REMARKS.

No. 2 shows that a spar or thickness over the front edge does not interfere with the lift, but much increases the drift. We may, therefore, infer that this, although a necessity in aerial machines, should be as thin as consistent with strength.

No. 3 shows that a circle has the same "lift," but less drift than a square of the same diameter.

No. 4. With a circular orifice having half the area of the circle cut out, the lift was not materially altered, but the drift is considerably increased. This confirms an experiment tried by the writer, with a plain circular kite in which the half area was afterwards cut out, with apparent equal efficiency termed a "ring kite."

No. 5. The same arrangement of superposed surfaces, proposed by the author, in the first issue of the Aeronautical Society in June, 1866, but with this difference, that the receding step-like arrangement would tend to prevent interference from each other with less distance in height. The lift of the arrangement is very great, and so is the drift, arising from too many edge resistances, which make the form too unwieldly to be of much use.

With Nos. 6 and 7 the results were very remarkable. So to term it, there was a degree of life and energy in this form of surface that the flat did not possess. On this point further remarks will follow.

A curious experiment was tried. A three-inch square was balanced on pivots as shown in Fig. 3, with half the area of one side cut away in four openings, leaving five narrow ribs, the open side was weighted, to compensate for the loss of material. On holding this in the blast, with the pivots vertical, the blank side having greater area, was driven back, the form taking an angle of about 65°. As the axis was brought towards the horizontal, till nearly parallel with the current, the open side rose up above the other, and had a greater lifting force than the close one. This explains a fact, that many persons may have noticed that some rooks at moulting time have lost most of the alternate primary feathers of one wing, so leaving openings; but instead of flying lop-sided, there is apparently no loss of balance, the support of one wing appears to be as good as the other.

The writer has long doubted whether flight can possibly be effected with *flat* aeroplanes. There is no such form in the wings of birds of passage, in which they are invariably concave beneath. Aeroplane or flat surface experiments are always difficult and unsatisfactory, from the lifting force persistently occupying the front edge. The after part of the surface does not assist much, and may be cut away or mutilated without detriment to the result. With flat surfaces we must adopt long planes extending laterally. We know where to begin, but not where to end, for obtaining the best advantage. *The whole secret and success in flight depends upon a proper concave form of the supporting surface.*

For comparison on a large scale if this 360 grains on the model surface of 1-16th of a square foot is increased in proportion 200 times, it will give a lift of more than 1 lb. per square foot. But the power to propel at 25 miles per hour must be estimated as the "drift." This is 45 grains taken at 200 times is equal to 1.56 lbs. at 2,200 feet per minute, equal to 3,432 foot pounds or about 1-11th h.p., or less than the half strength a man is capable of exerting. In this estimate no allowance is made for the resistance of frame work or appendages. The webs of a trial machine might be about three feet wide, in three tiers extending twenty feet from end to end sideways, thus spreading 180 square feet of surface. The great difficulty yet to be overcome is that of equilibrium during flight. More than thirty years ago the writer of this, made a winged model, duly weighted, which skimmed away steadily when launched from a house top; Mr. Glaisher was requested to drop it from the car in his next balloon ascent; he did so, and reported that it descended steadily for some dozen yards, then tripped and whirled over rapidly till it reached earth.

A long tail or expanse of surface aft under the instant control of the aeronaut must be considered as indispensable for the purpose of steering and balancing.

Mr. Hargrave's Paper on Sailing Birds.

To the Editor of the AERONAUTICAL JOURNAL.

SIR,—I hardly think that Lord Rayleigh can have fully understood Mr. Hargrave's contention when he "fully agreed" with Mr. Maxim that the simple lifting up and down of the air by waves could not, without any onward wind, enable a bird to sustain its weight. It is of no consequence to a bird whether the air within which it is flying is or is not accompanied in its motion by the seawater or by neighbouring air, and if any simple upward draught of air can enable a bird to support its weight, the upward draught accompanying the back of a wave can do so. No doubt the bird must be falling relatively to the air in which it is moving, and from that point of view it might appear, at first sight, as if it must ultimately reach the water below it which is rising at the same rate as the air. This, however, ignores the forward motion of the bird, which is constantly carrying it over a fresh water surface, which, though moving upwards with the same velocity as the last, began at a lower level, and is, consequently, when the bird reaches it at the same level as the one it has just left, while this latter goes on and does reach, at the crest of the wave, a maybe, higher level than the bird.

It is a mere question as to whether the bird, when moving through the air at the same rate as the waves, will, or will not, fall in still air at the rate of the upward draught on the face of a wave. If a bird gliding downwards at a constant velocity in still air goes forward at the rate of the wave and sinks downwards more slowly than the air at the face of the wave is moving upwards, then it could maintain itself in this upward draught.

It might, at first sight, appear as if the question were the same as the problem as to whether a bird could fly over an undulating country when there was no wind, but the forward motion of the waves and consequent variable motion of the air over them makes the problem entirely different. If we could assume that there was no tangential force between the water and the air, and it must be quite small, the problem is essentially the same as that of the motion of an undulating country under still air, or what comes to the same thing the motion of air over an unmoving undulating country, and on every hand, by Lord Rayleigh and all other authorities I know of, it is conceded that a bird *can* use the upward draught of air blowing up a hill to sustain itself in a position fixed relatively to the hill. Now suppose the air to be stopped, and the bird and hill given a velocity equal and opposite to that of the air, and we have exactly Mr. Hargrave's case.

The real problem in the case of the bird is probably much more complicated because the motion of the air near the sea is not merely up and down, but is almost certainly, like that of the water, approximately in circles as the wave passes. The bird consequently has not only vertical, but alternating horizontal draughts to depend on, to enable it to sustain itself, so that I have no doubt Mr. Hargrave is quite right in his observation. The only case in which the bird would be unable to use the waves, would be when the wind was blowing at exactly the same rate as the waves were moving forward; that would be the same as if the bird were trying to fly over an undulating country when no wind was blowing. The case would not, however, be *exactly* the same, because there *is* a tangential action between the water and the air, which in the case of the wind blowing at the same rate as the waves would set up eddies, and prevent the lower air from moving as fast as the upper air, and might, in a variety of ways, make it quite possible for those dexterous utilisers of differences of wind motion, the seabirds, to fly without exertion.

I feel the more interested in this question, because from the time of my first taking an interest in Lilienthal's experiments, I have looked forward to the possibility of human beings utilising the trade winds blowing over the sea as a means of locomotion. The irregularity of most winds renders their utilisation by mankind almost hopeless, but the regularity of the trade winds and of the waves they produce makes their utilisation quite possible.

Yours truly,
GEO. FRAS. FITZGERALD.
Trinity College, Dublin,
16th April, 1900.

Count Zeppelin's Air Ship.

While the AERONAUTICAL JOURNAL is in the press, the news of the first trial of Count Zeppelin's Air Ship has arrived, and it is reported that it has travelled from Lake Constance to Immenstadt, a distance of 35 miles, with safety. Any further comment on this fascinating experiment must be held over until the next number of the Journal, when it is hoped that it will be possible to publish a full and reliable account of the initial, and perhaps subsequent, experiments with the greatest air ship ever launched.

NOTES.

The Duration of the Lifting Power of Balloons.— Up to the present, no very methodical scientific investigations have been carried out to ascertain the time that a balloon of a given size can remain in the air without losing its lifting power; and aeronauts who