THERMALS AND HELICOPTERS

BY EDWARD A. QUARTERMAN

FROM a casual glance at generally distributed facts about the performance of positive vertical lift aircraft it becomes evident that many of the techniques learned by expert gliding and soaring pilots ought to be adapted to the use of vertical lift planes and to a more adequate understanding of ptocesses of circulation in the atmosphere.

Emphasis upon the performance of vertical lift planes as it is altered by processes taking place in the atmosphere brings ever closer the fundamental truth that weather is essentially a thermodynamic process. For if vertical currents can be shown to alter the performance of vertical lift planes, then essentially work has been done by the atmosphere upon something that has been suspended within it and certainly work may be done by the atmosphere only at the expense of heat energy that it holds.

Those who are experts in the matters that pertain to the flight of motorless planes know from experience and can predict within astonishing close allowances the magnitude of vertical currents that are associated with the movement of masses of air over hills or other obstructions; and also something about the vertical lift to be expected in areas of the atmosphere that contain whirling vertical currents which we speak of as thermals.

That the changes in performance of vertical lift aircraft may be astounding as slight vertical currents are made use of, may be demonstrated by a few figures which seem in keeping with previous experience.

If it is supposed that a vertical lift aircraft weighs 4000 pounds and carries a load of say 2000 pounds, and is powered with a 180 H.P. motor, the following would seem plausible:

Weight of plane	4000 pounds
Useful load	2000 pounds
Total	6000 pounds

180 H.P. equals $550 \times 180 = 99{,}000$ ft. lbs./sec.

Work done per second in lifting the craft at the rate of one foot per second:

$6000 \times 1 \times 1$ equals 6000 foot lbs./second.

Amount of energy available:—99,000 ft. lbs./second.

Kinetic Energy equals $\frac{(M)\ (V)^2}{2g}$ = Power available

or $\frac{(6000)\ (V)^2}{64.4} = (180)\ (550)$

$V = 32.6$ ft./sec. Terminal of vertical velocity (Maximum rate of climb)

The air passing through the rotor must also be accelerated and one might expect that this might reduce the vertical velocity to perhaps 15 feet per second.

Power required to raise craft 10 feet in one second:

$$\frac{6000 \times 10 \times 1}{550} = 109 \text{ H.P.}$$

Height 180 H.P. will raise craft in one second:

$$\frac{(6000)\ (X) \times 1}{550} = 180 \text{ H.P.}$$

$$X = \frac{(180)\ (550)}{6000} = 16.5 \text{ ft.}$$

Average vertical velocity at take-off not more than 16.5 ft./sec. Except as rotor might be over speeded while on the ground this is not likely to be attained.

Soaring experience has shown that vertical velocities of about 5 ft./second will be encountered at about 400 feet altitude on the windward side of a mountain ridge which has been rounded by glaciers and has a rise of about 1000 feet above the valley floor, provided the wind velocity (horizontal) is about 18 mi./hr. and the point of measurement is about as far from the crest of the mountain measured horizontally to the windward as the crest of mountain is high above the valley floor. (Lift of lesser magnitude extends to windward a distance of about twice the height of the mountain.)

Moreover, spirals of rising air, spoken of as thermals of vertical velocity of about 4 to 10 feet per second, may be encountered as low as 200 feet above the earth. At about 200 feet altitude one would expect to find the diameter of such swirling currents to be of the order of about 90 to 125 feet.

Moreover, looking from above toward the earth these