be detectable from a distance by measuring the electrostatic field from the sailplane. Such potential gradient equipment has been developed for airplanes (see for example, References 6, 7 and 8) and in Reference 9 application to soaring is suggested. The apparatus can be light and relatively simple. Two standard techniques are available. In one the air voltage (relative to the aircraft) at a probe is measured: the probe is "coupled" to the air via a radioactive tip which makes the air within a few inches of it highly conducting, and this coupling lowers the probe-to-air resistance enough so ordinary electrometers and insulators can be employed. In the other the gradient at the surface of an object (say the wing or fuselage) is detected by cyclically covering and uncovering a conductor and noting the bound charge that enters and leaves it. In either case, two sensors must be adjusted and located so that the potential gradient caused by charges on the sailplane affects each probe equally and so is automatically cancelled when the probe voltage differences are measured.

There is a vertical fair weather field of about ½ to 1 volt per centimeter and the instrumentation must not be confused by this field. In thunderstorms the charges in clouds can give gradients outside clouds of many hundreds of volts per centimeter but during such conditions the cloud appearance tells even more than electrical measurements would. In ordinary conditions, a recommended method would be to measure the gradient along the direction of the line of flight, for this lines stays close to horizontal (say one radioactive probe at the nose, one at the tail). Then if the sailplane is flown in a direction making the observed gradient maximum, it should be heading toward (or away from) the charged thermal.

Figuring out a Thermal from Measurements of Vertical Velocity

Every soaring pilot has wished he could fly into or through a thermal and then know immediately just where to maneuver in it to get the maximum climb and know whether it will be getting stronger or weaker. Measurements from the sailplane, coupled with intelligent interpretation, can go a surprisingly long way toward providing the information.

The definition of a thermal — and its use to the soaring pilot — is its vertical velocity. Therefore, vertical velocity is worth measuring well and the state of the art permits this.

The vertical velocity of the air, rather than the sailplane, is what the pilot really wants. A standard rate of climb indicator shows the vertical motion of the plane. The indication is corrected for airspeed changes by a "total energy" venturi or diaphragm unit, and can be corrected by drag loss (ordinary sink) by a throttled pitot. The basic subject is reviewed in Reference 10 and the new total energy device is discussed in Reference 11. Reference 12 shows how to improve the total energy unit still more by filtering out the effects of the longitudinal turbulence on the "total energy" correction. References 13 and 14 offer further pertinent information. To summarize the situation now, excellent variometers are available, and with special correction techniques they can give satisfactorily fast and accurate readings of vertical air velocity under any typical flight condition. The electric variometers are especially fast, such as the Crossfell unit (see Reference 15) any of which can be obtained with a total energy diaphragm corrector.

The biggest single improvement in thermal soaring performance can come from optimizing the use of the variometer. This means maneuvering the sailplane jointly to get the maximum vertical motion and the maximum information about the thermal. The average pilot does not know how to get back to a particularly good spot in a thermal through which he has just traversed. This requires a good memory of the variometer record and experience in precision maneuvers. To obtain a good memory a logical tool to utilize might be a recorder which plots a continuous trace of the variometer reading, within easy view of the pilot, with about 100 seconds of the record visible at one time. With judicious use of a pilot-operated event marker on the recorder to show the sailplane is entering a cloud or on the north edge of a spiral, this recorder can greatly assist the pilot in determining the thermal structure without lost motion. Even without a recorder it is not difficult to remember the readings at the four cardinal points during circling flight, so as to estimate the direction to the thermal center.

There is a large variety of useful precision maneuvers which the pilot can compute and practice in calm conditions. Most would involve tight precision turns, at fairly low velocity, at bank angles of 30-45°, for strong, sharp thermals — and even a wingover or Immelmann may be optimum for a fast efficient direction change. For large thermals more intricate probings would be appropriate. For example, with an 18 second turning rate, and a turning radius R of about 65 meters (a 30-45° bank), a 270° turn to the left then a 90° turn to the right brings you back along the original flight line about 18 seconds after you start the maneuver, meeting the original line a distance 2 R back. For setting up a parallel reverse course, a 180°

A gopher's view of Dick Bush's Briegleb BG-12A sailplane set to roll with take-off flap deflection at Skylark Field, Elsinore, Calif.

Photo by George Uveges