MAN'S ATTEMPTS TO FLY.

HERR LILIENTHAL'S EXPERIMENTS IN AERIAL NAVIGATION.

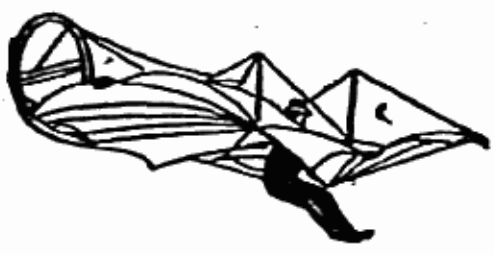
What He Has Done and How He Has Done It—His Belief Regarding What Will Yet Be Done—Certain Physical Penalties.

Until recently all the experiments in aerial navigation have been based on the supposition that man, in order to achieve flight, must avail himself either of artificial motive power or of the lifting qualities of some substance lighter than air. Many trials have been made with wings operated by various forms of motive power, and many others with balloon contrivances propelled by machinery, but all have been unsuccessful for various reasons, unless the experiment might be called a success which was tried some years ago by Eddy Hogan in the Campbell air ship, a combination of air propellers and a cylindrical balloon. Hogan went up all right, it is true, and struck a lively upper current. When last seen he was going rapidly out over the sea. No trace of him was ever afterward found, but the wreck of the air ship was sighted at sea by a passing steamer.

Aerial experts of late have been following a new course. The old school endeavored to emulate the flight of a bird as it propels itself with flapping wings. The new school takes for its model the bird of some large species which soars gracefully and without apparent effort against strong breezes. Among the pioneers of the experimenters in this line is Otto Lilienthal of Berlin. He has been experimenting in flying, or rather soaring, machines for twenty-five years, and has finally contrived an apparatus by means of which he can sail from a height through the air for considerable distances, and, given a good wind against him, can rise to a point equal to or even greater in height than his starting place. What Herr Lilienthal has accomplished is not, however, flying, but wind sailing. The flying, he believes, will come later, when by experiments he can adapt proper machinery for furnishing motive power to his apparatus.

The contrivance of which he now makes use is an aeroplane, modelled after the great soaring birds, like the stork.

"Dexterity alone, in my opinion, invests the native inhabitants of the air with superiority over man in that element," says Herr Lilienthal, and on this principle he went to work to get himself up as much as possible like a full-fledged bird. Starting with the wings, he found

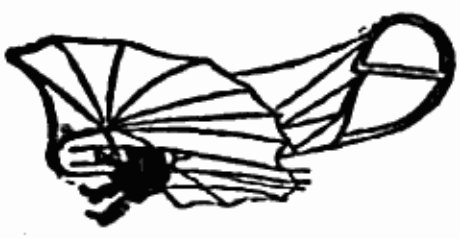


DESCENDING FLIGHT.

by experiment that about 80 square feet of sustaining surface was necessary for sustaining the weight of an ordinary man. These wings he constructed with willow frames and light, strong sheeting fabric, and he followed in various experiments both the model of the birds of prey and waders, which have broad, full wings, and that of the sea birds with narrow wings tapering to a point. There are advantages and defects in both, he says. His latest experiments have been made with the broad wings. With regard to the wings he formulated the axiom that "success in artificial flight is to be expected only from concavo-convex sustaining surfaces." For large surfaces the depth of curve was found by experimentation to be from 1-15 to 1-20 of the length of the wing. The wing material is stretched on ribs, making the wing like that of a bat.

In the matter of steering apparatus the experimenter went one better than his models, for he contrived two tails—one horizontal, to turn the flight up or down, and the other vertical, to act as the rudder of a boat acts. The whole apparatus weighed about forty pounds. He proposed to suspend himself between the wings, and by adjustments of cords and levers so operate the wings and sails as to guide his course through the air. This required practice; in fact, it required a great deal of very hard practice. Herr Lilienthal advises no one to enter upon experiments in aerial navigation from a hygienic standpoint. Many are the bumps, bruises, sprains, and other injuries which he suffered.

"In spite of my caution," says he, "the wind frequently played the mischief with me, and but for the circumstance that I was able to release myself quickly from my apparatus I might have had a broken neck instead of the

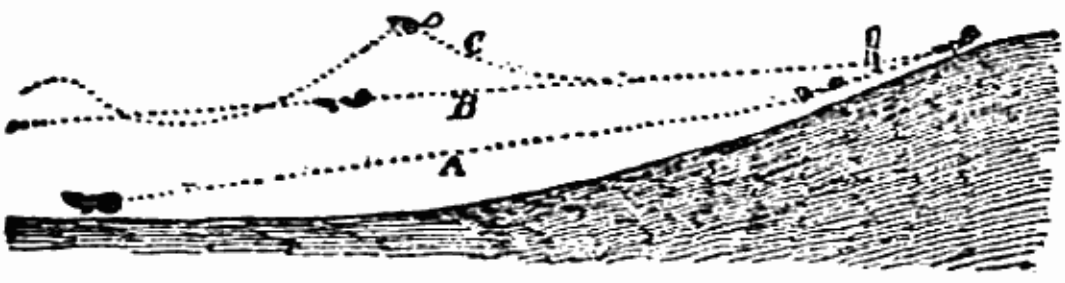


A DANGEROUS SQUALL.

sprains in feet or arms, which always healed in a few weeks."

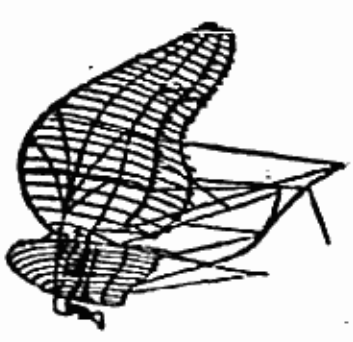
There is the heroism of the scientist in this calm disregard for physical injuries. Herr Lilienthal's first experiments were made in his garden, where he rigged a powerful springboard with a running path of twenty-six feet leading up to it. With his wings attached, he would rush up the springboard and launch himself into the air. Then he would land in some wholly unstudied attitude and suspend operations for repairs to his person or the apparatus. By the time that he had increased his weight some pounds by the number of plasters that he had on various parts of his anatomy, the experimenter began to get the knack of managing his wings and tails. Despite the opposition of his neighbors, who said that he ought to be kept in a cage as a dangerous lunatic, he persisted and presently resolved to enlarge his sphere of flight. A hilly region in the suburbs of Berlin was selected. The soarer would run along the summit of a hill, against the wind, and jump when he reached the brow. The force of the wind against him constituted a sustaining power, and he would float gently along almost parallel to the ground for a distance of from sixty to eighty feet. With a wind velocity exceeding twelve miles an hour, however, he found great difficulty in controlling his apparatus.

Constant practice, however, made him more fearless as well as more expert, and the scientist rapidly picked up valuable and hitherto unknown bits of knowledge regarding aerial phenomena. One of these was that irregular surfaces of ground produce much the same effect on wind blowing over them as they would on water flowing over them; that is, a steady breeze blowing over land that is broken into small hillocks and ridges breaks into wind rapids and varying currents.



TRAJECTORIES OF FLIGHT.

This is, of course, a source of danger to the flyer, who is likely to find himself suddenly whirled about or carried powerfully upward by one of these air waves. In general, however, Herr Lilienthal believes the aeronaut can count upon a steady upward trend of the air currents. A mechanic, Hugo Eulitz, who built the experimenter's aeroplanes for him, practised with him every Sunday, and finally they concluded to have some instantaneous photographs taken, to show that they had really accomplished something.



LILIENTHAL MACHINE 1892.

"Herr Kassner of the Meteorogical Institute was so kind as to photograph me in the air," says Herr Lilienthal; "and has thus enabled me to exhibit to the members of the society how I sailed right over the head of the miller of Derwitz (in whose barn I started my apparatus) and of his esteemed poodle dog."

Finally, in order to obtain the best results, Herr Lilienthal built a tower about twenty feet high on the top of a hill, and made that the starting point of his flights. Jumping from this, he made many successful flights, in some of which he sailed up above the top of the tower, rising and sinking by guiding himself with the wings and tails. By assuming different positions with his legs and body he was enabled to change the centre of gravity, thus steering partly by weight, as the navigator of a sailing canoe sails. He made flights in winds as high as eighteen miles an hour.

"To go up in the air" (while soaring), he writes, "it is necessary for the flying man to

LILIENTHAL'S MACHINE.
Front View.

raise himself by making use of the force acquired by his forward motion. I have often been compelled to pass over some such obstacle as a tree, or a group of people, placed below me. Indeed, one may go up easily, but at a height one becomes stationary, and if one is not able to throw his weight quickly to the rear then the aeroplane swoops forward and is crushed against the ground."

There is also great danger, as he goes on to explain, when the flyer is suddenly struck by a squall. The weight must be then thrown as far forward as possible lest the apparatus be tossed up and overturned.

VIEW OF THE MACHINE AT STARTING.

The illustration above shows Herr Lilienthal in such a moment of danger. For a moment it seemed doubtful if his weight would keep the head of the apparatus down, but the squall soon abated, and he came to the ground safely. In descending the flight is at a very small angle, the wings acting as a parachute. The diagram shows the trajectories of flight in various winds. A is the line of flight in a calm, B in a mild breeze, and C shows the flight in a lively breeze with squalls. Here the human bird soars up with the stress of wind, sinks gradually and then goes up again.

Herr Lilienthal has reduced this soaring to something approaching an exact science. He contemplates next constructing an apparatus in which the wings may be flapped either by steam power or some other motive force. Comparatively small power—about 1½ horse power—will be required. The main difficulty is in the increased difficulty of guiding the flight when the wings are moving, and careful and patient experiments will be necessary to solve many of the hitherto unknown phenomena of air pressures.

Herr Lilienthal believes confidently that as soon as a sufficiently light and powerful motor can be constructed flying machines that will hover, swoop, or fly at the will of the operator can be made. When once the navigators are able to get into the steady upper currents a great element of difficulty will be eliminated, that of the billowy nature of the wind near the earth's surface.