIFIC AMERICAN SUPPLEMENT.

DESTRUCTIVE FUNGUS OF WHITE CEDAR.

The fungus which destroys commercial white cedar trees, *Chamæcyparis thyoides*, has at last been discovered by William Hosea Ballou of New York in the forests of Ocean County, New Jersey. For a half century, almost every fungist and botanist of America and Europe has overrun the Atlantic coastal plain,



Steecherinum Ballouii, the parasite of the white cedar of commerce.

looking for the deadly parasite of the swamp cedars, one of the most important woods used in vessel construction. Mr. Ballou, who gives much attention to expert field photography of the fungi, made repeated examinations of the swamps without result. Finally, he commenced a systematic search, tree by tree, his efforts being facilitated by the prevalent drought. Still failing in this effort, he commenced over again, this time examining the canopies of the trees. Almost at

White cedar killed by the new species of fungus.

once he was rewarded by seeing golden yellow fungi growing very near the tops of the trees on the branches, near and extending somewhat down, on the trunks of the living trees. An examination showed the specimens to be hydnums, a class of fungi named after the hedgehogs, on account of their spines, often resembling the quills of the porcupine. Specimens were therefore submitted to Dr. Howard J. Banker of De Pauw University, specialist of the *Hydnaceæ*. Dr. Banker declares the species new to science and has named it *Steecherinum Ballouii*. The generic name

Typical white cedar swamp.

DESTRUCTIVE FUNGUS OF WHITE CEDAR DISCOVERED BY W. H. BALLOU.

Steecherinum is tentative, as the fungus at present appears to be an entirely new genus.

Mr. Ballou says: "The new fungus has escaped attention heretofore because of its lofty tendencies, and the density of the canopies of evergreens crowded together makes it almost impossible to see what they conceal, nor is it comfortable to wade in a miry cedar swamp bog gazing upward, taking chances on deep holes concealed under the carpet of sphagnum mosses.

"Dr. Banker will later issue a full scientific description of the new fungus, which has wiped out many square miles annually of the finest boat timbers, leaving large areas of dead trees. The fungus is a parasite which expires when it kills a tree, apparently drying up instantly and dropping off, so that no trace of its fruit is found on dead trees and scarcely a trace of its mycelium. It is semi-resupinate (lying on its back) and semi-pileate (having a cap). As seen in the illustration, the limb appears to grow across the top of it and a lichen on top of the limb. When drying, it forms into a series of cup shapes, resembling a bumblebee's honeycomb. One tree found had apparently just expired, together with the fungus. The fruit bodies in this case clung to the bark along the trunk of the tree, in form of single small cups, upside down. The least touch brought them all to the ground, rattling like peas in a pod. Unless one finds the living fruit bodies of the fungus on a living tree, he may never have a similar opportunity to find dead specimens on a dead tree. It is a fungus of mystery, the most beautiful as well as the most deadly I have ever come in contact with. Its spines are of a gorgeous golden yellow, visible high up only on a leaden day. Where I have marked trees with the fungus growing, I cannot see the specimens from the ground when the sun is shining."

Red Cross Christmas Stamp.

A little red and white penny stamp about the size of a two-cent government postage stamp, with "Merry Christmas" and a red cross among the holly leaves, would hardly seem to be a promising agent to use against tuberculosis. The Christmas stamp in America started in Delaware, but before that time there was a Christmas stamp in Denmark issued by the government and sold at all post offices for the benefit of a hospital for children afflicted with the white plague. The Red Cross Society of Delaware, with the approval of the National Red Cross, decided to try this Danish idea last Christmas. The plan was backed by many influential people, and Jacob A. Riis took up the subject of such stamps and urged their adoption in America. At first only 50,000 stamps were printed, and the whole community seemed willing to help. The dry goods merchants of Wilmington gave bolts of muslin to print street car banners; local printers did the work of printing the posters and banners at cost; the street cars displayed the advertising posters on their fenders day after day; the protected bill boards were placarded without expense; department stores and drug stores sold the stamps without commission, and even the school children took up their sale. Every penny for the stamps, after the expense of printing and distribution was paid, went to the anti-tuberculosis work in Delaware. Interest in the plan spread, and in a short time it was taken up by the North American in Philadelphia. The Pennsylvania Red Cross backed the plan and helped to sell the stamps. In the short space of eighteen days nearly 400,000 Christmas stamps were sold, and nearly $3,000 of clear profit resulted. The stamp had proved its possibilities in so short a space and in so conservative a section.

The National Red Cross has now taken up the Christmas stamp in a formal manner. A stamp has been designed by Howard Pyle and is printed in three colors by the Bureau of Engraving and Printing and is issued by the National Red Cross. The stamp will be offered for sale in every State this Christmas season. They can be procured in any quantity from the Red Cross headquarters in any State, or the central one in Washington, for cash only at one penny for each stamp. It will not carry mail, but any kind of Christmas mail will carry it, and they are most appropriate as stickers on Christmas presents. Every cent will go toward tuberculosis work in the State where the stamp is sold.

Experiments by the Forest Service, at its timber testing station at Yale University, show that green wood does not shrink at all in drying until the amount of moisture in it has been reduced to about one-third of the dry weight of the wood. From this point on to the absolutely dry condition, the shrinkage in the area of cross-section of the wood is directly proportional to the amount of moisture removed. The shrinkage of wood in a direction parallel to the grain is very small; so small in comparison with the shrinkage at right angles to the grain, that in computing the total shrinkage in volume, the longitudinal shrinkage may be neglected entirely. The volumetric shrinkage varies with different woods, being about 26 per cent of the dry volume for the species of eucalyptus known as blue gum, and only about 7 per cent for red cedar. For hickory, the shrinkage is about 20 per cent of the dry volume, and for long-leaf pine about 15 per cent. In the usual air-dry condition, from 12 to 15 per cent of moisture still remains in the wood, so that the shrinkage from the green condition to the air-dry condition is only a trifle over half that from the green to the absolutely dry state.