How THEY STAY UP

Part of a Thesis by Arthur L. Lawrence

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EDITOR'S NOTE: *In view of the constantly increasing number of new readers of* SOARING, *it will be our policy in the future to publish articles answering most of the questions asked by newcomers to the field of gliding and soaring. This article will explain the principles of soaring flight. In our next issue, we will describe the seemingly impossible task of training students safely in single-place gliders.*

Motorless flight is a sport comparable to any in which swift motion is a principal element. But neither skiing nor ice boating, sailing nor any other surface sport dealing in speed is able to give the individual that emotional exhilaration provided by eagle-like soaring flight in the invisible up-winds which sweep the earth's surface. Such currents have carried pilot and glider to altitudes higher than 28,000 feet above the starting point, for airline distances in excess of 400 miles, and for as long as 50 hours in continuous flight.

The principle on which soaring flight is based is very simple. Given a moving air mass having a certain vertical component of velocity, it is merely necessary to fly around in that particular portion of the atmosphere in a craft which has a lower sinking speed than the rate at which the supporting medium is rising in order to soar (to maintain or gain altitude in a motorless plane).

The development of aerodynamics since the World War has made possible the design and construction of the sailplane, a type of aircraft the chief characteristic of which is a feather-like sinking speed of less than two feet per second when gliding forward at an air speed of around 35 miles an hour.

Once the fact was determined that certain air masses in motion had vertical as well as horizontal components of velocity, the mystery of the unseen energy producing soaring bird-flight was explained. Methods were developed for measuring the vertical movements of air, and at the same time the aerodynamic characteristics of soaring birds were studied. The problem of man's soaring was then reduced to the design of aircraft having the flying characteristics of such birds as the albatross, hawk, and vulture, and capable of supporting the weight of a 160-pound pilot, to be flown in the up-winds made use of by birds. Launched into an up-wind zone in a glider—the windward side of a mountain for example—human beings were able to soar.

Vertical currents in the atmosphere are produced by the contours of the earth's surface and by unequal temperature and pressure distributions in various air masses. Convection currents set up in the air by temperature differences have vertical velocities averaging up to 15 feet per second, and occasionally exceeding 100 feet per second (68 m.p.h.) in extreme or storm conditions. During a recent record altitude flight, the sailplane climbed 20,000 feet in 5 minutes.

Prior to the summer of 1932, soaring in the United States was accomplished principally by means of slope winds, augmented to a greater or less degree by purely local thermal currents. A slope wind is most easily described as an inverted waterfall of air. Winds sweeping across a valley toward a straight or concave ridge must flow over it, and depending on the angle of the slope, its height and the velocity of the air, may have vertical velocity components ranging from zero to more than 15 feet per second. The up-swing of air, as it flows over the ridge, may reach distances of approximately two and a half times the greatest elevation of the terrain. In the case of a ridge facing a wide cultivated valley, heat currents will be produced over the latter on a clear, warm day, which will be carried against the ridge to augment the slope up-current, frequently breaking away upward and providing vertical air movements to much greater altitudes.

In the summer of the year 1932, cloud flying was accomplished by many of the pilots at the 3rd National Soaring Contest at Elmira, with practically every type of glider entered. Jack O'Meara and Martin Schempp, with German sailplanes, established the new American distance and altitude records, while 16-year-old Robert Eaton, in an American utility glider, exceeded the previous year's records in both events. Since that time cloud soaring has become a familiar technique to motorless pilots in the United States. Included among the many flights made by this means are a number of good distance and altitude performances. The present American distance and altitude records of approximately 210 miles and 6,700 feet, respectively, have been established through the direct use of cloud up-currents, preceded by slope-wind starts.

The clouds used for this type of soaring are the large billowy cumulus formations one sees on a summer's day. They form when warm masses of relatively moist air, rising up into cool regions, are chilled, largely by a diabetic expansion, to a degree where the saturation point is reached and condensation of the vapor takes place—usually between 4,000 and 8,000 feet. As the vapor condenses to cloud, the heat of condensation is liberated, which gives the mass of air new impetus upward.

Under and in one of these clouds, therefore, is a column of turbulent, rapidly rising air which may reach and sometimes exceeds a velocity of 25 feet per second. The cloud mass bobs up beyond its point of equilibrium, however, and soon the process is reversed, with a down current and the dissipation of the cumulus. The time of the cycle is relatively short, and the soaring pilot generally has about half an hour, from when the cloud has started to form until he must leave it or be forced earthward more rapidly than he was lifted up.

A particular technique is used for distance soaring. The pilot starts off in the slope wind but is ever on