SOME PRELIMINARY EXPERIMENTS IN FLYING.

BY L. J. LESH.

The art of flying has now reached a state of development that gives a great deal of satisfaction to its exponents, and provides ample inducement to new recruits entering the field.

A remarkable success has been scored by the Wright brothers, of Dayton, Ohio, and some comparatively unimportant but promising results have rewarded the efforts of other experimenters here and abroad. The success of these men has been directly proportional to the thoroughness of their preliminary training in managing motorless machines; and the numerous failures and disappointments that have developed can be traced directly to ignorance or neglect of the fundamental principles of equilibrium and control, rather than to any special defect in design or workmanship.

It is generally conceded that Lilienthal was the first man to demonstrate a practical way of learning how to fly, and that his experiments paved the way for Chanute, Pilcher, and the Wrights, who carried the work on after his death.

These men built machines which, when launched from a height, would support the weight of a man, and descend in gliding flight to the ground. The best angle of descent obtained was about five degrees, the machine sailing down the side of a sand dune into an ascending current of air.

After a number of experiments with gliding machines which gave indifferent results, the author ventured to suggest that in preparing to operate a motor machine, it might be better to learn to *rise* instead of fall; and since the conditions met in gliding flight were different from those met in motor flight, I became convinced that I had been working along wrong lines.

In thinking the matter over, it seemed that it would be practical to attach a long tow rope to the machine, and then rise into the air after the manner of a kite. When the wind was strong enough, it was expected that the machine would lift the weight of a man, and that the rope (one end tied to a post) would prevent the structure from drifting backward. If the wind was light, it was hoped that a horse or automobile could supply sufficient pull on the towing rope to make the machine rise.

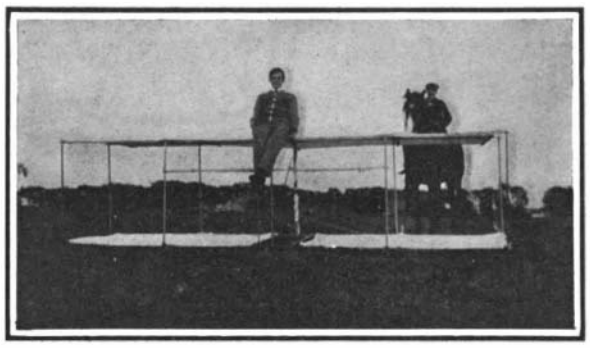
It will be seen that in such experiments the pull of the rope corresponds to the power of a propeller, and that practically the same conditions are met in managing a motorless aeroplane towed by a rope and a flyer propelled by motor and screws.

The Wrights, of Dayton, and Israel Ludlow, of New York, made use of these methods of experiment, but with rather unsatisfactory results. The Wright brothers abandoned the idea when it was found that a wind of over twenty-five miles an hour was necessary for support in the air, and never tried their machine by towing it behind a motor car or horse, although they might have obtained some interesting results in this way.

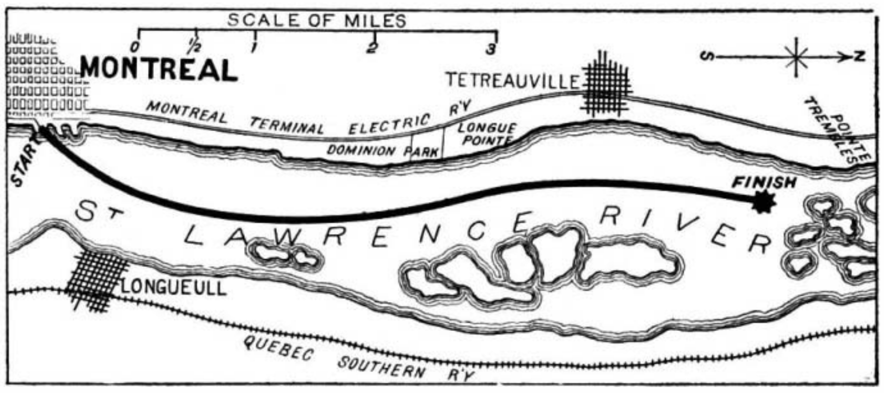
Ludlow designed machines, some of which were structurally weak and lacking in balance and control. They were gigantic structures, and required a tremendous pull to get them up in the air. Generally, an automobile or fast tugboat supplied sufficient power, but at times the flight resembled a tug of war, the aeroplane pulling so hard in the wind that the towing power was forced to a standstill.

Although the prospects did not seem particularly inviting, I decided to leave off gliding experiments, and undertake the management of an aeroplane in towing flight. Accordingly, a machine having about two hundred and eight square feet of supporting surface, and weighing thirty-five pounds, was built and tested during the exhibition of the Chicago Aero Club.

Experiments with the machine flying alone in kite fashion were first conducted, to make sure of its strength and balance. These proved satisfactory, and it seemed safe to attempt the management of the apparatus in actual towing flight.



This machine towed by a horse or an automobile was used in making experiments in rising from the ground. The machine had about 248 square feet of supporting surface and weighed 35 pounds. Five flights were made, averaging about 350 feet in length.



Black Line Indicates Course of Machine Over the St. Lawrence River.

These experiments were conducted in Washington Park, the machine rising in tow of a racing automobile steered by Mr. C. A. Coey, of Chicago. Five flights were made, averaging about three hundred and fifty feet in length, at heights ranging from ten to twenty feet above ground.

These results seemed to indicate that it was quite possible to balance and steer a machine in towing flight, and that this kind of work provided better training than experiments conducted in gliding flight. Of course, if an experimenter had in mind the development of a motorless soaring machine, it would be preferable for him to acquire skill in managing a glider; but since the conditions approximating true gliding flight will never be met in dynamic aviation, the value of this kind of work to a prospective motor aeroplanist looks doubtful.

However, my previous experiments in gliding flight having proved unsatisfactory, I decided to become a little more familiar with this part of the work before devoting myself entirely to the management of machines performing horizontal flight. An ideal practice ground for gliding was found at Saugatuck, Mich., where the sand dunes rise to a height of more than three hundred feet. Suitable materials for a machine were hard to find, but a stout framework of bamboo braced with heavy wire was finally erected, and suitably tested to prove its strength and rigidity. The wings were covered with strong muslin, and a combined vertical and horizontal tail placed about five feet behind the main supporting surfaces added to the stability of the machine in the air.

Circumstances compelled me to break up this machine before the contemplated experiments were finished, but I proved at least to my own satisfaction that more was to be learned by soaring up from a level field than by darting down the side of a sand hill. The longest glide with the Saugatuck machine was about one hundred feet at a height of about eight feet above the side of the sand dune. Gliding flight is undoubtedly the safest of the several methods of experimenting with aeroplanes, but it is not the most instructive. After coming to this conclusion, I proceeded to design and construct a flyer especially suited to experiments in towing flight. This apparatus was put up and tested at Montreal, Canada, where I was spending the summer. As first built, this machine measured twenty-two feet from tip to tip of the wings, and spread about two hundred and forty square feet of supporting surface. The frame was constructed chiefly of spruce rods 7/8 of an inch in diameter, and was fastened together by bolts. Heavy piano wire was used in trussing the structure, which, when completed, weighed about 60 pounds.

The first flight was made over land in an open field located about eight miles from the city of Montreal. A fast horse supplied the necessary pull at the end of a strong towing rope. A height of over sixty feet was attained, and the flight lasted about two minutes, during which time I covered over a quarter of a mile. The balance and control of the machine were perfect, and it did not seem that it would be overbold to attempt a much longer flight.

I desired to study the problems of balance and control under more suitable conditions than were possible in these short flights over land, and so made a long and altogether satisfactory trip over the St. Lawrence in tow of a fast motor boat.

The start was made from a wharf on the Montreal side of the river, the machine rising rapidly into the face of the wind until a height of about sixty feet was reached. At this alti-

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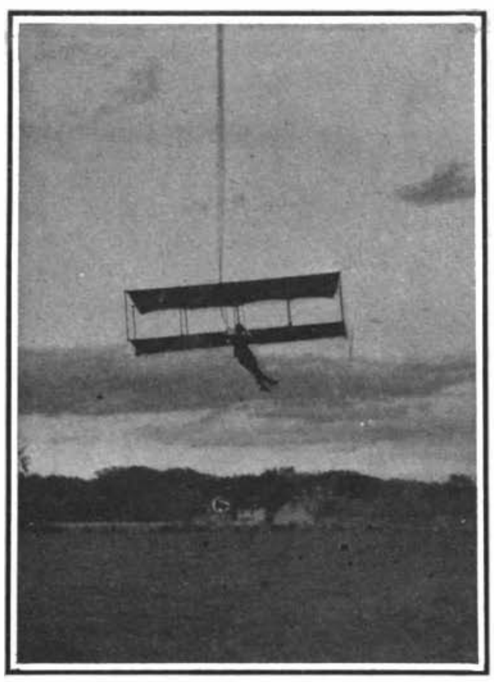
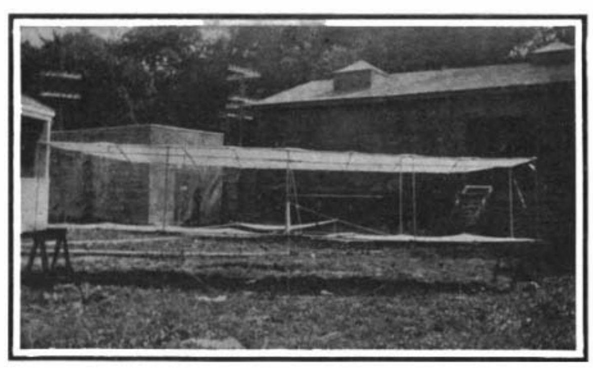
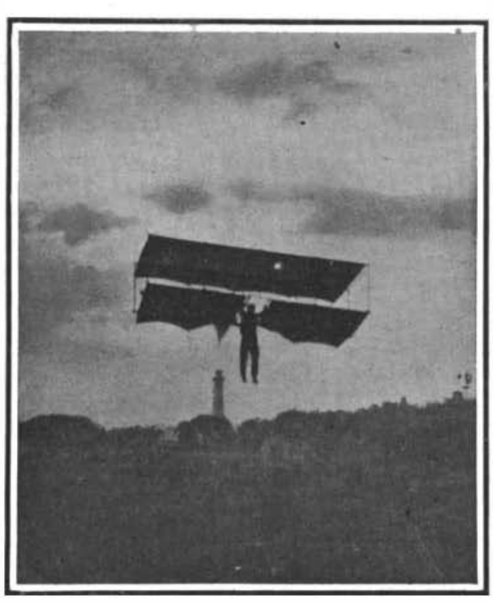


Soaring Up in a High Wind.



The First Machine Which Was Constructed for Experiments in Towing Flight and Which Flew Over the St. Lawrence River.

The Second Machine Equipped with the Final System Rudders. This System is to be Used on a Motor-Driven Flyer.



In Full Flight. The Aeronaut Sailed Over the Photographer Who Took This Picture.

Starting a Flight of the Second Machine, Equipped With Final Arrangement of Rudders.

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one until the beautiful American and Center waterfalls were a mass of colors. Such harmony, such blending, was never before witnessed, the ever-moving, dancing spray cloud creating effects that were fascinating and dazzling. The intermingling of the colors surpassed all rainbow effects ever seen by day in this place of wondrous water beauty. The Center Fall afforded magnificent opportunity for using a solid color, and either in red or blue the glory was beyond description. The uneven face of the American Fall served to assist in a display of a different character; for the prominent part at Prospect Point was radiantly blue, while all the remaining section of the fall was illumined with chatoyant colors in glorious harmony.

At Terrapin Point the spray cloud was so dense and heavy, that the lamps did not have the power to penetrate the sheet of water and reach far into the depths of the mighty waterfall. However, a never-to-be-forgotten effect was the red, white, and blue flashed on delicate sections of the Horseshoe as it poured over the Canadian cliff.

The evening's entertainment was varied by the discharge of bombs, that developed a smoke cloud on the Canadian side to the north of the gorge battery. When this smoke cloud appeared, all the projectors were directed upon it. As the smoke ascended, it produced an artificial cloud effect that rendered possible wonderful color reflections. There were several displays every evening.

It was possible to cast the lights in any direction, and now and then they were used to outline the upper steel arch bridge, or to give spectators a glimpse of the wild beauty of the waters that pour from the tunnel of the Niagara Falls Power Company. When sent high into the sky the white beams were visible many miles, the largest lamps being very powerful.

The future of the illumination is not yet apparent. Mayor Douglass hopes to make it a nightly feature. The railroads must become generous supporters of the project, for it is already evident that they will receive the most benefit. As a feature of beauty the illumination is an unquestioned success—a superb scene that gives to the tossing, tumbling, chaotic waters of the greatest waterfalls in the universe a night splendor unsurpassed by anything on earth.

SOME PRELIMINARY EXPERIMENTS IN FLYING.

(*Continued from page 272.*)

tude the flight continued without interruption for about three miles, when an accident occurred to mar the success of the trip. The machine was equipped with a small wooden seat, swinging below the rest of the framework by two small ropes.

At a very awkward moment one of these broke, leaving the operator to hang by one arm and retie it. The repair was made without coming down, however, and the aeronaut again safely seated, the flight continued without incident for some two and a half miles farther down the river. At this point recent history repeated itself in the form of the other ropes' breaking. Not being so well prepared for this second accident, the operator came very near to taking a drop into the water, but caught the arm rests in time to avoid trouble.

With the seat out of commission and no other support for his weight available, he decided that it would be prudent to head for shore. The boatmen misinterpreted the signals, however, and becoming confused steered around with the wind, forcing him to descend.

The flyer was badly damaged during subsequent attempts on the part of the men to tow it to shore. The total distance traversed during this flight was first stated by the boatmen to be three miles; and as they were men supposed to be well acquainted with the river, I took their word for it. When the flight was actually charted on the map, however, it was found that the distance was more than six miles, the line of flight being shown on the diagram.

The machine was given a thorough overhauling, and several changes in design and method of operation were made before a third flight was attempted. This experiment ended disastrously, the flyer collapsing in mid-air after a brief struggle with the wind.

The cause of this breakage is still something of a mystery to me, for the machine withstood the most severe tests preparatory to the flight. It is possible that I put undue strains on some part of the structure, since I was not yet familiar with the new system of control. The machine was completely wrecked, but I came out unable to show a scratch. This was the first time in my experiments that any untoward accident occurred, and it seems remarkable that the result was not more serious, for the machine plunged headlong from a height of over thirty feet and struck hard ground.

This performance was rather discouraging, for it indicated that even a seemingly strong structure could not be trusted under certain little-understood conditions of flight.

I decided to design and construct my next machine in a manner that would eliminate all chance of a breakage in mid-air. Mr. Octave Chanute, of Chicago, very kindly made it possible for me to build this machine, which had turned out to be rather an expensive proposition.

In the new apparatus the span of the wings from tip to tip was reduced to sixteen feet, and the total supporting surface was cut down to about one hundred and seventy-five square feet. It was found that the resistance caused by exposed framing could be safely diminished by reducing the number of uprights connecting the surfaces and the number of ribs forming the wings. The whole structure was also strengthened considerably by incasing the framework at the joints in steel tubing.

With this new machine I felt little apprehension in flying under any condition of wind or weather, and was able to devote more time to learning the tricks of steering and balancing than before. During the first week that experiments were carried on about forty flights were made, ranging in length from a few hundred feet to over half a mile.

Much was learned concerning the eccentricities of the wind, and in fact the real object of the trials was to accustom the aviator to the management of an aeroplane rather than to acquire scientific data.

By manipulating the rudder and shifting the center of gravity of the operator, it was found possible to "quarter" into the wind for considerable distances. This feat was accomplished with the wind blowing at speeds exceeding at times forty-five miles per hour.

Although it is generally best to start and land facing into the wind, yet it is quite possible to steer to right or left near the ground, if care is taken to prevent lateral oscillation when the wind strikes the wings from the side. At the moment of landing it is important that the surfaces be nearly horizontal, or the framework is liable to be damaged in striking the ground.

After several weeks' practice I find it possible to make safe landings at considerable speed, and the machine has been damaged only three or four times. Generally, the framework does not come in contact with the ground at all, but of course an occasional awkward landing must be expected.

After about fifty preliminary flights I have taken up the actual development of a motor aeroplane, and experiments are now being conducted to ascertain the most effective system of controlling surfaces.

The experimental flyer has been fitted with the arrangement of rudders which I will in the near future install in a motor machine, and the results obtained have been very promising.

The development of a full-fledged aeroplane is a difficult proposition, but much of the bitterness of disappointment may be avoided if the investigator is willing to learn the tricks step by step. As Lilienthal and Octave Chanute pointed out, "man must fly and fall and fly and fall until he can fly without falling."

ENORMOUS POWER CONSUMED IN OUR INDUSTRIES.

On the front page of the present issue we give a graphic representation of the enormous total of horse-power which is required to run the industrial establishments of the United States. The drawing is based upon the latest available statistics on this subject, which are to be found in the report of the United States Census Bureau for the year 1905. The mere statement of figures which run into the millions conveys to the mind of the average layman no adequate idea of the quantities involved; and particularly is this true when applied to such a subject as total aggregates of engine horse-power. But when these figures are translated into concrete forms, they begin to take on intelligible meaning. Everyone is more or less familiar, either through the medium of illustration or through a visit to an actual plant, with the general appearance and the great proportions of the typical steam engine of large size used in modern power plants, whether for electric lighting, or power, or for providing the necessary air for blast furnaces. So also the general appearance of a typical gas engine, or of an electrical generator, is more or less familiar; and in the front-page illustration above referred to, the total number of units of steam engines, gas engines, and electric generators are supposed to be thrown into one, and the resulting dimensions of the single unit, thus obtained in each case, is depicted, with the great Singer tower shown in the group for comparison.

The results are certainly very striking. If the 10,664,560 steam power used in our industries were represented by a vertical cross-compound blowing engine, of the kind that is used in our blast-furnace practice, we would have a huge affair, whose base plate would cover one-half of a large city block, and the top of whose topmost cylinders would tower 735 feet skyward. The tallest building in the world to-day, the tower of the Singer building, is 612 feet in height, so that this monster engine would overtop the great building by 123 feet. Similarly, if the total electrical horse-power of 1,138,208 were to be represented by a single generator, we would have to build a machine whose base would measure 134 feet in length, and whose highest point would be 126 feet above the ground. The great proportions of this machine are shown by comparing it with the dome of the Capitol at Washington. To develop the total of 289,514 gas engine horse-power, would call for an engine 350 feet in length by about 80 feet in height from the base plate to the top of the cylinder.

The census figures showing the growth of total horse-power by decades since 1870 are of great interest. In addition to those which we have illustrated, there is a total of 1,647,969 water power, 91,784 miscellaneous horse-power, and 632,905 rented horse-power. The grand total for the whole United States is 14,464,940, as compared with a total of only 2,346,142 horse-power in the year 1870. In 1880 the total had risen to 3,410,837, an increase of 45.4 per cent. From 1880 to 1890 the total grew to nearly 6,000,000 horse-power, an increase of 74.6 per cent. The same percentage was maintained from 1890 to 1900, when the total had risen to 10,409,625 horse-power. It will thus be seen that the greatest actual relative increase occurred between 1890 and 1900; and notwithstanding the great increase in other kinds of power, steam has continued to be the motive power of greatest importance, representing in 1870, 51.8 per cent of the total horse-power employed in manufactures; in 1880, 64.1 per cent; in 1890, 76.9 per cent; in 1900, 78.2 per cent; and 73.7 per cent in the census of 1905. One of the most notable features of the development of machinery in manufactures has been the growth of the use of the electric current for the transmission of power. The first census to show electric power was that of 1890, when only 15,569 horse-power was reported. Fifteen years later this had grown to 1,138,208 horse-power. It should be noted, in connection with the above statistics, that when the electric power is generated by the manufacturer, the combination of the horse-power of the engines and the motors results in a duplication; but since in some cases the steam engines are used for purposes other than the generation of electric current, it is impracticable to avoid this duplication.

In conclusion, we would draw attention to the fact that our front-page engraving shows the day to be very far distant when the steam engine is to be relegated to a subordinate position, and the lead taken either by electricity or gas.

The Navigation of the River Danube.

One of the most important engineering undertakings in progress in Europe is the improvement of the navigation of the mouth and lower reaches of the river Danube. This enterprise was taken in hand by an international commission appointed in 1856. It was anticipated that the labors of the commission would occupy at the utmost only two years, but it has been sitting for fifty years. At the time of its inception the Danube was one of the most inaccessible and difficult of rivers, the estuary being a mass of sandbanks and treacherous swamps. During a severe gale one winter's night in 1855 alone, no less than twenty-four sailing ships and sixty lighters were wrecked in the shoals, with a loss of three hundred lives.

The task of improving this treacherous approach has, however, proved exceptionally difficult, but according to a recent report to the British government by their representative engineer, conditions have been considerably improved. Instead of there being only a minimum depth over the Sulina bar of 9 feet, there is now 24 feet of water, while the arm of the same name has been improved from a depth of 8 feet to 20 feet. The navigable channels have been straightened and there is a fairway from St. George's Chatal to Sulina only 34 miles in length, as compared with the former distance of 45 miles between the two points. The total cost of the undertaking has been $8,000,000, the money for which, however, has been derived for the most part from shipping dues. That the improvements have proved commercially valuable is shown by the increase in Sulina's maritime traffic. Since 1867 the traffic in cereals has increased fivefold. Sulina itself, owing to the installation of an elaborate sanitary system, has risen from a mere collection of huts to the status of an important and flourishing port of 5,000 inhabitants. The improvement of the estuary and the greater safety afforded to shipping has resulted in a corresponding decrease in freights, for whereas in 1856 the tariff to Great Britain averaged $11 per ton of cereals, it is now only $2.50, while the rate has been as low as $1.50 per ton. The improvement works are to be pushed forward as vigorously as in the past.

Eugene Godet, a French aeronaut, had a narrow escape from being drowned in a recent ascent at Jamestown, Va. His propelling machinery failed to act, and the wind swung the airship against a water tower, both propellers being knocked off. Relieved of the weight, the airship rapidly ascended, and when over Hampton Roads suddenly dived toward the water but again arose and drifted away. Godet clung to his machine, and finally landed in a badly bruised condition, and with a wrecked airship, fourteen miles north of Newport News.