Thermals at Low Altitudes

Their Vertical Velocity, Size and Origin

By **DR. KARL O. LANGE**

FEW glider pilots are fortunate enough to be located near a ridge that permits slope soaring with the prevalent winds. Fronts are few and far between; cumulus clouds can be reached ordinarily only from airplane tow or some other means that assures initial altitude. So, "everyday soaring" depends in most locations on thermals. But at present it is only too common an experience for an entire glider unit to operate throughout a whole day without accomplishing a single soaring flight. The thermals are there all right but we do not know how to utilize them at the low altitudes obtained from common tow.

In order to make more systematic and more efficient attempts at catching thermals from auto tow or winch tow on level ground, three things have to be known: (1) what upcurrent velocities may be expected at low altitudes; (2) how big around is a thermal near the ground, and, (3) where do the thermals generate. And, of course, it would be a great advantage to have a means beyond and better than the climb indicator with which to locate upcurrents. David Stacey, when doing graduate work at Harvard's Blue Hill Observatory in 1941, investigated these problems under the author's direction. The results have not yet been published and many of the following data come from this work.

Measurements of Vertical Velocity and of Horizontal Size of Thermals at 1000′ Above Ground

The test flights of this investigation of thermals were carried out during March, April and May. Thus, the results may apply only to spring conditions. The flights were made—with a Piper Cub Coupe—on days with "thermal weather" only, as any experienced glider pilot would define it; namely only when there was strong insolation (little or no scattered clouds) and after the ground had heated up in the morning. The temperature lapse rate was not measured, but it may be assumed to have been dry adiabatic (5.5°F per 1000′) in the lowest 5 - 6000′ because of the selection of days and daytime for the flights.

The measurements were made over a fixed triangular course from Norwood, Massachusetts airport to Blue Hill Observatory, to a point north, and back to the airport. The underlying territory includes fields and pastures, a golf course, swamp lands, woods, the town of Norwood, also highways, railroad beds, a quarry and the airport aprons—all features that were proclaimed by several authorities to be good thermal sources. The measurements were made about 1000′ above level ground, which changed from 400′ to 1000′ above the fringe of the Blue Hills. Other variations from 1000′ were caused by the upcurrents and downcurrents encountered in flight. They are small enough to be spoken of generally as 1000′ above ground.

The basis of the evaluations are barograph traces of a special Lange barograph with very open time and pressure scales. Only such vertical motions were evaluated as might be of immediate interest to soaring; that is, small turbulence recognizable in the traces was evened out.

The Vertical Velocities of Thermals at 1000′

The results of 17 test flights are summarized in Table 1.

TABLE 1

Vertical Velocity	Percentage of the Total Number of Upcurrents Encountered
2 feet per sec. and under	31%
3 and 4 feet per sec.	39%
5 and 6 feet per sec.	15%
7 and 8 feet per sec.	6%
9 and 10 feet per sec.	7%
Over 10 feet per sec.	2%

The table states that 69% of all upcurrents encountered during the investigation had a vertical velocity of 3 feet per sec. or more at 1000′. That is, about 2/3 of all upcurrents found should sustain soaring flight in sailplanes and even in utility gliders if expertly flown. 30% of all upcurrents have a vertical component of 5 feet per sec. or more; that is, a sufficient rate to soar with comparative ease. The relative number of upcurrents having a velocity of 3 to 4 feet per sec. is the highest of all groups. It is almost 40% of the total. This appears to be quite significant in two ways. Firstly, it suggests a peculiarity in the mechanics of thermals that is also borne out by other indications, and that might lead to the discovery of further valuable knowledge on the behavior and usefulness of thermals. Secondly, it points to the fact that a large number of thermals represents the very lowest limit at which we can soar, and thus emphasizes the importance of gliders with a low sinking speed.

As a whole the results of the measurements of upcurrent velocities agree well with our general experience. It is generally known that occasionally upcurrents are encountered at an elevation of 1000′ that can hardly be missed, namely currents of 9 feet per sec. and more. According to the above table, these cases represent roughly 10% of all thermals. But the majority of upcurrents is only of the same order of magnitude as the sinking speed of the glider. According to the measurements, 70% of all thermals are 4 feet per sec. or smaller and, therefore, sufficient for prolonged soaring only if the pilot can manage to stay strictly within