# EXPLORATIONS WITH THE THERMAL SNOOPER


## by Rick Masters

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**It has been a great privilege for me to have been so deeply involved in testing the first prototypes of what is unquestionably the most significant development in soaring instruments since the advent of the variometer. This article is my way of expressing my gratitude to Alan Fisher for the dramatic improvements the Thermal Snooper has made in my personal flying ability, and for expanding the horizons of all soaring pilots, regardless of the type of aircraft they may fly.**

The serenity of the summer sky is an illusion.

If suddenly, by magic, we could see the movements and shapes defined by the temperature and pressure interfaces of different segments of air, we would find ourselves in a bizarre theater more alien than any distant planet. And we would be well on the way to deciphering the enigma of meteorology.

Unfortunately, masked by its own transparency, the sky gives hints to its nature only by its effects on other things. We are left to theorize what action of the air caused a cloud to form, established a lenticular above a mountain range, carried an eagle to cloud base, formed a destructive tornado, or brought a drought to Africa.

As soaring pilots, we are constantly challenged to visualize the most efficient aerial pathway to altitude and distance. In this quest we employ various tools, most notably: the variometer. This instrument measures the rate of change in atmospheric pressure. Its sister instrument the altimeter measures the change in pressure.

Virtually all soaring pilots rely primarily on pressure-sensitive instruments to aid their understanding of an energetic and constantly changing atmosphere. This seems perfectly normal until one considers that the prime mover - the originator and force behind atmospheric dynamics - is not pressure.

It is temperature.

How would a temperature-sensitive instrument be used in soaring? This question has intrigued several researchers. The first significant experiments were made in the 1960s with sailplanes. A new development in solid-state electronics was the "thermistor," a device that varied electrical resistance with minute changes in temperature. By mounting a thermistor on each wingtip, the researchers reasoned, it would be a simple matter to turn in the direction of the warmer thermistor to locate a thermal. Unfortunately, in practice this was not effective.

There were several problems. The speed of the sailplane and the extended response time of the early thermistors conspired to provide essentially useless data. The distance between wingtips did not seem to be great enough to generate a reliable temperature difference. And sinking into warmer air or rising into cooler air wrought havoc with all attempts of measurement.

But even if these problems had been overcome, the basic premise dictated that the thermal have a relatively laminar temperature gradient from periphery to core. If this is not the case - if, for instance, thermals shed pockets of warm air which separate beyond wingspan distances as they rise - then the concept of thermal location using wingtip sensors is flawed.

## MY QUEST FOR A TEMPERATURE VARIOMETER

In 1984 I was fascinated to discover that the world's most accomplished cross country hang glider pilot, Larry Tudor, was sensitive to small changes in the temperature of the air he felt on his face. Sensing small increments in temperature, he frequently tracked warm bands of lift along the crest of shears. Could the ability to sense these small changes in temperature be a factor in Tudor's consistently stunning performances? I was determined to find out.

My own ability to feel small variations in temperature is rather limited. I tried flying with thermometers, but even the most sensitive were too slow in response to allow me to develop a strategy that offered any indication of positive results. What I needed was a very fast rate-of-change thermometer that functioned much like an audio variometer.

Unfortunately, such an instrument didn't exist. And despite my training in Mechanical Engineering, I did not have the electronic expertise to develop one. In October 1984 I wrote to a prominent hang gliding instrument designer hoping to stimulate his interest in a development project:

"In my discussions with Tudor and other leading pilots, I have found that significant decisions concerning proximity to thermals and orientation of shear lines are made on the basis of perceived temperature increase. With our slow speed, we can determine the differential with a 180-degree turn, possibly obtaining a superior measurement than possible with a sailplane...

"I am greatly interested in doing whatever I can to help develop such a device by doing flight tests in the Owens Valley. Contrary to popular belief, thermal conditions exist year round in the Owens Valley and the nearby launches are seldom closed by snow."

Although the idea was received with interest, I was told the costs involved for developing a prototype and the time constraints of other ongoing projects, not to mention that such an instrument would probably appeal to a very small market, would tend to keep any research on the back burner. So for a year and a half, the idea remained nothing but a remote yet tantalizing prospect. Then in May 1986 I was utterly astounded to come across an article in the June issue of "Whole Air Magazine" titled "The Thermal Snooper" by Alan and Jeff Fisher!

## THE THERMAL SNOOPER

Alan Fisher lives in Huntsville, Alabama, where NASA has its Marshal Space Flight Center. Much of his career was spent designing special radio equipment for the early scientific satellites, including those that mapped the Van Allen radiation belt. Today, as the owner of Digi-log Circuits, he manufactures a magnetic card reader. And when he can find the time, he pursues other projects he describes as "interesting and worthwhile."

When his son Jeff began hang gliding, the need for an instrument that indicated lift became apparent to Alan. Not being a pilot himself, he was not inhibited by the conventional logic that would have led to the building of a form of barometric variometer. Instead, he chose a fresh approach.

"Air rises primarily because it is warmer than the surrounding air," he reasoned in the article. "That is clearly the case for thermals. And even though wind movement rather than air temperature is the prime cause of ridge lift, that air is also likely warmer because it has been deflected from a lower level. Therefore an indicator of subtle increases in airstream temperature might well alert a pilot to nearby lift and greatly assist him in finding, and remaining, in its warmest core."

With this simple concept in mind, Alan designed his first temperature variometer. He knew nothing about previous attempts along similar lines other than having heard a rumor that a hang glider pilot somewhere had found his own temperature sensitive instrument to be useless in flight. Undaunted, Alan created a prototype unit for Jeff, who eagerly headed off to his local flying site.

Unfortunately, the first Thermal Snooper proved useless in flight.

But Alan was certain his concept was solid. The glass bead thermistors that nestled under their protective shield were definitely capable of measuring the small temperature changes required. The instrument simply needed tuning. Further adjustments were needed in sensitivity, time lag, lapse rate dampening, and more esoteric technical aspects of the design. He doggedly kept at it. And by the third model, Jeff began getting positive results.

In November 1985 Jeff entered a weekend cross country competition at Walker's Gap, Alabama. He was the only pilot without a variometer. Yet, with only 50 hours of flying experience, he placed third.

In the article, he expressed his excitement over the Thermal Snooper's potential:

"I was amazed to hear its pitch rise seconds before feeling any indications of a thermal ahead. And once within a thermal, it warned me if I circled too close to the edge. The first thermal indicated took me to 1500 feet above launch. I was able to track its movement all the way up.

"Whenever I had to revert to ridge lift to maintain [altitude], the device then distinguished between gusts and thermals. I was now no longer wasting turns to work what I otherwise might have thought to be a thermal."

Alan had succeeded in developing an instrument that promised incredible gains in soaring efficiency. And I was particularly impressed by the Thermal Snooper having changed Jeff's concept of a thermal.

"I always imagined that the effects of a thermal stopped at the sink-to-lift boundary," he wrote. "It surprised me to realize that air significantly outside the shear action is detectably heated."

I had not suspected this, either. I wondered how many other readers had realized the implications. If true, it would have a tremendous impact on the future of cross country soaring because it would expand our ability to sense thermals, resulting in longer flights. Alan's Thermal Snooper was the instrument I had been yearning for. I had to get my hands on one. Like the vario, it promised to serve as another pair of eyes that would see beyond the limitations of my own. Perhaps by joining vario, Thermal Snooper, and intellect, the mystery of the sky would unfold as never before.

I drafted a letter to Alan offering to conduct a flight testing program for the Thermal Snooper in Owens Valley. I included a copy of my film AOLI COMET CLONES AND POD PEOPLE to demonstrate the conditions that exist in the Owens and, I assured him, persist throughout the year on a lesser level. I was confident there was no better place in the northern hemisphere for winter testing.

Sure enough, the Thermal Snooper arrived in Owens Valley in late September 1986. It was nothing but a small circuit board, the components coated with a thick layer of cream-colored epoxy to protect against the elements. Attached to the board was a nine-volt battery, a crystal-driven (piezoelectric) speaker, and a curving shell of copper which protected the tiny, exposed thermistors from sunlight and abuse. It looked more like a hunk of candy than a soaring instrument.

I snapped the battery into place and the Snooper immediately started beeping much like a Litek vario I'd once owned. After a few minutes the circuits normalized and it quieted down. Alan claimed that it "beeped" once for each fractional rise in temperature, and "booped" once for each fractional decrease.

I held my finger near the thermistors. The Snooper began "beeping" happily. A big grin formed on my face and wouldn't go away.

## EXPLORATIONS WITH THE THERMAL SNOOPER

Fall had come to the Owens Valley, bringing the smooth north winds and the big, lazy thermals that would quietly disappear at the level of the highest peaks. It was a time to relax, a time to come down from the intense highs of the cross country season and again enjoy flying for flying's sake. The advanced pilots had gone home, burned out, sated. The intermediates worked the ridge lift of their local hills and longed for the next summer to hone their thermalling skills. Some day they would discover the Owens Valley in the Fall and Spring. But for now, as always this time of year, I was alone.

The peak I favor in Fall is Mazourka. It stands out from the northern Inyos in the path of the valley winds. In the summer, long and shallow Santa Rita Canyon gathers the south wind and guides it to the summit. It was at the head of this canyon I had located the 1984, and part of the 1985, Owens Valley XC competitions. But in the Fall and Spring, the north wind collides with Mazourka, rushing up its steeply cascading flank to offer thermal-rich ridge lift, while ten miles to the north Tinnemaha Reservoir indicates the wind strength and direction in the valley.

From the summit at 9140 MSL (measured from [Mean] Sea Level) the view is inspiring - all the more so because Mazourka is the only mountain launch in Owens Valley to offer an unobstructed view in all directions. Just east of Mazourka, the main spine of the 11,000+ MSL Inyo Range marches north to descend into the rolling hills of Westgard Pass, then rises again as the great White Mountains. Westward, the raw granite spires of the Sierra Nevada rear from the valley floor to form an unbroken wall, reaching over 14,000 feet. Between these awesome ranges the boulder-strewn alluvium, pockmarked by magenta cinder cones and scarred with tortured fields of dark lava, is cut by narrow, brush-choked streams that gurgle from every canyon only to be seized by the Los Angeles Aqueduct, leaving the meandering Owens River to struggle pitifully southward alone in a futile attempt to moisten the red eye of Owens Dry Lake.

The day was extraordinary. A broken cloud street of the classic type with flat-bottomed, underdeveloped cumulus had established itself along 100 miles of the Inyo-White range. Cloud base beckoned a mile above Mazourka. Across the valley, the crest of the Sierra was laced with a narrow and continuous band of cloud. Only the tallest snowcapped peaks pierced the cloud tops.

At the north launch point on Mazourka summit the wind was light to moderate (5 to 15 mph), driven from the north but veering due to thermal cycles, resulting in a predominant northeast wind with an occasional west. But every few minutes the wind would straighten and hold north, the optimum direction for launch, for 20 seconds or longer. Several gaggles of ravens and hawks, the lords of Mazourka, drifted on thermals above me. I decided to set up.

The glider I'd chosen for this flight was a Pacific Wings *Express* "Racer," a fast European design that had carried me 178 miles great circle distance from Horseshoe earlier in the season.[1] My hook-in weight of 215 pounds resulted in a wing loading of nearly 2 pounds per square foot, and therefore demanded an aggressive thermalling technique with tight turns centering the core for effective altitude gains. Because of this, I felt the Express would be ideal for testing the Thermal Snooper.

I clamped the Snooper to my instrument mount and turned it on. It's "beeps" and "boops" were easily discernible from the "chirps" and "buzzes" of my variometer. I assumed the Snooper would quiet down after the circuits normalized - but it didn't. That was my first surprise.

[1] the ninth-longest hang glider flight ever made.

Instead of remaining silent like my vario, the Snooper was giving me a running commentary about the quality of thermal cycles rolling through launch. When a freshening breeze began to tease the first flag 100 feet down the mountainside, it would begin to "beep" hesitantly. Then as the nearer flags became agitated, the "beeps" would increase excitedly. If the thermal was centered and all the flags stood out from the north, the Snooper would fall silent. But when the flags skewed off to the east or west as a thermal passed to the side, the Snooper would immediately follow its "beeps" with a series of low "boops."

Fascinated, I stood at takeoff for 20 minutes. For each cycle that passed through, the Snooper gave an indication of its size by the duration and frequency of its "beeping." A few "beeps" meant a small, short-lived thermal. Many "beeps" told of the arrival of a large thermal. At some point during each thermal's passing, the Snooper would begin to "boop" - a few "boops" for small thermals, many "boops" for large thermals. It was obvious that these "boops" warned of the "downside" of the thermal's cycle.

Years of observation have led me to attribute the majority of takeoff accidents in thermal conditions to pilots launching into the tail end, or down-side, of thermal cycles. It took a lot of practice to read thermals accurately, and some pilots just never became adept at it. Now here I was with a tiny instrument clearly identifying both the up and down sides of each cycle! I was impressed. Even if the Thermal Snooper didn't do anything else, it promised to make mountain flying a lot safer.

But surely, if it could read thermals on the ground, it could read them in the air. I eagerly shouldered the *Express*. When the Snooper announced another large cycle, I was airborne by my fourth step. The air was straight, smooth, and lifting. The vario began "chirping." The Snooper fell silent.

When I am first to launch, I never attempt to work the occasionally treacherous takeoff thermal. It has never proved necessary for me in the Owens because there is always another just as good nearby. So I flew fast and straight away from launch - and out of the thermal lift. The vario went silent and the Snooper began to "boop" just like it had on the ground during a down-cycle. With the gentle ridge lift helping sustain me, I turned to seek out the resident "thermal snake" on the knife-edged western shoulder of Mazourka Peak.

As usual, it was there. But the Snooper started beeping just as the glider encountered a bit of sink prior to the lift. "Odd," I thought, "that the vario would register sink and the Snooper a thermal, simultaneously..." Then the vario started screaming. I banked up the Express and centered in 600 fpm (Foot Per Minute) lift. And the Snooper quieted down to nothing.

I deliberately left the "snake" at 11,000 MSL, knowing I could return at any time. The Snooper "booped" as I flew out, then became silent as I turned upwind of the ridge in search of a random thermal. I'd lost 1000 feet when the Snooper began "beeping." The vario, however, continued to indicate the 150 fpm sink rate the *Express* averaged in glide. After ten seconds or so, the Snooper "booped" a few times and fell silent. The vario remained unchanged.

"I must have passed by a thermal" I thought. "A thermal far enough away that my vario couldn’t sense it, but close enough that the Snooper could!"

Eager to give the theory a try, I sent the *Express* into a thermal search pattern. I began with an evenly-banked 270 degree turn. Finding nothing, I rolled out, wings level, and prepared to cross my previous path to repeat the turn on the other side. But almost immediately the Snooper began to "beep." After a few seconds more, the vario "chirped" and a wingtip lifted. I count to three, then threw the Express into a climbing turn. The Snooper quieted down as I centered the core, and the vario sang 600 fpm up.

I left the thermal and searched out many others. Each time, the Snooper would alert me to the presence of a thermal long before the vario. If the Snooper kept "beeping," I would run right into the thermal. If the Snooper stopped "beeping," I would execute a search pattern. I only guessed the correct direction to turn about half the time, but a thermal was always waiting somewhere along the search pattern. I was amazed that every time the Snooper sang out a series of "beeps," I found a thermal - regardless of what the variometer indicated. And I was finding thermals that, without the Snooper, I would simply have passed by, never even suspecting their existence.

The implications were tremendous.

"Wow!" I thought. "This thing is going to boost the average cross country flight by a whole bunch of miles!"

I rode the last thermal in this series to cloud base at 14,500 MSL and headed southward in a light mist of ice particles. The cloud was not generating lift, however, and I began losing altitude at 100 fpm. The Snooper "beeped" constantly at a slow, steady rate. It was registering the rate of change in temperature as I descended into warmer air. This lapse rate sensitivity hampered its ability to sense thermals, but I found one with my vario over Mazourka Canyon with 10,000 MSL.

This thermal was the roughest I'd encountered. It kicked me out, sending the vario and Snooper into paroxysms of "buzzing" and "booping" during the dive. The dive was so wild that upon recovery, I didn't know which direction to go. I initiated a wide, sweeping, turn, hoping to stumble back into it, but the Snooper began "beeping" so I rolled out and hit the thermal dead-center. It felt broken up and multi-cored. The vario wouldn't give me a steady reading because pockets of sink were mixed in with 1000 fpm up. The Snooper, likewise, was constantly "beeping" and "booping." I kept searching for a core I could work and was rewarded by the Snooper quieting down a bit. I remained in this area, for although the air felt almost exactly the same, the average lift indicated by the altimeter was much improved.

My favorite challenge in Fall and Spring north wind conditions is to try to cross the area of rotorless sink that exists for a few miles south of Mazourka Peak by riding a thermal onto the crest of the Inyos. Once there, it is often possible to make a 20-mile out and return along this steeply rising range. With this hope in mind, I left the broken thermal and, encountering only light sink at higher altitude, reached the crest 11 miles south of Mazourka with a healthy 12,000 MSL. At this point, I discovered another function of the Thermal Snooper.

I was hoping to find a "thermal snake" leaning downwind of a north-facing peak. On a good day, the ridges that descend from the spine scoop up the north wind, turn it eastward, and herd the thermals into the mountain where they blend into continuous ascending streams. Unlike the Sierra, where these tend to exit high ridge points far out from the peaks, the terrain of the Inyos leads the streams to the very crest. So I was envisioning a highway of "thermal snakes" waving like sea grass in current along the crest - when the vario chirped.

I banked up the Express to enter the thermal and was rewarded with a physical sensation of vertical acceleration. But not until I was halfway through the turn did I notice that the Snooper had remained silent.

"What's this?" I wondered. "Has the Snooper stopped working?"

At that moment the glider dropped into strong sink. I continued the turn, hit lift again, and again passed into sink. The altimeter told me I had lost 200 feet in each "360." The Snooper's silence continued.

I flew southward and hit more lift. Again, the Snooper was silent. But this time, instead of turning, I slowed the glider until the lift diminished, then sped up, anticipating sink. Sure enough, it was there, stronger than before.

"These aren't thermals. They're eddies!" I realized, remembering how Jeff Fisher had encountered the same phenomenon at Walker's Gap. Because eddies are constant in temperature, unlike thermals, the Snooper remained silent passing through them - while the vario registered their effect. By its very silence, the Snooper was providing me with information just as valuable as any gleaned from the sounds it made. I was gradually becoming more proficient in interpreting its functions: "Beeps," "boops," rate of each, and for cores - and now for eddies - silence.

I've encountered eddies on virtually every cross country flight of my 3400 miles of accumulated straight line distance in and from Owens Valley. But thanks to the Thermal Snooper, I won't be fooled anymore. I was beginning to get an idea of what a powerful tool the Snooper could be. All these inefficiencies it helped to eliminate were quickly adding up to big gains in cross country performance!

The sink was growing worse with every foot I lost. I began to notice a growing headwind from the east, out of Saline Valley. I tried to find a thermal rolling up the east face of the range, but I was running out of altitude fast. When my flying wires jerked in the growing turbulence, I pulled in the speed bar and sped westward, away from the Inyos. Although a few pilots have made a leeside run of these mountains, it is not the type of flying I enjoy. Thermal turbulence can make me shout with exhilaration, but lee turbulence is inherently dangerous and I tend to distance myself from it.

The tailwind really allowed me to cover ground during my "escape." Strangely, the Snooper did not "boop" very enthusiastically during this descent. I assumed the easterly wind was flowing over the crest and down the west face, feeding cooler air to the lower altitudes. After a four mile glide, I turned north with 2800 AGL (Above Ground Level) to investigate the southern foothills of Mazourka. This area often provides thermal lift regardless of wind direction, but what I found there exceeded my expectations.

The wind was out of the north again at 2500 AGL. I was penetrating at five to ten mph ground speed with a 150 fpm sink rate. But as I approached the first foothills, where the great wedge of Mazourka begins its long climb northward from the valley floor, my sink rate dropped to zero in glass smooth air.

Something unusual was going on. As I continued north against the wind for one, two, then three miles, I realized I was in a shear.

I couldn't believe my luck; to have encountered a shear on my first flight with the Thermal Snooper! I was very excited. I began a series of long-legged S-turns. The Snooper never "beeped," but when I headed too far away from Mazourka or approached too closely to its rising flank, the Snooper would give out a solitary "boop." Between these "boop" points, I located the crest of the shear. Slowing down, I soared against the wind in 50 fpm lift for six miles. Then, as I rose above the altitude of Mazourka Peak, the shear disintegrated.

I returned along the shear to its southern end, then ran north again for a few miles. I was astounded to realize that the Snooper was helping me map the shear - define its character and determine its orientation. I hadn't really expected this most esoteric of potential applications for the Snooper to actually work on the first try. But it did! Wow, was I excited! I'm still excited! Summertime shears, here I come...

By the way the shear set up, I deduced the descending easterly winds out of the Inyos had pushed underneath the warmer air flowing southward down the valley, causing it to well up and over the cooler air along Mazourka's western flank. This created an invisible ridge standing out in front of Mazourka that the Snooper magically allowed me to see.

With regret, I left the shear to search for sink. The shadows of the Sierra were halfway across the valley. Soon the sun would abandon the Inyos and the Autumn cold would set in. It was time to find my motorcycle and retrieve my van from the peak. I spiraled down and set up a landing approach. It was in these final moments that the Snooper surprised me again.

It had been "booping" occasionally during my descent, but at 20 feet it started "beeping" excitedly.

"Oh no! I'm flying into a thermal that's breaking off!" I thought, sucking in the bar. But it wasn't a thermal, it was dead air. My 20 mph headwind suddenly vanished. Severe wind gradient. I hadn't expected it. The presence of the shear and the lateness of the day had suckered me into thinking the wind would be blowing all the way to the ground. But the Snooper had sensed the warm, still air hugging the desert floor and warned me. My extra speed had prevented a low-altitude stall and allowed a good landing.

I sent Alan Fisher a report of the flight. He, too, was excited and encouraged by all the additional applications that were being discovered for rapid descent. Over the following months Alan sent me several different versions of the device in attempts to overcome the lapse rate sensitivity problem without degrading its performance.

## FURTHER EXPLORATIONS

In November I'd been playing around in light thermal lift over Santa Rita Flats with a friend who was soaring a 1939 Piper with the engine off. When he headed out, I resumed the downwind leg to my motorcycle, parked ten miles south of Mazourka's summit. Halfway there the lift faded. I found myself at 400 feet AGL searching for lift along the line of abruptly falling hills on Mazourka's western flank.

I'd grown quite used to the Snooper by now. I no longer regarded it as an instrument separate from my vario. Instead, the vario was now a complete instrument operating on principles of temperature and pressure - as seemed perfectly logical. Indeed, what seemed illogical was the fact that the soaring community had relied for generations on an incomplete device!

As I ran the ridge southwards, the Snooper would tend to get excited in the most promising areas. I'd slow down, then, and hunt around, happy to find zero sink to simply extend my glide. After a passing above a series of mashed-up, crosswind hummocks that offered little potential in the way of lift, I came to a prominent descending ridgeline that formed a bowl to the north wind. Confident of finding lift there, I cut a path along its face. The Snooper "beeped" agitatedly but there was no lift.

"Strange," I thought. "Why would the Snooper go off when there's no lift?"

I became suddenly uncomfortable without knowing why. I moved away from the ridge and sped up a bit. The Snooper continued to "beep" quickly. The hairs on the back of my neck stood up. Then, as I flew past the falling crest of the ridge, heading west into the valley, the rotor hit me. It threw the *Express* into a snap-roll to the left, hurling me toward the rocks. I stuffed the bar to my knees and countered with a roll to the right, clearing the ridge with several wingspans to spare. Later, it bothered me to realize that I would have passed much closer to the ridge if I'd not had the Snooper, thinking that the wind had died *when in fact it had actually reversed direction and strengthened* while I'd been working the lee, unsuspecting.

What had happened to trigger the Snooper? I surmised that the new south wind had placed a "cap" over the leeside pocket. Trapped in the sunlight, it had heated up with nowhere to go. Then, of course, I flew into it.

By March the snooper had evolved into a compact hunk of epoxy about half the size of a pack of cigarettes, looking utterly indestructible apart from the fragile, shielded thermistors. Alan had solved the problem of its beeping when rapidly descending into warmer air with some circuit design wizardry that was totally beyond my comprehension. Now the choice for this summer's production run had narrowed down to two nearly identical units, both of which I was flying with. Alan said they differed only in response time, but one became my favorite and was chosen for production.

One afternoon I left Mazourka with 12,000 MSL and reached the Inyos only to discover the easterlies flowing down-slope. I flew out into the valley but found no lift. Two miles from my motorcycle, I was down to 300 feet. Not wishing to walk, I concentrated on the Snooper's occasional beeping to circle in warmer areas of ground heat. Although my variometer was indicating nothing but zero sink, after a series of 360s I would find myself 30 feet or so higher. Gaining what little I could, I would head north and repeat the turns the next time the Snooper "beeped."

I lost 200 feet during the first mile and completed the second with only 100. After landing, I got a funny feeling that I could have kept going indefinitely at 100 feet! I have always admired the exceptional hang glider pilots who could do this kind of thing but I had never been particularly good at it. Now the Snooper was making it almost easy.

April 25 was a day of record high temperatures, producing summer-like flying conditions on the Sierra. I was chasing two other pilots who had left the Sierra for the Whites. But I stayed on the Sierra for a few miles farther, hoping for a big altitude gain on Mt. Tinnemaha that would allow me to cross the Owens Valley to the Whites at a point north of Black Mountain and possibly get ahead of them.

This strategy got me into trouble. For some reason the south wind turned easterly at Mt. Tinnemaha just as bad lee turbulence drove me from the mountains at a low altitude. I was unable to penetrate this wind. My options were to land in a rugged area of the alluvial fan or to find a drifting thermal, ride it across deep and narrow Big Pine Canyon and up to Coyote Flat. But if I lost the thermal between the canyon and mountain flat, I knew I could get into a desperate situation, one that would make landing on the alluvial fan look like a picnic.

Down to a few hundred feet over ugly terrain, no radio, no retrieval, no nothing - and the Snooper "beeped!" I hunted around for the thermal. It wasn't much, but at least I'd stopped sinking. I drifted on the weird wind over nasty Big Pine Canyon, trying to find the core where the Snooper would quiet down. Finally, I found it. I even started to get comfortable, climbing now at 50 fpm. Then the Snooper started "booping" on one side of my circles. I adjusted my turns, leading them more to the north, until the Snooper went silent once more. The thermal had changed direction in a wind shift. Now I was heading north.

The Snooper made it a lot easier to stay in the core as the thermal rose through different bands of wind direction. Much easier than it had ever been with just a variometer.

"Just wait until the flatland pilots get their hands on Snoopers!" I thought, drifting for 30 miles up the center of Owens Valley. "They'll go nuts!"

## NEW VISIONS

Using the large Fall and Spring thermals of Mazourka as a guide, I estimate that the Snooper senses a thermal at twice the distance from the core as does the variometer. This distance decreases as the power of the thermal increases. In the 2000 fpm thermals I encountered on the Sierra in late April 1987, the Snooper led the vario by only a second. Perhaps the speed of a rapidly ascending thermal prevents the parcels of heated air shed by the thermal from spreading outward as easily as seems to be the case with slower thermals. Of course, in such powerful conditions the vario and Snooper become much less important to the pilot than in weak conditions.

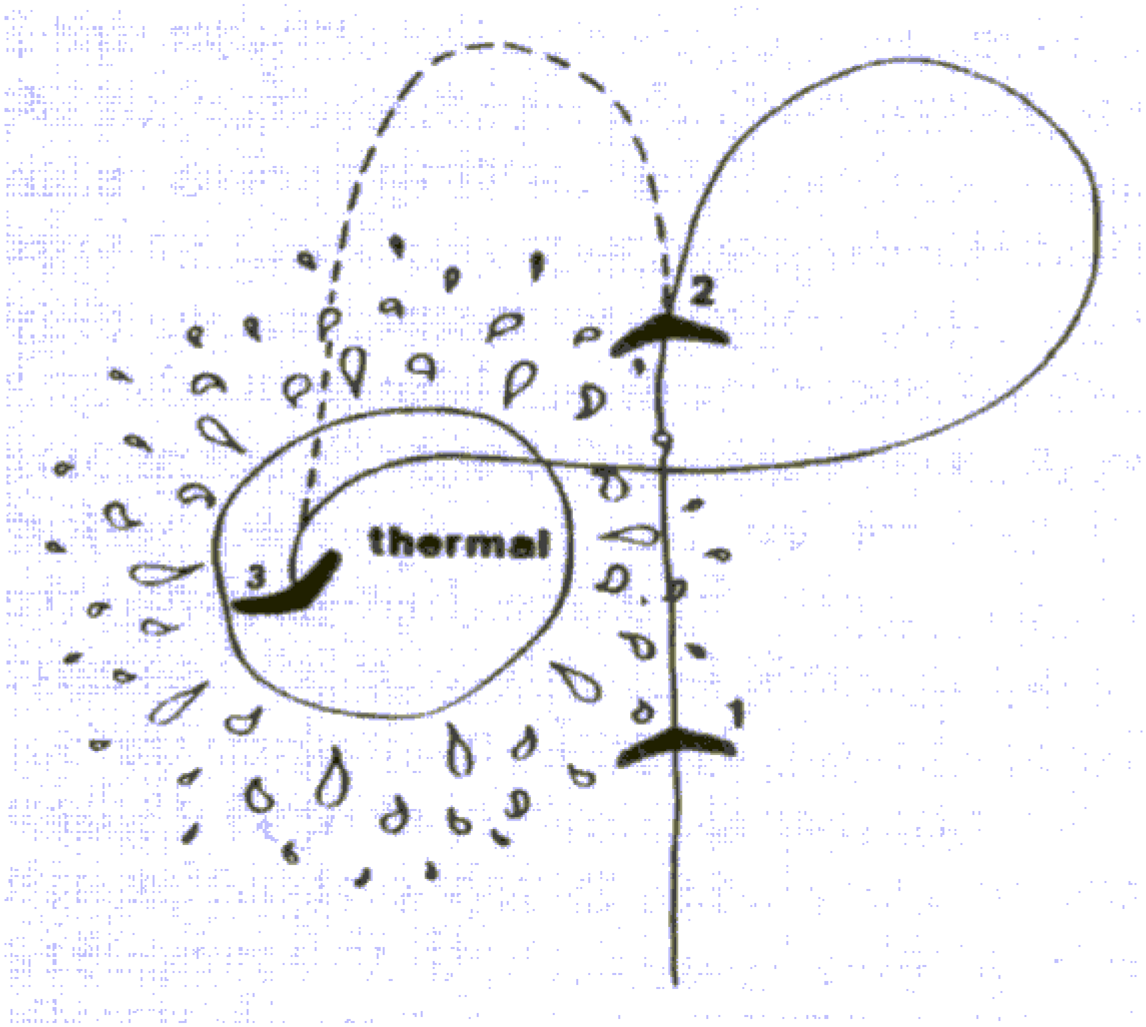
If we consider a thermal as a sphere for purposes of calculation, the Thermal Snooper increases the radius of detectability by a factor of two for encounters along any horizontal line. In cross section on a horizontal plane, each thermal offers the Snooper four times the detectable area as it does the variometer. And in volume each thermal is eight times as large for the Snooper as it is for the vario. Theoretically, at the very least, a pilot skilled in the use of a Snooper should be able to detect twice as many thermals as a pilot with only a vario, although I suspect that the actual capability is much more than doubled.

Of course, thermals are not spheres. Contemporary theory envisions a rapidly rising bubble of warm air pushing its way through the relatively stable air in its path. As it passes, cooler air rushes around and below to fill in the area it has vacated: this causes sink around the thermal.

This theory was developed by observation from sailplanes. But a Thermal Snooper mounted on a hang glider traveling 20 mph suggests a slightly different picture - one that may revolutionize soaring techniques.

Imagine discrete segments of warm air from the thermal's outer layer being constantly torn away and set spinning by friction with the cooler air through which the thermal is rising. The thermal will be completely surrounded by these swirling segments of warm air and they will continue to move outward as they cool. These are what the Snooper senses. I have termed this new vision of a thermal the "sloughing thermal."

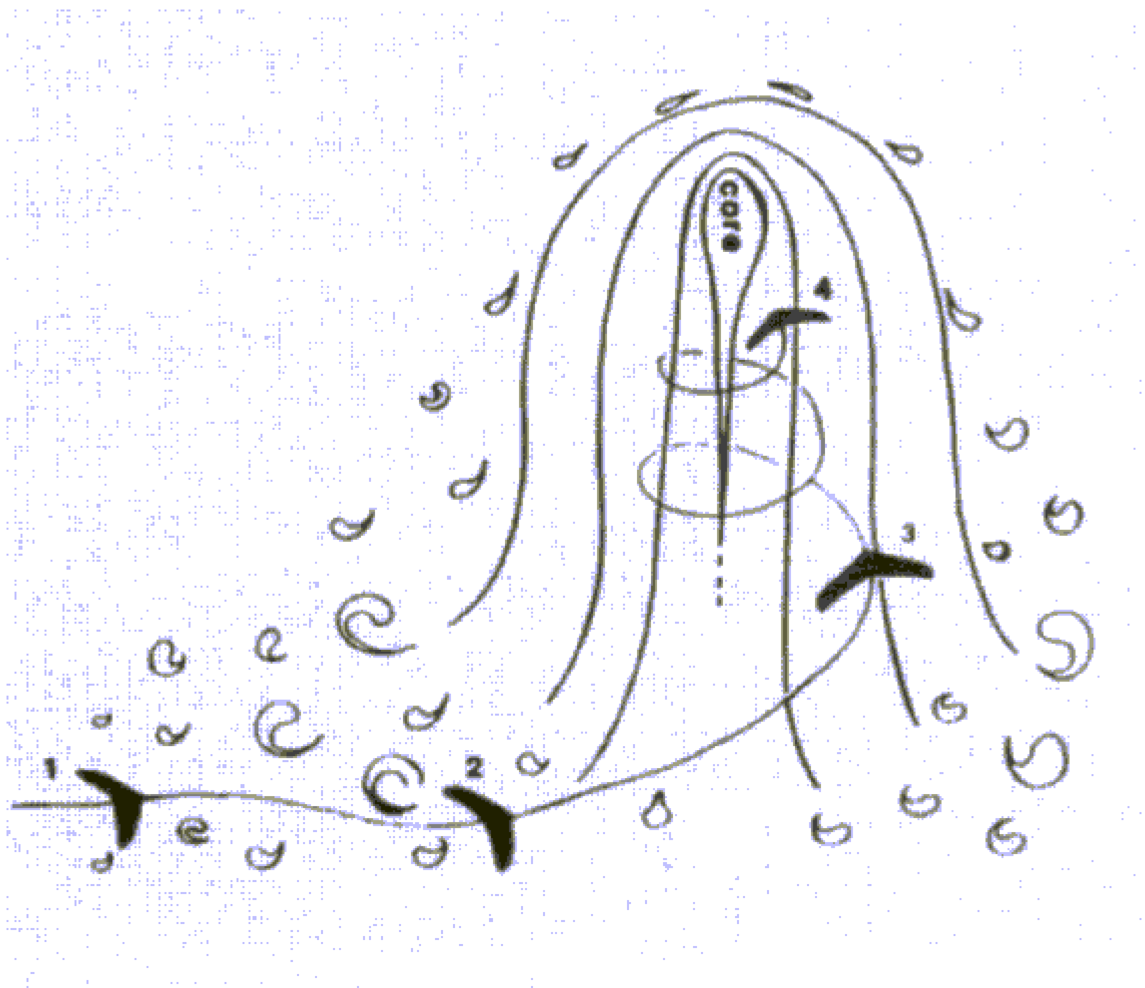
I will not be in the least surprised if the Thermal Snooper becomes a standard feature of every flight deck, be it on a Dacron or fiberglass soaring machine. What does surprise me, and continues to surprise me, are the new applications being found for the Snooper.




## FINDING THE SLOUGHING THERMAL

When using the Thermal Snooper to locate sloughing thermals, the same techniques are used as when locating thermals with a vario. The Snooper and vario work in unison, enhancing the likelihood of finding lift. Think of them as one instrument. The Snooper is the more sensitive aspect of this device. It tells you a thermal is nearby. The vario tells you when you are actually touching the thermal. It verifies your guess.

The Snooper will "beep" when it senses the warm eddies sloughed from the thermal (1). If the "beeps" stop, immediately execute a 270 degree turn that leads back to the central point of the beeping (2). Regardless of which way you choose, you will intersect the thermal. The Snooper will continue to beep as you approach the core, but the vario and tactile feedback must be employed to center it (3).




## MASTERING THE SLOUGHING THERMAL

The Thermal Snooper allows the pilot to recognize the presence of a thermal from far outside the point where his vario would register anything. First, the warm eddies are sensed (1) and the Thermal Snooper begins to "beep" while the vario remains silent. Next (2) the vario may indicate sink but the Snooper will continue beeping. Entering the ascending outer layer of the thermal (3), the vario will register lift as the Snooper continues to beep. Finally (4) when the thermal is cored, the vario registers lift but the Snooper is silent because the temperature of the core is constant.