HOW MEN FLY.

A POPULAR ACCOUNT OF SOME OF THE MORE INTERESTING FUNDAMENTAL PRINCIPLES OF ARTIFICIAL FLIGHT.

Now that such a much larger section of the general public is taking an interest in aviation, there must be a greatly increased number of readers who are searching for some brief and elementary explanation of the laws of flight in order that they may more readily grasp the significance of the practical work which is going on at the present time. Already there is a fair amount of literature on the subject in the form of text-books, which should certainly be read by such as go into the matter deeply, but our object in this article is to write something which will appeal more particularly to those who have neither the time nor the inclination to worry with details, but who wish, nevertheless, to have a general idea of the main theme and to know about one or two of the more interesting specific cases.

It will have been perfectly evident to everyone that man's conquest of the air has been far more the result of experiment than theory, and even in the earlier days—before practical flying machines were constructed—pioneers were then devoting the greater part of their time to construction rather than mental study. Among the earliest workers, yet living, was Sir Hiram Maxim, who has just published a little book called "Artificial and Natural Flight" (Whittaker and Co., 5*s.*), containing the first and only account of his experiments. Sir Hiram, as all the world knows, once made a machine which succeeded in lifting itself off the ground and flying for a short distance. This was in the days before petrol engines had been developed, and the inventor, in common with others, found himself most seriously handicapped by the weight of his steam machinery. Apart from this *magnum opus* by which he is best known, however, Sir Hiram Maxim made a lot of minor experiments connected with the effect of the wind on objects of different shape, and it is these tests which form, in our opinion, the most interesting portion of his afore-mentioned book. They touch upon the fundamental principle of flight, and we purpose using them as a basis of reference in this article. The data itself is unfortunately set forth in the book, we think, in a somewhat confusing manner, but we have re-tabulated it to a considerable extent for our purposes, and have prepared little sketches of the objects, so that the significance of the figures may be more readily apparent to the reader. Incidentally it may be mentioned that Sir Hiram Maxim never had time either to finish his tests or to properly check those that he had made; but although this essentially detracts from their intrinsic value, it does not affect their general interest, and the book itself, taken as a whole, is very readably written in simple language, and should certainly be read by all who are curious about the author's early work.

Wind is, as everyone knows, air in a state of motion; but the effects which it produces upon objects against which it blows may be reproduced exactly if the objects themselves are moved through still air at an equivalent speed. If, therefore, it is desired to make experiments on a small scale, the model may either be projected through the air or be subjected to a draught, as may be most convenient, without affecting the nature of the resultant information. Sir Hiram Maxim carried out both classes of experiment, and his object was to find out the relative effects produced by winds of known velocity upon objects of different shape. Wind blowing against an object exerts pressure upon it, the nature of which is, so far as an ordinary observer's everyday experiences would go to show, that of a direct thrust. The pedestrian in the streets feels that he is being blown backwards by a gale, the motorist in a fast car feels the same effect in calm weather, and the occupants of a balloon, who feel no effect at all, know that they are *drifting* from the same cause. "Drift" is the term which Sir Hiram Maxim employs to denote this thrust or pressure of the wind in the direction of its motion—which is commonly supposed to be horizontal—and it is useful to have an alternative expression for "wind resistance," which has hitherto served the same purpose in automobile terminology.

There is another, and far more important, attribute of the wind than "drift," however, and that is its capacity for *lifting* certain objects, while it is apparently blowing straight *across* them. Thin boards or sheets of light stiff material placed edge-on to the wind will be lifted bodily in this way when their front edges are but a fraction higher than their rear edges; and if, instead of being flat, these planes are slightly cambered, the wind will still lift them while their front and rear edges remain on the same level. To engineers and others who understand all about "component forces," these facts may not seem extraordinary, but to the lay mind they are wonderful enough, because circumstances do not commonly arise in everyday life to demonstrate the existence of the underlying law, which is, moreover, the fundamental basis of flight as practised by man to-day.

The aeroplane is a structure devised to carry a pilot, propelling machinery, and a large expanse of surface formed by thin planes. These latter being forced through the air, extract the lifting power from the draught thus artificially produced across them, and so cause the whole machine to rise bodily off the ground and fly. Flight is due solely to this principle, and is maintained over a long duration solely by virtue of keeping this force alive. The force is created by motion and cannot exist without it; consequently if there is no wind, an artificial draught must be produced by forcing the flying machine up into the air. A kite is an example of a machine which soars by virtue of natural wind. Another important point to be borne in mind is that the direction of the wind or draught which produces the lifting effect must essentially be contrary to the direction in which the machine is flying. If, therefore, it is desired to fly *with* any natural wind which may happen to be blowing at the time, the machine must be forced through the air at a greater speed than the velocity of the wind, so as to create an artificial draught in the *opposite* direction.

When wind blows across a suitably designed surface or plane placed practically edge on to it, it exercises its lifting effect with comparatively little tendency to make the object *drift*; but if the front edge of the plane be tilted up a little more, the drift becomes considerable indeed, although only a comparatively small increase may have taken place in the lifting power by way of compensation. When the plane is set vertical to the wind the drift is, of course, at its maximum and the lifting effect *nil;* so between these two extremes there are numberless relative values of lift and drift available. Naturally the aviator wants the most lift he can obtain for a minimum drift, and this quest opens up a vast and interesting field for useful experiment. It was this "spade-work" which Sir Hiram Maxim was engaged upon in his early