

AERONAUTICS.

Under this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor of it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

THE LILIENTHAL FLYING MACHINE.

HERR LILIENTHAL, of Berlin, has for many years past been working at the problem of flight, and as he now seems to be fairly successful, an account of his apparatus and the method of using it will perhaps be of general interest.

He has constructed two machines – one for soaring flight only, the other with a carbonic-acid motor for rowing flight. He kindly showed me both of them at his practice ground, near Berlin, with the method of using them and allowed me to try the soaring machine myself.

Previous to constructing his machines, Herr Lilienthal tried a number of experiments to ascertain the pressure and line of action of the air on surfaces of different shapes. His experiments are fully described in his book, “Der Vogelflug als Grundlage der Fliegekunst,” but the following are the principal results from them:

1. Soaring flight can be successfully accomplished without motive power, provided there is wind. The birds, when soaring, do not expend any power, all their movements being due to their own weight and the force of the wind.
2. Experiments with small rotating apparatus give far smaller wind pressure than experiments conducted in the open against the moving air.
3. With plane surfaces there is much less lifting power than with slightly curved surfaces.
4. The line of action of the resultant air pressure is not normal to the surface of a plane or to the chord of a curved surface, but varies greatly according to the angle of inclination of the surface. With curved surfaces, at small angles, it acts forward of the normal.
5. Repeated experiments show that the wind does not flow horizontally, but has a slight trend upward of about 3°. In warm weather this angle may be very much increased.
6. When the wind is blowing directly against the machine, the lifting power is largely increased.
7. When the wind is moving in the same direction as the machine, the latter must move faster than the wind, or it will be forced downward.

8. Although it is possible to proceed in any direction by soaring flight only, such a process will generally be very slow, and it is consequently desirable to have a motor powerful enough to drive a machine in a given direction without soaring.

9. A man is not powerful enough to work a wing-flapping machine under all circumstances.

10. Only the outer half of a wing should flap, the inner half being for sustaining and not for driving.

Herr Lilienthal has up to the present constructed two machines, and he is now constructing a third one of a slightly improved pattern: His first machine is for soaring only; it weighs 40 lbs., and he has succeeded in soaring flight very fairly well. His longest flight was about 400 yds., and he has been 200 ft. up in the air. His second machine is very similar to the first, but the outer halves of the wings feather, and it is fitted with a small carbonic-acid motor weighing 40 lbs., capable of working the machine for about one and one-half hours on fair day. The machines are made of willow and canvas, the willow being bent into the necessary shapes to suit the curvature. The arching of the wings is one eighteenth of the spread at the deepest part, running out to nothing at the wing tips. The outer halves of the wings move through an angle of about 30°; there is no hinge, only the spring of the wood.

Both machines are very neatly made, all the attachments being very carefully designed. Most of the guys underneath are of wire; those above and connecting the tail are of stout cord.

The new machine will be very like the second one, but the surface will be slightly larger, the machine itself rather lighter, and the wing tips will work on a hinge. The pistonrods will be attached to the wing levers directly, and not by chains and pulleys, as in the second machine.

Herr Lilienthal's practice ground is at Lichterfelde, about 7 miles from Berlin. The hill from which he takes a preliminary run is about 150 ft. high, with an average slope of 1/8. Four yards around the is a grassy slope; the remainder of the slope is covered with sand, in case of accidents. The first thing to be learnt is how to use the machine without a motor, and a good deal of practice is required to get off the ground and keep one's balance when in the air.

Starting.- Stand on the top of the hillock, facing the wind, and hold the machine so that the wings are about level. Then take a sharp run downward for about 4 or 5 yds., and you will feel yourself rise in the air and float gently down the slope, the inclination of which will depend on the force of the wind; the legs to be kept well to the front.

Moving to Right or Left.- Throw the weight of the body toward the direction it is intended to move.

Coming Down.- In coming down, when the feet are about 3 ft. from the ground, throw the legs and weight generally well back and tip the wings backward.

A good deal of practice is required to use the machine well. Herr Lilienthal is very expert at it; on a perfectly calm day he glided downward a distance of about 90 yds. As regards using the motor, this was tried for the first time on the day of my visit; only one or two flaps were given, as Herr Lilienthal is very rightly very cautious when trying anything new. The movement of the wing tips did not in any way disturb the equilibrium.

The follower appear to be the principal points to be attended to when practising:

1. A beginner should commence on a day when there is very little wind. He should not start from any great height. I commenced by starting from a point about one-fourth of the way up the hillock, and gradually worked up to a point about 6 yds. from the top.

2. It is necessary to take a good sharp run.

3. The machine should fit the operator, just as bicycle should have dimensions suited to the person using it. I found this particular machine rather awkward to hold, as the arm tests were to

big for me.

4. It is not safe to practice in a breeze of more than about 22 miles per hour with such light machines. If the wind exceeds the above, greater weight should be taken up, in what proportion, however, has not yet been determined.

5. No difficult feats should be attempted at first. What is wanted is to learn the use of the machine, and great accustomed to being in the air.

6. Gustly weather is specially dangerous, as it makes keeping the equilibrium very difficult.

7. Until the operator is well accustomed to the use of his machine, he should not attempt turning round to move with the wind. When turning, wide sweeping circles should be used.

8. When landing, the weight should be well thrown back, the object being, of course, to stop the forward velocity.

9. The manoeuvres performed by birds should be carefully studied.

The following works contain a good deal of information about Herr Lilienthal's work, and we are well worth studying:

1. "Der Vogelflug als Grundlage der Fliegekunst." Von Otto Lilienthal, Berlin 1889.

2. "Progress in Flying Machines." By O. Chanute, C.E., New York, THE AMERICAN ENGINEER AND RAILROAD JOURNAL.

3. "The Proceedings of the German Aeronautical Society." Berlin.

4. *Prometheus*, weekly Berlin scientific paper.

J.D. Fullerton, *Major*, R. E.

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-Royal Engineer's Journal.