

HOW TO GLIDE.

By WILBUR WRIGHT.

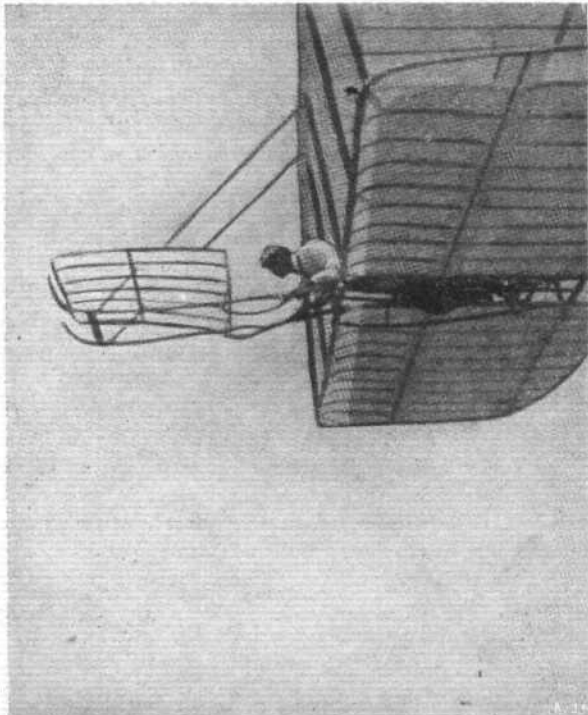
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Early Difficulties.

IN one glide the machine rose higher and higher until it lost all headway. This was the position from which Lilienthal had always found difficulty in extricating himself, his machine then developing, in spite of his greatest exertions, a tendency to dive downward almost vertically, and strike the ground head on with frightful velocity.

In this case a warning cry from the ground caused the pilot to turn the elevator to its full extent, and also to move his body slightly forward. The machine then settled slowly to the ground, maintaining its horizontal position almost perfectly, and landing without any injury at all.

This was very encouraging, as it showed that one of the greatest dangers of machines with horizontal tails had been overcome by the use of the front elevator.



A view from beneath, showing how Wilbur Wright lay prone on the lower deck.

Several glides later the same experience was repeated with the same result. In the latter case, the machine had even commenced to move backward, but was, nevertheless, brought safely to the ground in a horizontal position.

On the whole, this day's experiments were encouraging, for while the action of the elevator did not seem at all like that of our 1900 model, yet we had escaped without difficulty from positions which had proved very dangerous to preceding experimenters, and after less than one minute's actual practice had made a glide of more than 300 feet at an angle of descent of 10° , and with a machine nearly twice as large as had previously been considered safe.

On the Road to Discovery.

The trouble with its control which has been mentioned, we believed, could be corrected when we should have located its cause.

Several possible explanations occurred to us, but we finally concluded that the trouble was due to a reversal in the direction of the travel of the centre of pressure at small angles.

In deeply-curved surfaces the centre of pressure at 90° is near the centre of the surface, but moves forward as the angle becomes less till a certain point is reached varying with the depth of curvature. After this point is passed, the centre of pressure, instead of continuing to move forward with the decreasing angle, turns and moves rapidly towards the rear. The phenomena are due to the fact that at small angles the wind strikes the forward part of the surface on the upper side instead of the lower, and thus this part altogether ceases to lift, instead of being the most effective part of all as in the case of the plane.

Lilienthal had called attention to the danger of using surfaces with a camber as great as one-eighth of the chord, on account of this action on the upper side; but he seems never to have investigated the camber and angle at which the phenomena entirely cease. My brother and I had never made any original investigation of the matter, but assumed that a camber of one-twelfth of the chord would be safe, as this was the camber on which Lilienthal based his tables. However, to be on the safe side, instead of using the arc of a circle, we had made the camber of our machine very abrupt at the front so as to expose the least possible area to this downward pressure.

While the machine was building, Messrs. Huffaker Spratt had suggested that we should find this reversal of the centre of pressure, but we believed it sufficiently guarded against. Accordingly, we were not at first disposed to believe this reversal actually existed in our machine, although it offered a perfect explanation of the action we had noticed in gliding.

Our peculiar system of control by means of an elevator instead of a tail was based on the assumption that the centre of pressure would continue to move further and further forward, as the angle of incidence became less, and it will be readily perceived that it would make quite a difference if the front surface, instead of counteracting this assumed form of travel, should in reality be expediting an actual forward movement.

The Discovery.

For several days we were in a state of indecision, but were finally convinced by observing the following phenomena:—

(Fig. 1.) We had removed the upper surface from the machine, and were flying it in a wind as a kite to see at what angles it would be supported in winds of different strengths. We noticed that in light winds it adopted the attitude shown in the upper diagram, and exerted a strong pull on the cord, C. As the wind became stronger, the angle of incidence became less, and the surface flew in the attitude shown by the middle diagram, in which position it exerted a slight horizontal pull on the cord, C. But, when the wind became still stronger, it took up the attitude shown by the lower diagram, and in this position exerted a strong downward pull on the cord, C.

It at once occurred to me that here was the answer to our problem, for it is evident that in the first case the centre of pressure was in front of the centre of gravity