

HOW TO SAIL THROUGH THE AIR.

Herr Lilienthal Describes His Latest
Invention in Flying
Machines.

ARCHED WINGS THE SECRET.

Soared for Nearly Three
Hundred Yards with an
Apparatus He Constructed.

HOPES TO SOLVE THE PROBLEM.

The experience of the century and more which has elapsed since the invention of Montgolfier has taught us that the balloon is of practical service only when confined. The attention of investigators has been diverted, therefore, to flying machines, like Professor Wilner's, and air ships, like Mr. Maxim's.

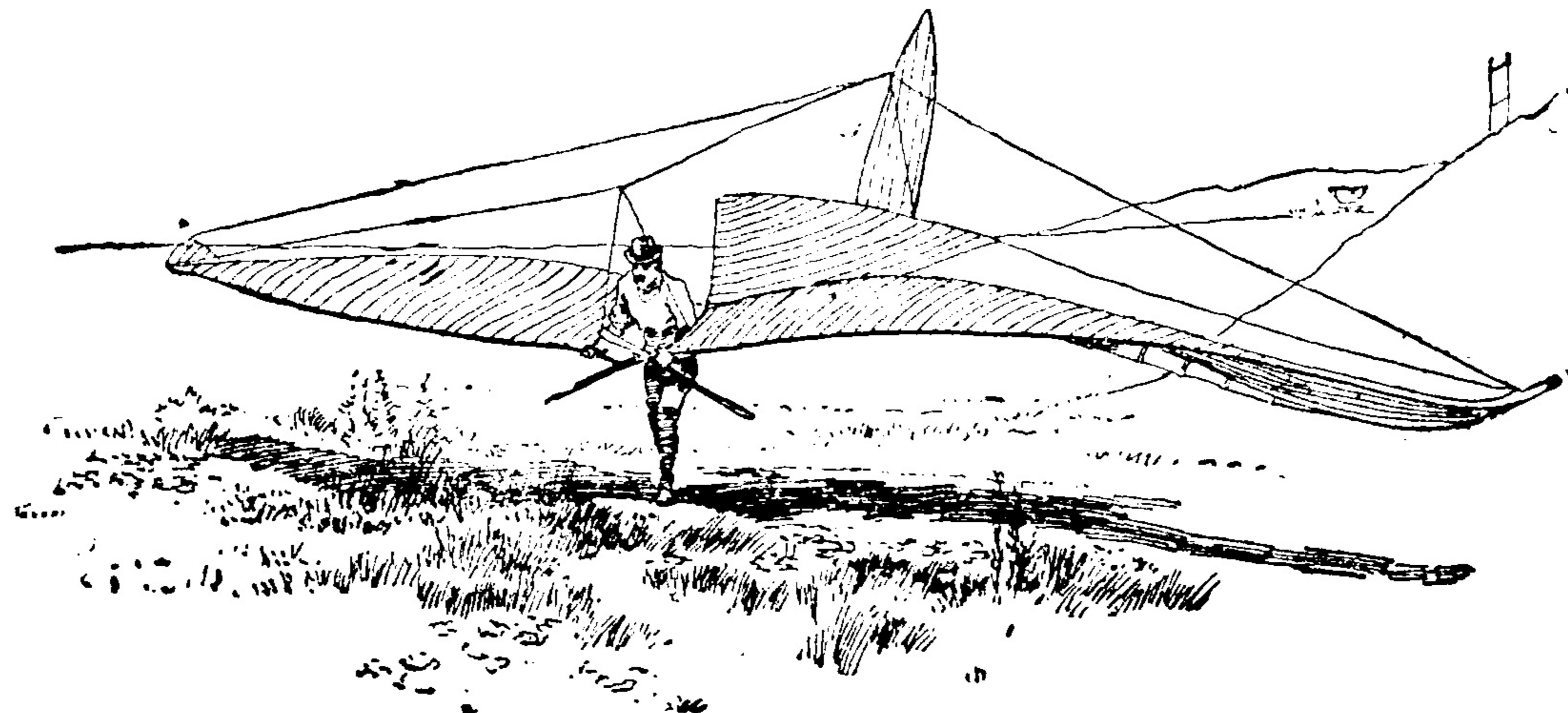
Herr Otto Lilienthal, of Berlin, who has some celebrity as "The Flying Man," has conducted a long series of experiments, which have at length been rewarded with an encouraging measure of success. Herr Lilienthal was born forty-six years ago in Anklam, near the Baltic coast of Pomerania, about sixty miles to the north-west of Stettin. A residence so near the sea afforded him in early life many opportunities of prosecuting his favorite studies and observa-

tions. In later years he migrated with his younger brother Gustav, his enthusiastic coadjutor in all his researches, to Berlin, where he established and is now conducting a large manufactory of small steam engines, whose mechanical appliances furnish him with every facility for the construction of his flying apparatus. He resides, however, in the suburb Lichterfelde, and his late experiments have been conducted chiefly in the neighboring localities of Steglitz and the Rhinower Bergen. He is an accomplished mathematician and a close observer of nature.

After many experiments with flat wings, or plane surfaces, Herr Lilienthal became convinced that it was the gentle parabolic curve of the wing which enables a bird to sustain itself without apparent effort in the air, and even to soar, without a motion of the wings, against the wind, like the albatross, or sea gull or stork; and this may be regarded as the most important outcome of Herr Lilienthal's investigations.

THEORY OF ARCHED WINGS.

"Now that we possess diagrams," said Herr Lilienthal, "which plainly illustrate all these phenomena, it seems quite easy to



JUST BEFORE THE ASCENT.

explain the flight of birds, for every crow that flies over our heads offers a practical solution of the riddle. Recent researches into the laws of atmospheric resistance lead clearly to the deduction that curved or arched surfaces are to be preferred to flat ones."

To the conviction that concave or vaulted wings were essential to success, Herr Lilienthal was led not only by the examination of a great variety of natural wings, and by theoretical deduction, but by actual experiment. The means adopted for this purpose were ingenious and simple. He fitted up an apparatus in the form of the "fly fans," with two long arms revolving horizontally, to the ends of which surfaces of different kinds and degrees of curvature could be affixed in any required position. The motive power was furnished by a weight, and could be exactly measured. There was also an adjustment which enabled the observer to measure the lifting force of various surfaces moving at different angles of inclination through still air.

By this means Herr Lilienthal was enabled to reach conclusions which were of great value to him in the construction of his flying machine, and the most important of them was that the most effective form of wing was that whose convexity, as measured by the versed sine of the arc, should be one-twelfth of the breadth of the wing, or of the length of the chord connecting the opposite edges.

The flying machine devised and now used by Herr Lilienthal is designed rather for sailing than for flying, in the proper sense of the term, or, as he says, "for being carried steadily and without danger, under the least possible angle of descent, against a moderate wind, from an elevated point to the plain below." It is made almost entirely of closely woven muslin, washed with collodion to render it impervious to air, and stretched upon a ribbed frame of split willow, which has been found to be the lightest and strongest material for this purpose.

Its main elements are the arched wings, a vertical rudder, shaped like a conventional palm leaf, which acts as a vane in keeping the head always toward

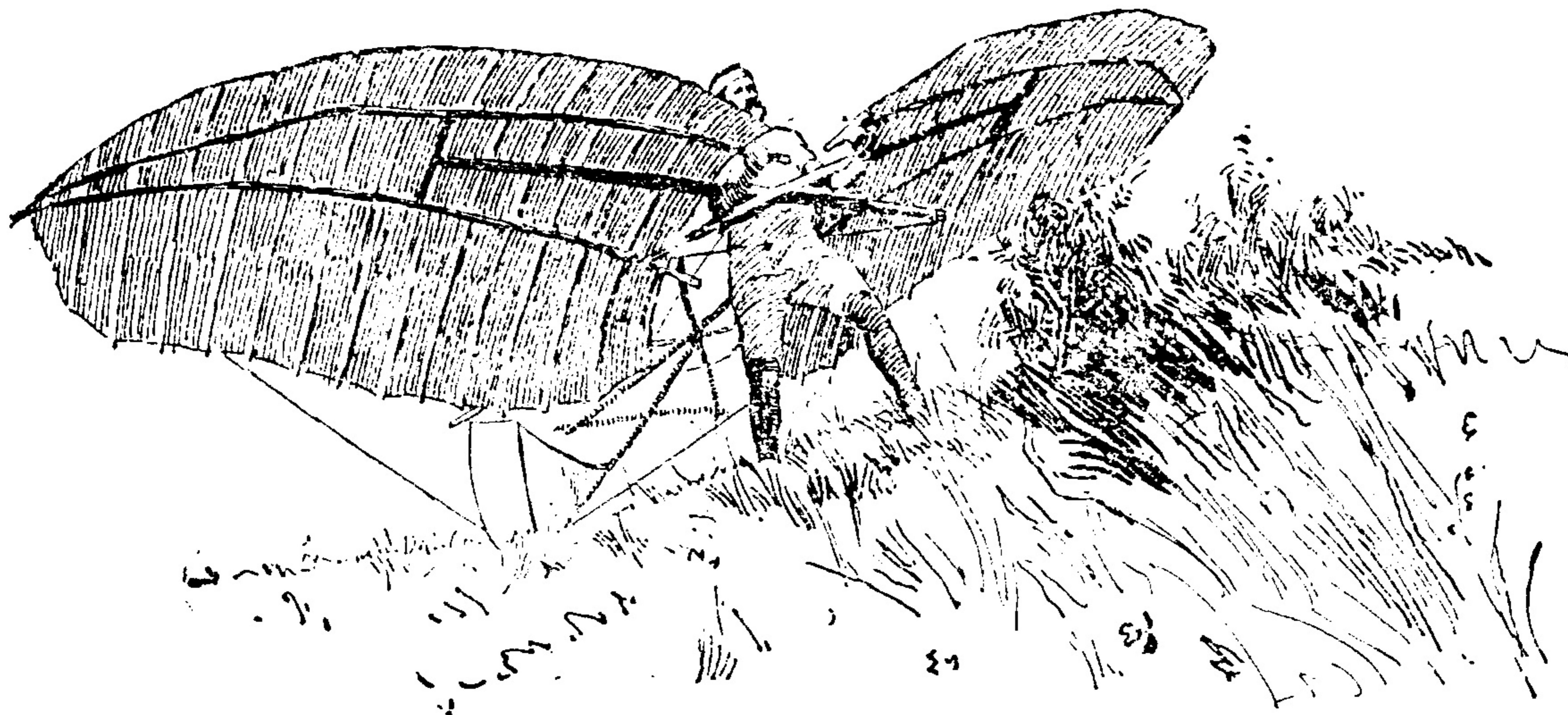
the wind, and a flat horizontal rudder to prevent sudden changes in the equilibrium. The operator so adjusts the apparatus to his person that when in the air he will be seated upon a narrow support near the front, and, with the wings folded behind him, makes a short run from some elevated point, always against the wind, and, when he has attained sufficient velocity, launches himself into the air by a spring or jump, at the same time spreading the wings, which are at once extended to their full breadth by atmospheric action, whereupon he sails majestically along like a gigantic sea-gull. In this way Herr Lilienthal has accomplished flights of nearly three hundred yards from the starting point.

"No one," said Herr Lilienthal, "can realize how substantial the air is until he feels its supporting power beneath him. It inspires confidence at once. If the wings were flat the speed might be greater, but the sustaining power would be reduced, and the descent would therefore be more rapid. With arched wings it is possible to sail against a moderate breeze at an angle of not more than six degrees to the horizon.

"The principle is recognized in the umbrella form universally adopted for the parachute. Try to run with an open umbrella held above the head and slightly inclined backward, and see what a lifting power it exerts.

"I am far from supposing that my wings, although they afford the means of sailing, and even of soaring in the air, possess all the delicate and subtle qualities necessary to the perfection of the art of flight. But my researches show that it is well worth while to prosecute the investigations further, and in the end, perhaps, to realize the *beau idéal* of all modes of motion and to put it to practical account."

Having demonstrated the practicability of sailing and soaring, Herr Lilienthal has sought in his recent experiments to reach a practical solution of the problems of actual flight. The first difficulty to be overcome was the discovery of a suitable motor. Herr Lilienthal conceived the ingenious idea of employing, as a motive force, the vapor of liquid carbonic acid, which, under ordinary atmospheric pressure, boils at a temperature far below



THE WINGS SPREAD FOR FLYING.

that at which mercury freezes. The engine devised by Herr Lilienthal required no fire, no boiler, nor steam chest—only a diminutive cylinder with the requisite valve arrangements, which may be readily worked by hand, and a small reservoir of the liquid acid lying close beside it.

The engine first constructed was of two horse-power, with a receiver to contain enough carbonic acid to last for two hours, and was attached to the front of the flying apparatus. The whole contrivance, with the necessary machinery to impart motion to the wings, added less than 25lb. to the weight, and this will probably be reduced in future by the use of some alloy of aluminium instead of iron in the manufacture of the heavier portions. The wings were also fitted with rotary pinions capable of automatic action under the pressure of the air. The first experiments with this apparatus were rather too successful, at least in demonstrating the power of the engine. Unfortunately the inventor had underestimated the energy of his motor, which acted with such unexpected vigor that the wings were broken, and the modifications thus shown to be necessary will require some time for their completion. It is only by a series of trials that the proper relations between the various parts of the machine can be determined. Herr Lilienthal confidently expects, however, eventually to solve the problem in this way.

