17A

HELPFUL HINTS FOR HANDLING FIBERGLASS CLOTH

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HAVING BEEN INTERESTED in the fiberglass/foam construction for several years, I was quite anxious to try my hand at building a plane using this technique. When the Dragonfly showed up at Oshkosh in 1980, I decided that it was time to get started. It had also been seven years since I had built my BD-4 and the urge to put the hands to work was becoming overwhelming. Obviously, the tools, techniques and materials to build a glass/foam airplane are quite different from those for a basically all-metal plane. (The glass panels for the BD wing were prefabricated and only required assembling.) Consequently, I spent some time reading the articles and books on glass/foam techniques and then read and reread Bob Walters' construction manual for the Dragonfly to absorb as much information as possible before starting.

Shortly after starting construction of the new plane, I found that, although all the material I had read was well written and contained much very important and helpful information, I was finding that handling the fiberglass cloth was quite awkward and required techniques that had not been covered in the reference material. Consequently, I devoted some time and effort to try to ease the task and achieve a better looking end result.

The following items represent the various guidelines and techniques that I am now following as I continue to build the plane. I have compiled and printed them here as an aid to anyone who is planning to build a foam/glass plane or has just started. I'm sure there is nothing very new here for those of you who have already been working several months with the glass cloth because I expect you have come up with your own methods which are very similar or equally as effective. For sake of completeness, I have included some of those items that may have been covered in other references.

1. Cleanliness is of primary consideration in handling the cloth. Keep it in a dry dust-free area where you can cut and store it without getting it contaminated with dirt, sawdust and, especially, the epoxy resin. Contamination of any kind will seriously affect the strength of your structure and usually it will be impossilbe to determine that the weakness is there until it is too late.

2. You need a work table in your clean area for cutting the cloth and it should be large enough for laying out flat the largest pieces to be cut. It should be at least slightly wider than the widest piece of bidirectional cloth and at least twice as long as it is wide. A long table is very desirable because much of your cutting will be done on the bias, that is, at 45 degrees. Therefore, you will need extra length to accommodate the diagonal layout of the pieces to be cut. For example, if your cloth is 60 inches wide and you are cutting a piece that is about 24 inches wide, you will be cutting from a section of material that has to be at least $1.414 \times 60 + 24$ inches or about 9 feet long.

3. A smooth glossy or slippery work surface will greatly facilitate laying out the cloth for cutting without distorting the cloth fibers. The glass cloth snags very easily because of its loose weave and fine slick fibers. Disorientation of the fibers will also seriously affect the strength of the structure, so great care must be exercised to see that the cloth does not get snagged or pulled out of shape while it is being handled. If the cloth does get snagged, the horizontal fibers can be realigned by pulling at the selvage (edge) on the fibers that are involved. Be sure that you grasp the same group of fibers with both hands, otherwise, you will further distort the cloth. Use a snapping action several times to get the snagged fibers back in alignment. The vertical fibers can be aligned in the same manner by carefully grasping the cloth above and below the snag. You may find that it is better to do this first before realigning the horizontal fibers because pulling vertically on the cloth tends to disturb additional fibers in the horizontal direction. Pulling at the edges last will solve the problem.

4. If possible, mount your cloth stock horizontally in rolls that are free to turn on a rack located at one end of the work table so that the cloth can be unrolled directly onto the table for cutting. If the rolls are difficult to turn, do not pull directly on the end of the cloth to unroll as this will tend to distort the cloth. Assist unrolling by turning the roll itself. Carefully rewind any excess cloth after cutting.

5. Carefully smooth out the cloth on the table with your clean hands so that the fibers of the cloth are straight and parallel with the table edges. I found that a couple of foam boards, about 4 by 36 inches, are very handy in moving the large sections of cloth around the table without getting it all out of line. Place one board on the cloth near the left edge and the other near the right, and then lightly push both boards using both hands to move the cloth to the desired position. The cloth tends to stick to the foam boards so will slip easily over the smooth work surface. Often you can use the two boards to realign large sections of the cloth that happen to get pulled out of alignment. Put one board on the part of the cloth that has not been disturbed, and then use the other board to slide the other portion in the proper direction. Also placing one of the boards down on the cloth helps visually to determine the alignment of the fibers by emphasizing the "grain" of the cloth.

6. When cutting large pieces of cloth, move your rack holding the cloth rolls to the part being made and lay the cloth directly on the part to get the proper size and shape. However, if you can't move the rack (boy, the stuff is heavy!), make simple patterns from thin paper, such as newspaper or the roll paper used as throwaway tablecloths for long dinner tables. Allow adequate edge material. Use a felt marking pen to transfer the pattern to the cloth. Use scissors with long blades, not the type you usually have around the house for cutting cloth. I bought a heavy duty pair of scissors at the hardware store with 8 inch cutting edges and I find that they could be even longer to reduce the number of cutting strokes and the amount of distortion to the cut edges. Every time you make a cutting stroke, you tend to disturb more of the loose fibers at the cut edges which easily pull free during layup and become quite bothersome.

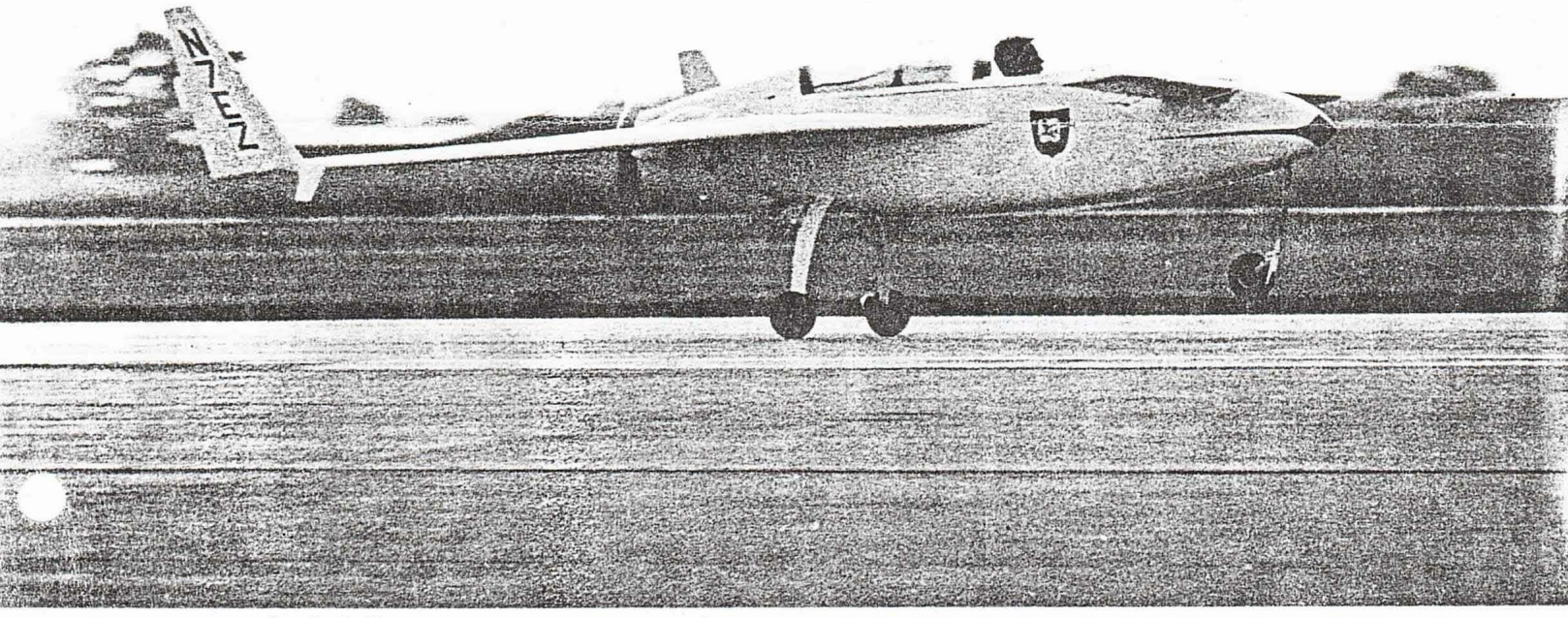
7. Cutting the tapes used to join together the various structural parts is quite tedious but can be greatly simplified. Also the final tape joints can be made to look neater. This is done by cutting the cloth between two sheets of thin paper and then carefully rolling up the cloth still between the paper for storage. Slide a large sheet of paper beneath the cloth being cut and then place another sheet on top of it and press them together. I use newspaper (taped together to get the needed length) and align the edges with the edge of the cloth. I place some weights to hold the paper in place, draw guide lines on the paper for cutting the 2, 3, 4 inch or whatever width which is required for the tapes. Then I carefully lift and squeeze the paper to hold the sandwich together as I cut the entire width of cloth. This procedure gives a very clean and straight cut and protects the tape until it is ready to be used. (Be careful so that, as you lift the sandwich to cut it, the cloth does not slide between the paper.)

8. In preparing the tape for layup, use a sheet of wax paper on which to lay the tape as you apply the resin. You will be able to get the cloth to wetout faster if you put some resin on the paper before placing the cloth on it. Lay up all the required layers of cloth on the waxpaper, thoroughly wetting out each layer as you go. Then squeegee out the excess resin. Carry the tape to where it is to be applied still on the wax paper. You can keep the cloth from pulling away with the paper by forcing the paper to fold back on itself as you pull it away. The cloth cannot bend as sharply as the paper and will stay adhered to the joint. (You will note that there is a fairly large amount of resin left on the paper. Don't throw it away; just reuse the paper for the next section of tape to be applied.) Be sure to stipple the tape using the end of a stiff brush after you have removed the paper. This will insure that all the air has been removed from the joint and a good wet bond has been formed.

I hope that you find these items to be helpful to you on your project. Good luck.

VARIEZE... FOR THE RECORD

David, I don't believe it would be possible to get a blow up of Jim's photo, but I will ask - it will be expensive



(Photo by Jack Cox)

5:55 a.m. . . . take-off run on the record flight.

By Jack Cox

5:30 IS A brutal hour in the morning for anyone to be up and about after a week of endless tramping up and down the aircraft display lines at Oshkosh. Yet, a score or so of us have summoned the strength from somewhere and now find ourselves huddled around this pale apparition of an airplane, intently watching as Bill Turner and Art Froehlich jiggle the weights right and left along the scale slides and call out:

"Left main, 399.5 pounds."

"Right main, 357.25 pounds."

"Nose gear, 169.75 pounds."

Harold Best-Devereux, the NAA/F.A.I. Official Observer for all that hopefully will transpire this day, jots down the numbers and after some quick addition, almost solemnly announces:

"That comes to 926.5 pounds, Burt. No sweat for the record."

After a few slightly puzzled looks and questions about how the weight could vary so much from a similar weigh-in two mornings before, the chatter trails off into a "What th' heck, we're still 'way below 1100 pounds", murmur. Harold's crisp British accent snaps everyone back to the matter at hand. . .

"Now, gentlemen, will you please step back – completely away from the aircraft?"

As the rest of us back off a few grudging steps, Harold strides forward, reaches deep into the rear cockpit of the Vari-Eze — behind the hulking fiber-glass auxiliary fuel tank — and starts the barograph. Then he proceeds to tape over the filler caps, affixing his initials to each with a flourish worthy of his station . . . and the occasion. Taking all this in with a slightly bemused expression on his face is pilot Dick Rutan . . . waiting calmly in the front seat, already strapped in and ready to go. Dick is the only one in the crowd who really looks like he is up to the occasion. Decked out in a powder blue turtle neck pullover, he is downright dapper as compared to the rest of us who have the disheveled appearance of a bunch of sleepy heads who have just been rousted out of bed . . . which, of course, is exactly the case.

Draped over each of Dick's shoulders are several stout strings,

each attached to some unseen object behind his seat back — plastic bags containing a couple of Baby Ruth candy bars, a package of cheese and crackers, three pull-top cans containing Beenie-Weenies, chicken gumbo and chocolate pudding, a Chap Stick, Rollaids and some aspirin and a couple of plastic bottles full of water laced with just a dash of lemon juice, ¾ of a gallon in all. One string leads to a large, empty plastic bottle.

Not exactly an Apollo life support system, but simple, effective and, most important, lightweight.

A short exchange of pleasantries between Dick and Harold ends with a groping with the canopy support rod and a lowering and locking of the plexiglass bubble through which, if all goes well, Dick's only sensory contact with the rest of us will be possible for the next 12 to 14 hours . . . except for intermittent use of his battery powered Escort 110 radio.

With brother Dick properly and officially encapsulated in the VariEze, Burt Rutan takes charge.

"O.K., let's have lots of hands under the canard and the main wing – anyplace except the control surface on the canard – and s-l-o-w-l-y ease forward off the scales and down the ramps."

Instantly, every square inch of under surface of the VariEze is cupped in the palm of someone's hand . . . attesting at once to the ol' EAA can-do spirit and the advantages of the "hard" skin of the foam and fiber-glass construction method employed in the radical little canard.

"All together, now . . . lift!"

Effortlessly, the tiny bird, its pilot and 279 pounds of gasoline are palm-powered up, forward and gently down on the taxiway . . . its first "flight" of the day a total success.

Now Burt assumes the position at the rear of the craft and addresses the Monnett VW and Ted Hendrickson prop.

"Make it hot."

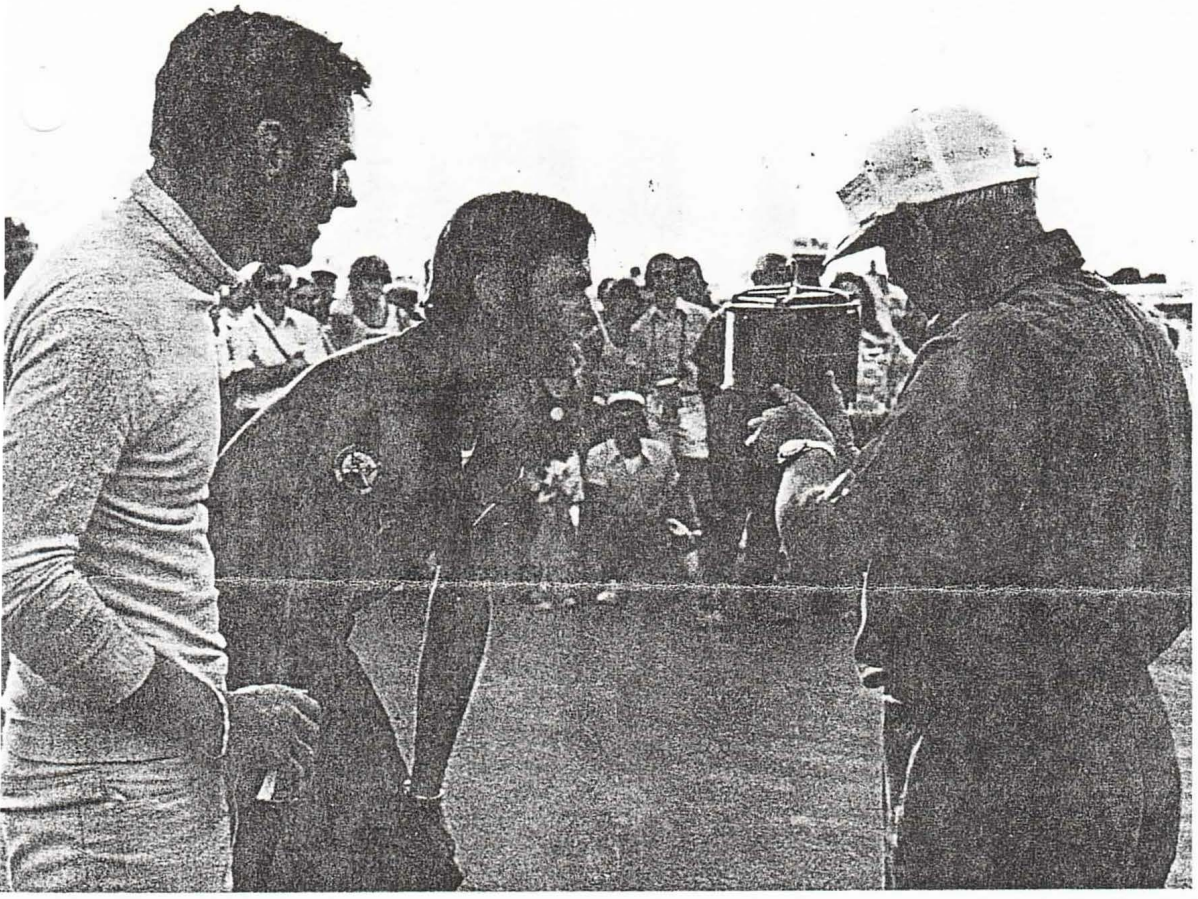
Flip . . . flip . . . flip. Come on, you little Wolfsburg prima donna — this is no time for dramatic pauses! Flip . . . flip . . . b-r-o-o-o-o-m!

"O.K., just as a precaution let's walk him out to the end of the runway. Keep the nosewheel light over the bumps and tar strips."

The leading edges of the canard and main wing lined with willing EAAers like starlings on a powerline, the rather odd looking entourage marches down the taxiway from EAA's blue arch, on to runway 18/36 and heads north toward the 18 end. It's a funny looking sight . . . for a few strides, all are in step, then one and then another get out of step, then all are in step again. Reminds me of a company of raw recruits at Boot Camp nearly 20 years ago. From the front all that can be seen are two files of shoulder-to-shoulder "troops" — no airplane is visible, just a white nose of something protruding between the two halves of the front file, a kind of silly round face with wide red lips but no eyes. When the troops did a column left on the runway, Burt and John Monnett pulled out and climbed aboard the VariViggen. Now they have fired it up and are taxiing along behind the VariEze, preparing to accompany it on the first lap of this attempt to break Ed Lesher's World's Closed Course Distance Record of 1554.297 miles set back in 1970.

As the end of the runway is neared, I turn my car around and race down towards the other end, trying to guess about where the heavily laden little canard will lift off. I guestimate the area just north of where the Florida Chapter's Lockheed Lodestar is parked as a likely spot . . . based on what I had seen on Saturday morning. Screeching to a halt, wife Golda and I bound out and start prefocusing our cameras and wondering whether the red ball that is the sun will lift up out of the low stratus hanging over Lake Winnebago to zap our lens opening settings . . . just as the VariEze comes whistling by us.

(Photo by Lee Fray)
Official certification of the scales by Vernon Erickson of the local Weights and Measures office.



(Photo by Dick Stouffer)

Dick Rutan, Burt Rutan and Harold Best-Devereux check the barograph to be sure the squiggly little line tells all. It did.

From our vantage point of about 4500 feet down the runway, we can hardly see the VariEze, so razor-like is its head-on profile. We see the "troops" move away from it and we hear the growl of the Vari-Viggen's Lycoming, but we hear nothing from the VW and can detect no movement from either aircraft.

More noise . . . and finally it appears the VariViggen is advancing, but the VariEze still appears to be stationary. Then, you can tell — it has moved. The motion seems lateral from this angle, however . . . and still no VW buzz. This almost head-on angle and the distance are tremendously deceptive.

Suddenly, the angle widens to a point where the VariEze seems to wildly accelerate and now we are frantically fumbling with the cameras . . .

"My gosh, he's going to flash right by before I can punch the shutter!"

The rest of the take-off is tightly framed in my camera's view finder. Dick is really ripping now — holding 'er down to build up speed. Just as I snap off my first shot, the nose gear is raised and on the second click I see the mains clear the pavement. Dick's Air Force training makes him a believer in airspeed above all else . . . he levels out just after lift-off and accelerates in ground effect right down to the end of the runway. Although I don't see it, I hear the VariViggen snarl by in hot pursuit of the VariEze . . . futile pursuit, it turns out, for as Dick smoothly brings up the VariEze's nose the rate of climb is far in excess of what even the new long winged VariViggen is capable. Turning inside the tiny swept-wing wonder as it arcs around to its northeasterly course gains little or nothing for Burt. I can't believe it . . . that little son-of-a-gun is carrying over 126 pounds **more** than its own empty weight, propelled by a 1700cc VW — and the 150 hp VariViggen can't even head him off at the pass!

Leveling off, Dick throttles back to his programmed rpms and begins cruising up the shore of Lake Winnebago, heading for his turn point at Menominee, Michigan. Only then can the VariViggen catch up and slide in under the VariEze for a look-see to determine if all is well in the engine compartment. In a matter of moments, the VariEze is just a speck, then nothing. The larger VariViggen appears to be alone. Finally, both have disappeared and those of us on the ground drift back toward the Control Center trailer to sit out the expected hour and twenty-five minute lapping of the Oshkosh/Menominee course. If that VW continues to purr away, we can expect to spot that unmistakable VariEze profile overhead at about 7:20 or so.

The long waits between laps provided time for reflection upon the events of the past few weeks and, particularly, the last few days leading up to this Monday morning record flight attempt. By all rights that airplane should not be in the air now . . . the engine should be on another airplane and in another city . . . and, at best, without the unflagging assistance of scores of EAAers, the VariEze would still be sitting in one of the workshops with oil drooling from its belly. The past

48 hours had been incredible . . . and undoubtedly possible only at Oshkosh during Convention week.

The plan, as stated by Burt Rutan in the July issue of *SPORT AVIATION*, was to fly the VariEze nonstop from Mojave to Oshkosh. Then an assault would be made on the Closed Course Distance Record for aircraft in the F.A.I.'s Class C-1a Group I. This is the class for the smallest of aircraft, those weighing less than 500 kilograms or 1102 pounds. Most of the records in this class belong to Ed Lesher and his super efficient little homebuilt, the Teal. It would not be an easy task to take any of them away.

Strangely enough, however, this saga did not start in Mojave . . . or even in California. It started the Saturday before Oshkosh over Elgin, Illinois, just west of Chicago. John Monnett had just circled over his house in his Sonerai I to let wife Betty know he would be home in a few minutes. In quick succession he experienced an engine stoppage, an easy glide to a nearby street adjacent to a golf course, a successful touch down . . . and a nasty ground loop after hooking the very last sign post in his path. No personal injuries, other than to his pride when he learned he had run out of fuel, but the familiar little green racer was out of it for Oshkosh '75 with crunched wingtips, main gear and aft fuselage.

Then the scene shifts to Mojave on the morning of Wednesday, July 30. Burt and Carolyn Rutan had flown east in the VariViggen a few days before, leaving his brother Dick with the task(?) of flying the VariEze to the EAA Fly-In at Oshkosh, hopefully in one big hop. The little bird had nearly 100 hours of flying time on it when Burt left and all manner of flight testing, fuel consumption tests, etc. had been accomplished. All that was left was for Major (Lt. Colonel by the time you are reading this) Richard Rutan, USAF, Field Maintenance Squadron Commander of the 355th Tactical Fighter Wing at Davis-Monthan AFB near Tucson, to get away from his duties, get up to Mojave and blast off on Wednesday. Flying non-stop to Oshkosh would be the grand entrance of all times for a new homebuilt design, Burt and Dick had figured.

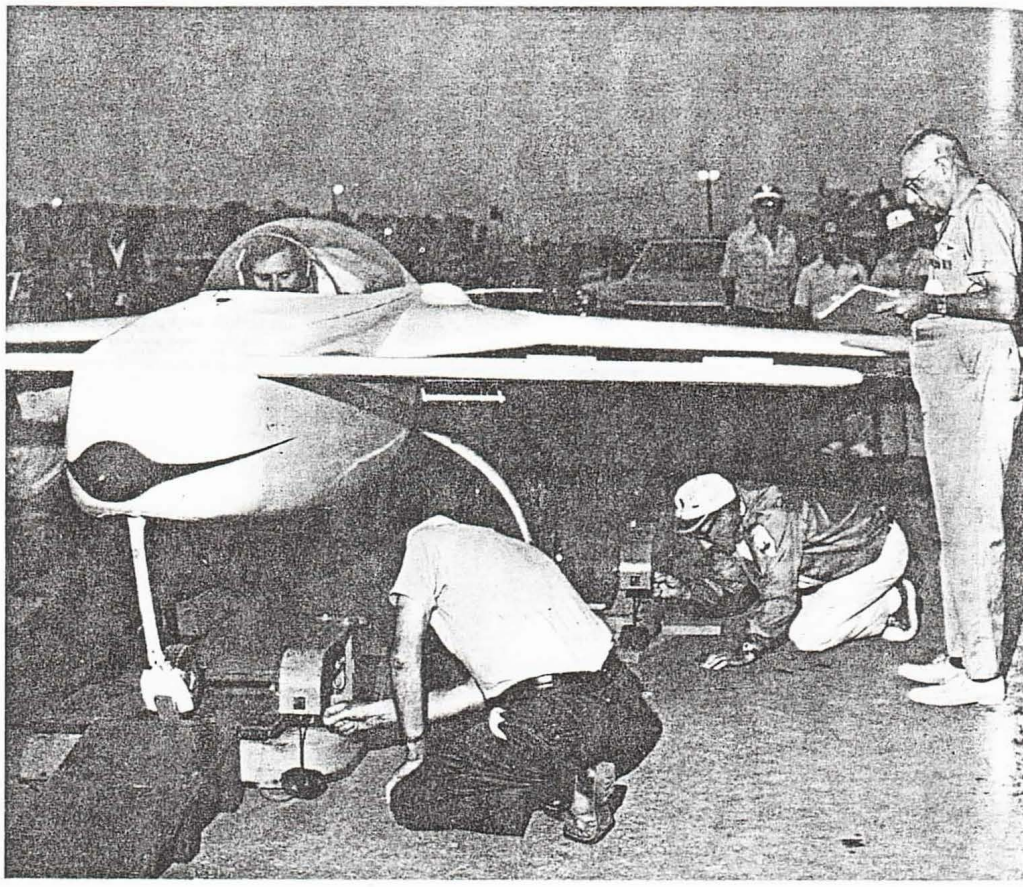
In the wee hours of morning, Howard Ginn and other local EAA types strapped Dick in and fired up the 1834cc Barker VW . . . only to have oil come gushing out of the cowling. The start-up had ruptured the oil cooler. A quick decision was made to remove the cooler, plumb the system "straight" and attempt the flight anyway. This wasted a precious hour or so but still left just enough time to make Oshkosh by sundown . . . if winds were favorable.

Taking off with nearly 50 gallons aboard, Dick climbed to 7500 feet and headed east, accompanied the first 100 miles by Howard in his T-18. The route to be flown was a gentle curve out across the Sierras, southern Nevada, through the heart of Utah, clipping the corners of Wyoming, Nebraska, South Dakota, Minnesota and, finally, a dash across the mid section of Wisconsin to Oshkosh. The course was selected partly because it overflew major Interstate highways and partly because it allowed some pressure system flying that promised tailwinds.

Settling back in the semi-supine and super-comfortable seat, Dick could see nothing ahead except clear sailing — visibility was unlimited, all the gauges were in the green and he was indeed picking up a tailwind. There was even time for a little thought of things past . . . how he had entered the Air Force in May of

(Photo by Dick Stouffer)
Harold Best-Devereux points to his seal on the fuselage tank.

(Photo by Dick Stouffer)
David Scott supervises the weigh-in for the first, unsuccessful record attempt.



1958 as a navigator and after 7 years of fingering computers and figuring ETAs had been assigned to flight training at Del Rio, Texas. Even now, high above the Rockies, a little swell of pride came from recalling he was first in his class of 400 cadets at Del Rio . . . and that this got him the thing he wanted most in the world at the time — assignment as a fighter pilot. Only two F-100 slots were awarded his class, and one was his! After gunnery school at Luke, it was off to Phu Cat, South Vietnam and combat in the F-100. Eventually, he would volunteer for a special assignment as a "Super FAC", flying 104 successful, low altitude missions over North Vietnam. Opting for several additional tours, he and his F-100F Commando Sabre would spend more hours over the North than any other combat pilot — no one has challenged his claim to this day. And then there was that 105th mission . . . checking out a new pilot . . . hit by ground fire . . . the race towards the coast with the plane streaming flaming jet fuel . . . punching out at the last moment and the hours on a life raft until the chopper arrived.

A ground speed check somewhere over Utah revealed that the tailwind was really picking up. Later checks showed that a full 45 minutes had been picked up — wow! Call a preselected FSS that Burt will call later in the day to let him know that ETA at Oshkosh will be about 20 minutes before official sunset. What luck! This called for another Life Saver from the package taped to the side of the cockpit.

Slipping back into a little rapture of the heights, Dick recalled a pleasant 4 year tour of duty in England following 'Nam . . . spoiled only by that day when he saw his F-100's oil pressure jerking back to zero in, of all spots, the last stages of an instrument approach. Seconds later he was dangling in his chute harness from a substantial English tree. Next came a tour at Wright Pat and the chance to fly almost everything in the inventory . . . most impressive? The F-111.

About this time Lady Luck turned her beneficent smile elsewhere. Over Nebraska the tailwinds became headwinds and the oil temperature began to rise. Over southwestern Minnesota the oil temperature **and the oil pressure** started shooting up. The more he stared at that oil pressure guage, the more it looked like a twitching F-100 guage that no longer seemed so long ago or very far away . . . and this time there was no ejection seat or English tree. Down there there's only . . . an airport and a Holiday Inn right beside the Interstate???

Not one to question Providence, Dick took advantage of his "gift" airport and shortly was rolling out on the runway at Worthington, Minnesota . . . after 8 hours and 50 minutes of non-stop, non-refueled flying, some 1500 miles out of Mojave. And wouldn't you know it, the first persons to run out to greet him were EAAers — they're everywhere, you know.

A check of the engine revealed nothing that could be seen, except that most of the oil had been consumed. This would explain the rise in oil temperature, but what caused the oil pressure to rise?? After replenishing the oil supply, a run-up showed everything in the green again . . . and left a nagging suspicion that in the rush to remove the oil cooler that morning, maybe the oil

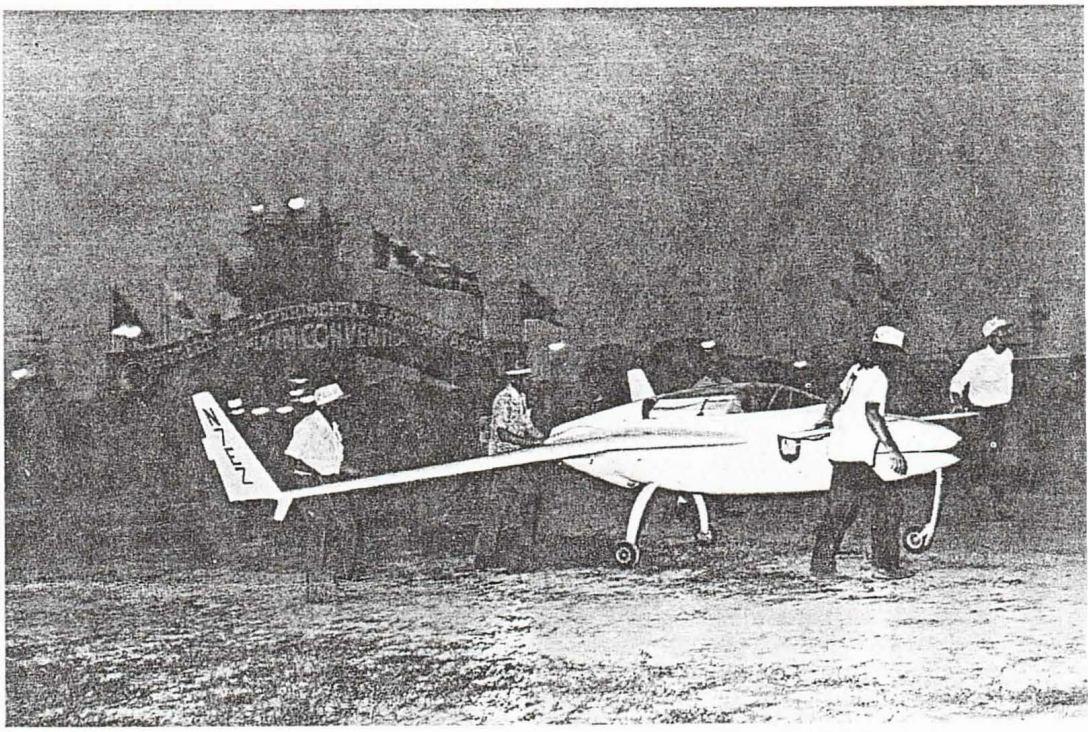
had not been topped off before take off. Better call Burt and give him the bad news.

Burt, meanwhile, had been following the progress of the flight by calling in to the FSS stations along the route that he and Dick had agreed to use as "message drops". Dick was hardly on the ground before Burt knew about it and shortly the two were talking it all over by phone. After hearing about the puzzling oil pressure reading, Burt agreed Dick had made the wise decision, sparing himself and the VariEze to fly again another day.

After a night's rest in that Holiday Inn, Dick flew on to Oshkosh the next morning . . . to the most spectacular reception an aircraft has ever received at an EAA fly-in. Several PA announcements had been made the previous day keeping everyone informed of the VariEze's progress as it winged its way across the continent, and Burt had talked briefly at the evening program detailing the problem with the oil pressure. An announcement was made Thursday morning when the tower reported the VariEze entering the pattern at Oshkosh and it appeared that everyone there was standing on the show line — just like at evening air show time — to witness the landing on runway 18 at 8:40 a.m. There was no way to taxi in through such a multitude — the tiny craft had to be walked to its already roped off parking spot beside the VariViggen. There it was to be totally surrounded by huge crowds every minute of the daylight hours that it was on the ground.

A thorough check was immediately made of the engine and nothing could be found awry. After removing the long range fuel tank from the rear cockpit, a test flight was made with this writer serving as an inadequate replacement for the weight of 35 gallons of fuel. Again, no problems. With no controls in the rear 'pit, my only impressions of the VariEze were strictly from a passenger's point of view . . . perfectly normal take-off and landing characteristics — no wild angles of attack or unusal gyrations of any sort; the absence of propeller noise; no discernible wind noise over the moderate buzz of the VW; the ability of pilot and passenger to converse at almost normal conversation levels; and very comfortable seating and tremendous visibility.

On Friday Dick took the bird out for some more flying and on landing, had to go around to avoid a slow plane rolling out long on the runway. Cranking the nose gear up and then right back down again for the second landing attempt, he apparently did not get the circulating ball system wound up to the stops — although it had felt to him it was "down and locked." On touchdown, the little panel mounted crank started spinning wildly, slowly letting the nose right down on the pavement. A layer or two of fiber-glass was ground off the nose gear leg and the bottom skin, but that was the extent of the damage. Repairs were made by Gary Morris right at the aircraft's parking spot — with a pair of scissors, a paint brush, a can of epoxy resin and strips of glass cloth. By evening, 7EZ was pronounced ready for the record attempt the following morning, Saturday, August 2.



(Photo by Dick Stouffer)
Pre-dawn roll out of the VariEze for the first record attempt.

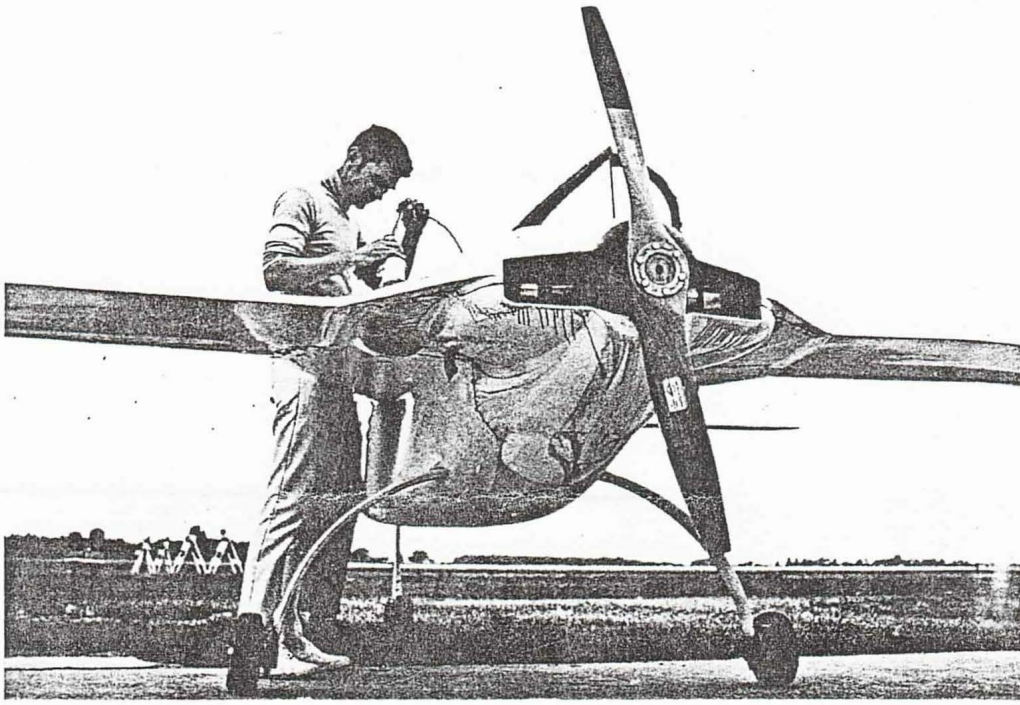
All that day frantic preparations were being made elsewhere on the field for the record attempt. Several weeks earlier, Burt had made application to NAA, the U.S. F.A.I. affiliate, for the attempt. David Scott had been designated as the official NAA observer . . . and he had much to "observe" even before the first prop was turned. A barograph had to be smoked and sealed, scales had to be certified, turn point observers on the other end of the closed course had to be lined up, communication with the Oshkosh tower had to be coordinated, etc. Fortunately, Bill Turner also became available at the conclusion of the very successful EAA Aviation Greats Day program and pitched in with the legwork. Harold Best-Devereux, who was an old hand at this sort of thing, was there whenever he was needed.

Adding to the last minute adrenalin level was the fact that the closed course was changed at the eleventh hour. All week the weather had been unseasonably hot for Wisconsin. Gulf moisture was being pumped up the back side of a titanic high pressure area stalled in the east, resulting in a really bad haze condition all over the mid-west. The original closed course was to have been from the Oshkosh Omni to the Burlington, Wisconsin Omni — but the rather featureless Wisconsin landscape would make Burlington awfully hard to find groping through the atmospheric goop. The use of omni could not be depended upon because the VariEze's radio was powered only by a primary system consisting of an 8 amp gell cell and a secondary system consisting of a 2 amp motorcycle battery. Only intermittent use would be possible because the electronic instruments were also drawing off the power supply. The Barker engine was devoid of all but mags and a carb to keep it at a spare 138 pounds. Starters and generators simply

meant less fuel, reasoned Burt. Being the Original Interstate/Railroad /Coastline Chicken Flyer, I suggested a course I have often flown: up the west shoreline of Lake Winnebago, over the freeway to the city of Green Bay and up the west shore of Green Bay to Menominee, Michigan and return — a 182 mile, no-sweat navigation run, even in marginal visibility. This met with everyone's approval . . . except now how do we find a turn point observer willing to be on duty for about 13 or 14 consecutive hours?

Ah, but this is EAA, fellows! It just happens that a new Chapter, number 535, has been formed in that area, and its president, Jim LaMalfa, is one of our fly-in photographers.

We page Jim and shortly he is on the phone to Paul Schultz, Senior Vice President of Enstrom Helicopters (and a long-time EAA member). The Enstrom plant is located right on the field . . . and the triangle formed by Menominee's three runways would make a perfect turnpoint . . . and, sure, we will be happy to help out. Almost sooner done than said.

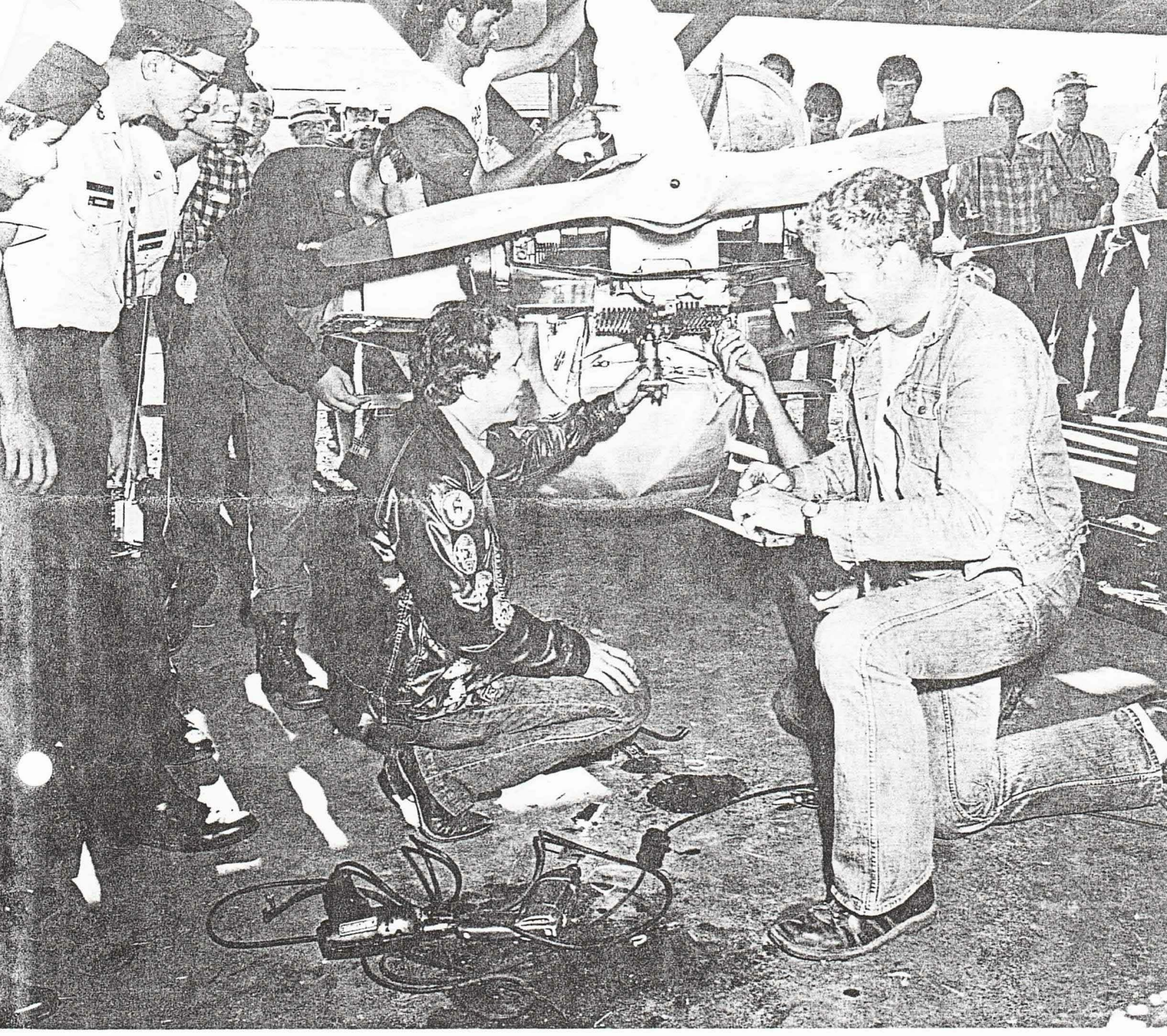


(Photo by Jack Cox)

Down and out in Green Bay . . . temporarily. Dick checks the pump can to see how much oil he had remaining. This last minute addition allowed him to make it back to the Green Bay airport after the engine dumped its normal oil supply. Dick did a tremendous job of dead-sticking the heavily laden little VariEze.

(Photo by Jack Cox)

Silhouetted against the first light of dawn, Burt Rutan reaches for the propeller to set the days events into motion.



(Photo by Lee Fray)
John Monnett, kneeling, left, and Mike Core, right, are laughing now, but 12 hours later — after working straight through the night — both were beat. They installed John's personal Sonerai I engine so a second record attempt could be made.

Now, if the weather will cooperate . . .

Saturday morning started at 4:30 A.M. for those of us involved in the launch. A quick breakfast for some of us, none for others, and it's off to the airport . . . with one eye on the somewhat low overcast, the first since the fly-in started. The weathermen say some scattered showers and maybe a thunderbumper to fly around before the day is done, but ceilings should be VFR. The weighing, sealing of the tanks and barograph, etc., proceed under the direction of David Scott and, presently, the buzz of the VW is causing heads to peep out through tent flaps in the campground.

As Dick taxied out, Burt ran by and yelled,

"Jump in the back of the VariViggen and we'll pace him the first lap. Be back on the ground here at 7:30."

I dashed for my camera and hopped in behind Burt, who already had the Lycoming turning. Taxiing out to the end of 18, we lined up behind and to the left of the VariEze and followed him down the runway . . . at a distance that left us some place to go in case he had to abort. It was difficult to see much of the VariEze's take-off from the rear 'pit, but it was long and climb wasn't initiated until a real head of steam had been built up. We were already off and climbing, but when Dick started a climb-

ing turn back to the northeast, we seemed to be settling as he zoomed up. Burt kept yelling something about how he couldn't catch up, that we were at full throttle, etc. Also, he was laughing a lot.

When Dick throttled back to 3075 rpms, we were gradually able to catch up and finally pulled alongside, indicating just over 130 mph. We then slid up under the VariEze for a look at the engine and were greeted by a chilling sight . . . a brown streak, at least two inches wide, streaming back from the air inlet all the way back to the prop hub. Oil!

Some antimated radio conversation between Burt and Dick resulted in the hopeful conclusion that perhaps the oil was merely residual spillage in the cowling — because all the instrument readings were comfortably in the green. But we would keep a close watch the remainder of the lap to determine if the streak became wider or darker.

On we speed, over Neenah, Menasha, past Appleton, over Kaukauna, up U. S. 41 to Green Bay where we can see Packer Stadium and wonder if Bart Starr is already whipping his charges into shape at this early hour. As we speed up the shore of Green Bay the overcast begins to break up and by the time we are approaching Menominee, shafts of sunlight are creating luminous, shimmering pools on the otherwise drab green surface of the Bay.

Sweeping around the easily spotted airport, we see Paul Schultz, Joe Gypp and others spreading a white sheet near the Enstrom helipad, indicating a confirmation of our pass. Burt has also received the good word via Unicom.

Turn completed, we head southwest toward Oshkosh. Sliding in under the VariEze for perhaps the tenth time, we can detect no change in the size or color of that ugly streak on its belly. As the landscape slides so rapidly beneath us, it is easy to believe our assumption that the oil is spillage . . . merely spillage.

Over the city of Green Bay, the overcast becomes solid again and as we proceed down towards the north shore of Lake Winnebago the area ahead of us darkens dramatically. By the time we are over Kaukauna and Little Chute, we are in light rain and the ceiling and ground fog that has materialized from nowhere are ominously close to what will be an illegal merger for Burt and I in the Vari-Viggen. We push on for a couple of minutes, but when the near all-white VariEze starts pulling momentary disappearing acts on us, we know we've been had. A quick call to tell Dick to follow the dual lane road south rather than following a coastline he sees to the west — that's Lake Butte Des Morts — then Burt takes full advantage of the Viggen's turn-on-a-pin-head capability and we are headed back to Green Bay airport. Somehow Dick gropes his way through to Wittman Field, gets confirmation on his turn and starts back north behind us. One lap completed.

Burt and I race the rapidly advancing line of crud back to Green Bay's Austin Straubel Field, land and dash into the FSS to see what th' heck has gotten the weather god's bowels in such an uproar. About 15 minutes later, I stepped outside into a light sprinkle and was greeted by,

"Hey, where were you guys when I needed you?"

To my utter astonishment, I turned to see Dick Rutan striding up the walk.

"Weather?"

"No, just blew the engine about 20 miles north of here. Made it back by pumping the extra oil we installed last night. Dead sticked in here."

"Dead stick . . . with all that fuel on board?"

"Had to, the oil pressure was reading zilch. Thought you guys would come running out to help . . . had to push th' little beast in to the ramp from out there in the middle of the runway."

We walked back into the FSS, turned a corner and confronted Burt. "Thunderstruck" is a pretty good adjective to describe the look on his face when he saw Dick. Out again into what had now become a light shower of rain, we trudged out to the VariEze and hunkered down to view the oil soaked belly.

All the effort, all those people at Oshkosh and Menominee who have helped out . . . and here we stand watching oil drip-dripping onto the pavement.

"Well, the weather probably would have zapped the flight anyway."

With the downpour getting worse by the minute, some kind gentleman drove out and invited us to push the VariEze into his hangar, which we gratefully accepted. Pulling off the cowling we find . . . absolutely nothing. No gaping hole in the case where a rod has smashed its way out, no ruptured hoses, nothing. More probing leads to the conclusion that the VW had spilled its oil out the number 3 cylinder, but it was impossible to say from what specific point because the entire lower side was covered with the stuff.

I suppose for some this would have been sack cloth and ashes time, but not so with Burt and Dick. Conversation immediately turned to where and how they could get a new engine and be ready to go MONDAY MORNING(!). With all the engines at Oshkosh, there's bound to be one that can be used, is the reasoning. It can be installed tonight, test flown tomorrow and be ready to go Monday morning. . . . sure, now all I have to do is run two hundred yards through this rain to the terminal, call Golda and tell her to start a search for a basic VW — try John Monnett — and, by the way, send someone after me. Burt is calling his father who will launch a trailer for the VariEze.

In your ear, adversity.

By various means, all of us got back to Oshkosh during early afternoon — in my case, two old friends from North Carolina, Swanson Poer and Roger Jennings, drove my car to pick me up since I had to get back to work. Roger had made a stab at flying up in his IFR Tailwind, but when he attempted to file, the stack up of clearances was so great that driving was quicker. Everyone was trying to get into Oshkosh that morning!

Golda had John Monnett waiting for me when I walked in the door at Press Headquarters. Sure, he had a brand new engine in his booth, ready to bolt on . . . but it was **brand new**, no run-in time, the mags would have to be timed and it had a Posa injector carb. He had a better idea. An hour or so later we caught up to Burt who had finally managed to get the

VariViggen back to Wittman Field, and right there in the middle of the busy display building floor John laid a deal on him that was impossible to refuse.

"I'll send a couple of my friends down to Chicago tonight, have them remove the engine from my pranged Sonerai, fly it back, and my crew will work all night installing it in the VariEze so you can start test flying tomorrow. With a new engine – **any** *new engine, you can't be sure what you have for the first 20-25 hours. With my engine, I* **know** *what you've got."*

The Godfather couldn't have topped that.

In late afternoon the VariEze arrived on a trailer loaned by the world's foremost airplane hauler, Molt Taylor. Burt's father and mother, George and Irene Rutan, and his Mojave sidekick Gary Morris had done the honors. Bill Chomo had the engine workshop ready for major surgery and the Monnett crew had scrubbed, laid out their tools and were ready to operate. All they needed was an engine.

After no little searching through the vast EAA grounds and not infrequent lapses into the fringes of sheer panic as darkness settled in, Sonerai builders Charlie Terry of Long Island — who just happened to have his Mooney on the field and Vance Graebner were located and immediately dispatched to Du Page County Airport to remove the engine from John's bent bird. It was after midnight when they returned with the vital organ John and Mike Core would spend the remainder of the night transplanting in the pallid body of the VariEze. (It should be pointed out that the Ted Barker engine could not be repaired or replaced because although Ted was present and had worked with Burt since the arrival of the VariEze, he had not brought another engine with him from California.)

By sunup two very weary bug doctors had completed their work and were ready to look for some breakfast and a couple of beds. Burt could handle the final closure, cleanup and bandaging. Throughout the morning the Rutans and the Monnett crew — Bob Hughes, John's father, John, Sr., and Gregg Erikson — applied the finishing touches. Finally, the moment of truth arrived. Considering the drama of the past 24 hours, it was almost disappointing when the engine simply fired right up and ran like it was supposed to . . . well, almost. It ran, but Burt was not happy with the characteristics of the Posa injector, so off with the cowling, off with the Posa and on with the Barker engine's float carburetor.. Whoops! The intake plumbing doesn't fit . . . and it's Sunday. Probably the only place in the U. S. that day with all sorts of aircraft hoses and hardware for sale was the EAA Fly-In. A scouting party soon turned up the needed bits and pieces and again the VW was fired up . . . this time to Burt's satisfaction. Within 30 hours of Dick's dead stick landing at Green Bay, the VariEze was winging its way around the fly-by pattern at Oshkosh.

(Photo by Lee Fray)
Sunday . . . back together after the engine change.

One last dollop of adrenalin remained to be squeezed out of the situation . . . after landing, Burt eased off the runway, came to a stop, shut down and climbed out to inspect the nose gear leg. The earlier fix had not been enough — a crack had developed. No big deal, however, as the repair, including an additional wrap with glass cloth, took only an hour or so. Most of that was curing time.

At dusk all that could be done had

been done, so everyone involved headed for bed. A 4:30 wake-up call would be much harder to take this time around. Come morning the same cast of characters would greet the rising sun, save for Dave Scott who would have to leave for home during the day. He had deferred to Harold Best-Devereux as NAA/F.A.I. Official Observer.

And that's how we came to where we are . . . standing around or absently walking over to look at a couple of homebuilts, waiting, watching for the VariEze to return. Then, finally, there it was . . . the VariViggen. Can't see the VariEze yet, but the "mothership" must be leading it in. Yep, there it is! What a beautiful sight!

After swinging wide around the Oshkosh tower where Harold is standing by to confirm the turn, Burt peels off and enters the landing pattern. Good sign! The VariEze must be O.K. if Burt is letting him head back for Menominee. In seconds the razor has disappeared again to the northeast.

When Burt and John taxi in, we descend upon them for word on the VariEze and they report that all seems well. Now they join the ranks of the watchers and waiters. We busy ourselves with the statistics of the first lap:

* Airborne at 5:55 A.M.
* Over Oshkosh Tower at 7:20, according to Harold Best-Devereux's watch — an hour and 25 minutes to cover 182 miles.

That's 128.5 mph and includes the climb-out from Wittman Field. Before landing, Burt has gotten fuel consumption numbers from Dick by radio and he seems concerned . . . but he isn't saying much.

"We'll see how it looks on the end of the next lap."

Lap two ended with Harold Best-Devereux's, *"Mark, 8:44."* That was one hour and 24 minutes — 130 mph.

"Too fast," says Burt.

He uses the VariViggen's radio to order a power reduction — from 3075 rpms to 3050. His brow knits a little deeper when he hears the fuel consumption figure for lap two.

More waiting. My major diversion is getting Dick Stouffer and Carl Koeling set to launch our T-34 photo plane to intercept Dick as he completes lap 3 and fly with him on lap 4, getting air-to-airs and shots of the Menominee turn point. We have also briefed Arv Olson and his co-horts in the Communications Center so they can alert everyone at the fly-in when the VariEze zips over.

"Ladies and gentlemen, the Oshkosh Tower has just established radio contact with the VariEze. If you will look to the northeast, you will soon see this aircraft completing its third lap."

That Arv is on the ball!

We all stand transfixed — watching Carl make a near head-on gunnery run on the VariEze, passing under, up and around to fall into formation with it.

What th' . . . hey . . . look, the VariEze is turning back. No . . . **No!**

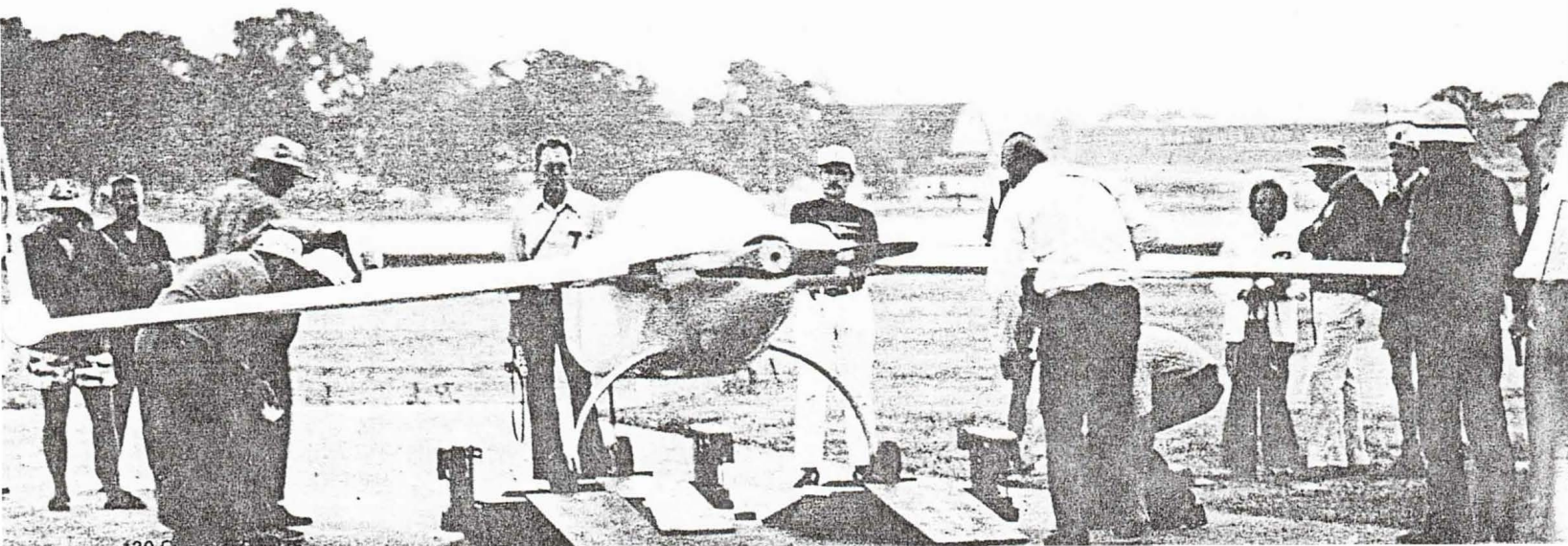
"Missed his verification!" yells Burt.

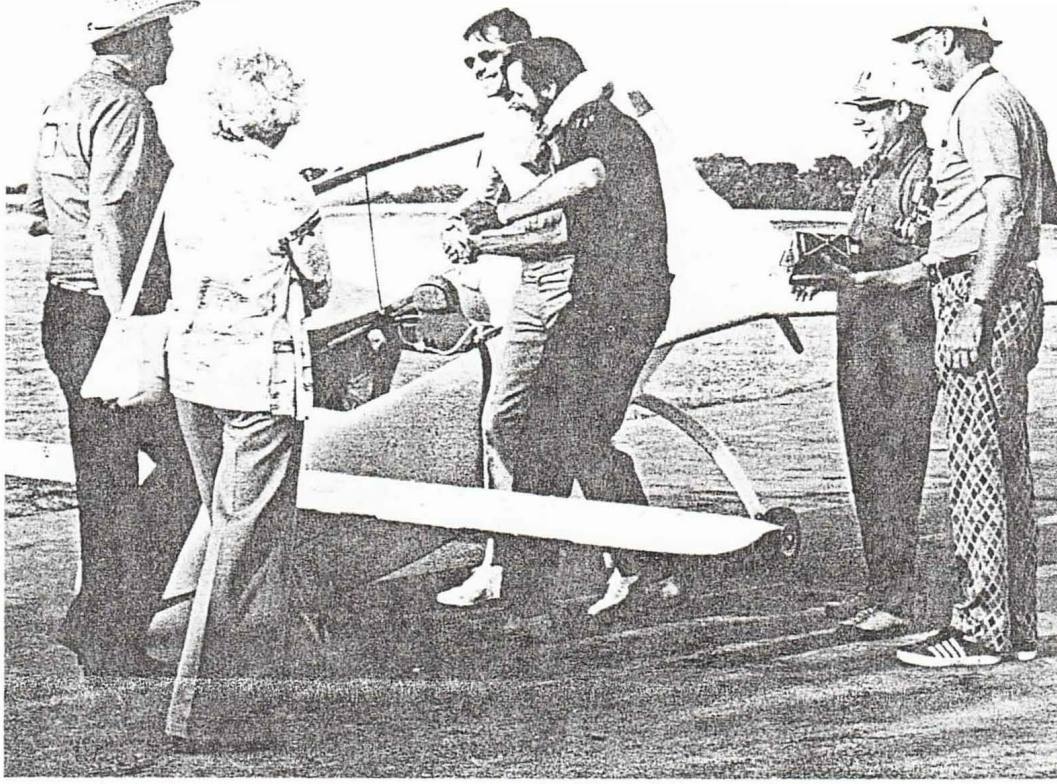
Damn! The turn over the tower had been a little too close in and despite running out and leaning over the rail, Harold simply had not been able to see past the overhang of the roof to spot the tiny VariEze. This time the turn is wide and Harold is able to verify. Only about 4 minutes are lost, but Harold decides that he may spare all of us possible cardiac arrest if he moves his vantage point to the Control Center and uses the tower as a marking pylon on future laps.

With the extra turn around the tower, lap 3 consumes one hour and twenty-nine minutes — 122 mph. Still not bad. By the time we have this figured out, the VariEze and the T-34 have disappeared, well into lap 4.

"Ladies and gentlemen, the VariEze is again approaching Oshkosh. Pilot Dick Rutan is completing lap 4 and will be beginning lap 5. When he passes over the Oshkosh Tower, the VariEze will have passed the halfway point toward breaking Ed Lesher's record. 9 laps are required to set a new mark." Arv is definitely

(Photo by Jack Cox)
Weigh-in for the record flight. It's about 5:30 a.m. and a long, long day lies ahead.





(Photo by Dick Stouffer)
WE DID IT! Left to right, Paul and Audrey Poberezny, Dick and Burt Rutan, Harold Best-Devereux and Bill Turner.

warming to the task.

"Mark 11:40." A one hour, 27 minute lap — 125.5 mph. Burt doesn't look quite as worried over the fuel situation.

"Mark 1:09." One hour, twenty-nine minutes — 122.5 mph. Funny, the mid laps seem to be going past faster than at the beginning. Complacency? . . . or is hunger dulling the senses? It's been eight hours now since breakfast.

"The VariEze is inbound again. This will be the completion of lap 6. At the turn, the VariEze will have covered 1092 miles. This is the first time a world's record has been attempted at an EAA Fly-In. We invite everyone to stick around this evening to greet Dick Rutan when he completes the flight." Now, that's confidence for you.

Harold's "mark" had caught Dick rounding the Oshkosh tower at 2:36 P.M. — an hour and twenty-seven minute time for lap 6. Same as lap 4. Obviously, wind is not a factor today.

"Mark 4:07. Two more laps for the record, gentlemen." Hmm, that's an hour thirty-one — 120 mph. A check with Burt reveals that, yes, he did slow Dick down again . . . to 2950 rpms . Fuel consumption?

"Yeah, it looks like we are burning a little more than we expected. Don't think we will be able to go the extra laps we planned. Running too slow now . . . but the record looks O.K. Know what? I don't think we had the tanks completely full at take-off. I couldn't believe the consumption on the first lap, but it has settled down some now."

So **that's** what was on his mind.

"Mark 5:37."

"Ladies and gentlemen, the VariEze has now completed lap 8 and has started the record lap. If all goes well, the aircraft will return over Wittman Field at just after 7:00 p.m. At that point Dick Rutan will have flown 1638 miles, 83.7 miles farther than Ed Lesher's 1970 record."

Decision time! While Arv Olson is keeping the crowd informed over the PA, Burt is busy taking data from Dick via the VariViggen's radio — speed, fuel remaining, temperatures, pressures — the decision has to be made now on trying lap 10 because now the race is also with the sun. The VariEze is not equipped with lights and a tenth lap at the present lap speeds would get Dick back around 8:30 — after official sunset. Is there enough fuel left to speed up?

The pressure is beginning to build again. Lap 8 took an hour and a half even . . . it sure seemed longer than that: 121 mph. Gee, look at the people who are beginning to gather around the Comm Center . . . there's Ed Lesher. Boy, wonder if he had to go through all this getting his records . . . and he's done it eight or nine times! Ed is fresh from establishing a new record, himself. On July 2 he flew his Teal nonstop from St. Augustine to near Phoenix . . . 1835 miles, a new straight-line distance record. What a shame it couldn't have ended at Oshkosh during the fly-in so he could receive the plaudits of all his fellow EAAers — something he so richly deserves. Ed has closely followed the VariEze's progress all through the day and couldn't be more gracious about the possibility of loosing one of his hard earned marks. That's class.

Wonder if Paul Schultz and the gang at Menominee are feeling the strain, too? So close now! (What we didn't know at the time was that during the latter stages of the flight, famed lawyer F. Lee Bailey, president of Enstrom Helicopters, flew into Menominee and witnessed one of the VariEze's turns. He reportedly was as amazed with the unusual profile of the little bird as the rest of us.)

"He's coming in this time!", somebody yells.

A dash to the Comm Center confirms it. Dick has decided to call it quits at the end of lap 9 — the fuel remaining is such that 10 laps would be slicing things too thin. There's a technicality that has to be kept in mind in these closed course record attempts . . . you have to land back at the same airport from which you started, otherwise all goes down the

(Photo by Jack Cox)

Matched pair? This candid shot was snapped shortly after the completion of the record flight. Dick, left, is telling his wife, Geri, back in Tucson that he did it. Burt is telling John Monnett that his engine now has 13 more hours running time than it did the previous day . . . and a little history to write up in its log.

tubes. Dick has figured his fuel at the turn at Menominee and has told them via Unicom to call us regarding his decision.

"Ladies and gentlemen, the VariEze will land at the conclusion of the 9th lap – setting a new world's record. When the aircraft lands, everyone is asked to stay back behind the showline barriers. For the record to be official, Harold Best-Devereux, the official observer, must check the fuel tank seals and remove the barograph before the plane is disturbed." Arv gives 'em the word.

I get Harold and his son, Igor, in my car and drive out by the runway to wait. It won't be long now . . . in fact, a lot quicker than we realize, because we can see the crowd looking to the northeast. Thousands of arms are pointing in that direction. We are out of earshot of the field speakers, so they must know something we don't. Dick must have speeded up on the last half lap.

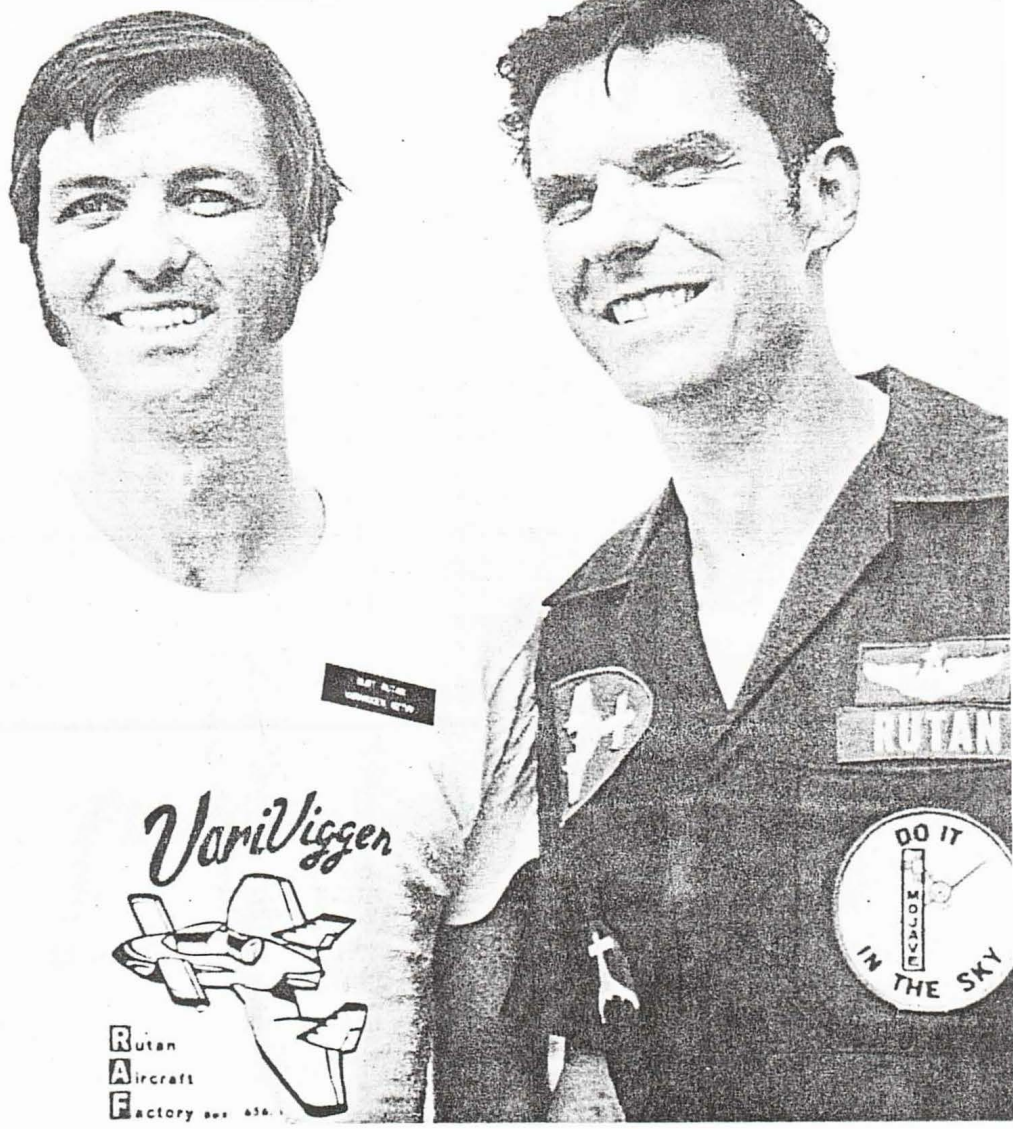
Sure enough, there he is. Harold's "mark" comes at 6:58 p.m., officially ending the course time. That is a 1:21 lap, the fastest of the day. Just over 134 mph. We will let the tower mark his official touchdown time and figure his total time in the air from that.

Just over 13 hours aloft is not enough to cool off Dick's enthusiasm . . . he has to do a high speed fly-by before landing on 18! He says the VariEze cockpit is the most comfortable he's ever sat it . . . must be true.

This time around he has the nose gear cranked down . . . hope it's locked, Dick. That's it, he's down! He's done it!

We'll celebrate later . . . now let's pace him in to the EAA area taxiway and get him stopped before he gets to the show line so Harold can get the barograph. Wow! look at the crowd. Everyone on Wittman Field must be lined up, watching.

Dick taxis back up the side of the runway and turns down the EAA access. Harold is out of the car now and is giving him the "cut" sign. Dick brakes to a stop and is lifting the canopy . . . and is greeted by a resounding cheer from his fellow EAAers. Harold gives him a fast hand shake . . . wonder if he said,



(Photo by Ted Koston)
Burt and Dick Rutan

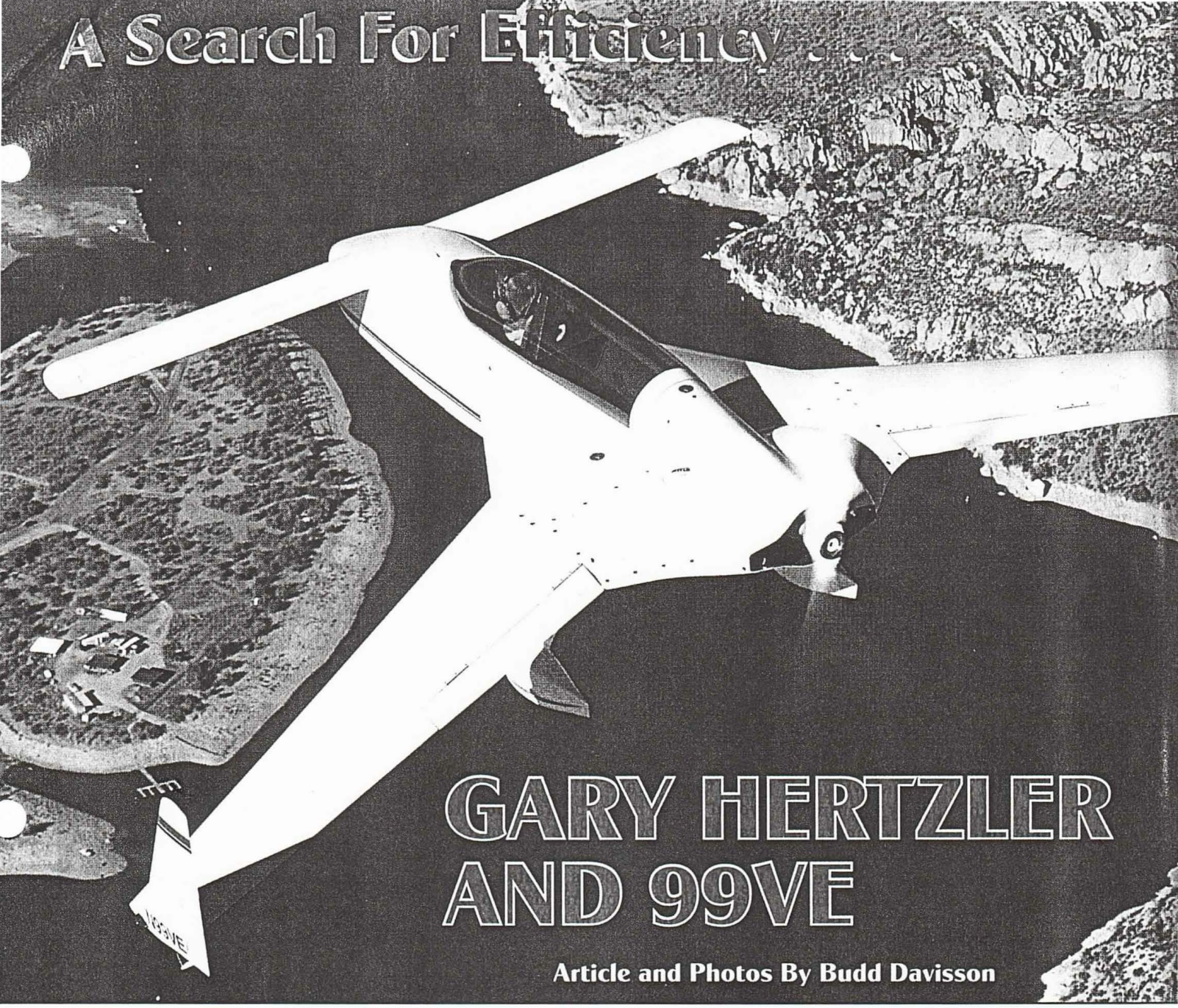
"Jolly good," or some such English expression?? . . . and proceeds to dive into the rear cockpit for the barograph. Presently he emerges and hoists it over his head like a trophy won. More applause.

Paul and Audrey Poberezny step in to congratulate Dick, then Burt, his family and even wife, Carolyn, released at last from her week-long bondage in the Rutan booth in the display building. Then the line breaks and the VariEze is suddenly swamped with people. It's a good thing they are EAAers, for I'm sure otherwise the tiny bird would be broken to bits like a goal post by the souvenier hunters of other sports. As it is a few trophies are indeed taken. Dick pulls out his can of chocolate pudding to show what provisions he has left and immediately it is requested by an admirer . . . who also wants it autographed after the prize is his. This starts a frantic round of autograph signing by both Dick and Burt.

Ah, fame may be fleeting, but it's sweet while it lasts!

In the hours that followed, after the admiring crowd had finally drifted away, there came time to figure out some of the significant numbers — all subject to final NAA/F.AI.. verification and approval, of course. Dick was in the air a total of 13 hours 8 minutes and 45 seconds. The tower officially had him down at 7:03.45 C.D.T. The 9 lap course distance was 1638 miles, which, of course does not count the extra turn around the Oshkosh tower at the end of lap 3 or the "victory pass" at the end of the flight. After some close checking, Burt Rutan finally figured that the VariEze had taken off with 46.5 gallons of fuel on board. 6.3 gallons remained when the flight was completed, so 40.2 gallons were consumed in the 13-plus hours. This figures to just over 3.1 gallons per hour for the day's flying. One pint of oil was used by the Monnett VW. The average speed had been 125.5 mph. These were tremendous figures for any small airplane, but more impressive when one reflects that the construction of the aircraft was started the last of January of this year and that it did not fly for the first time until May 21. The months and years ahead will see the effects of the shock waves that are even now rippling out through the aviation world. We suspect they will be profound. Certainly it can be said, no home-built design . . . or factory design . . . has made such a spectacular start as the VariEze. It took a lot of help from Burt's friends to get the first record — and he is grateful — but to Burt must go the credit for daring to be different in the design of this aircraft, by asking so much of it so soon . . . in full view of so many people.

Standing there in the last minutes of daylight, I suddenly realized that it was all over . . . Oshkosh '75 was done. What a fitting climax to a fantastic fly-in!



A Search For Efficiency . . .

GARY HERTZLER AND 99VE

Article and Photos By Budd Davisson

The question among devotees of efficiency racing is: By replacing the little A-80 Continental in his VariEze with a monster motor, has Gary Hertzler, oftentimes winner of his class in the CAFE 400 and holder of the C1a speed distance record, copped out? Has he forsaken his ". . . do as much with as little as possible" credo? Has he been caught up in the race in which price and performance is driven by horsepower?

Yes, he has . . . at least he has if you consider a Lycoming O-235 a monster motor. And very few of us do. And, yes, he copped out on the efficiency thing, if you consider it foolishness to combine airframe mods with a bigger engine to lower the fuel consumption at his original record speed of 157 mph (for 2490 miles) from 2.68 gallons per hour to 2.4 gallons per hour. That's over 50 mpg!

Just what manner of beast is Gary Hertzler's VariEze? It is obviously something other than your classic glassbackwards foambuilt. And Hertzler is something other than a lead footed airplane racer.

What drives Gary to spend a huge amount of time squeezing everything he can out of his airframe and making every single horsepower count in the quest for speed and economy?

"Basically, I'm always looking for value," he says. "Even with my cars it is a game with me to see how much performance I can get on the least amount of gas."

And how far is that? In establishing the record in October of 1993, he made four round trips from Chandler, AZ (Phoenix) to a VOR next to Palm Springs, CA, a total of nearly 2,500 miles, on 42 gallons of gas. His elapsed time was 15 hours, 45 minutes at 157 mph. Yeah, it looks like he really is a cheap kind of guy. A fast cheap kind of guy!

Gary is a mechanical engineer by trade and spends his days as part of the engine design team at AlliedSignal Aerospace in Phoenix. They spend hours splitting hairs to make their turbo-fan engines as efficient as possible. Then Gary goes back to his work shop and continues splitting hairs to make his VariEze as efficient as possible.

Basically, an airplane is an ongoing battle in which thrust (horsepower) tries to move an airplane forward while drag tries to slow it down. Granted, this is reducing aerodynam-

Gary Hertzler is a propulsion design engineer for a major aerospace company and holder of several world records for speed and distance in his class.

ics to a coloring book level, but it really isn't any more complicated than that. So Gary's search for speed and efficiency couldn't concentrate in just one area. Pure horsepower may help make an airplane go faster, but, all other things being equal, the faster it goes, the less efficient it gets. Each new mile per hour will cost an increasing amount of horsepower because drag builds up as per the square of the speed.

So the obvious move is to get the airplane so slick it really doesn't take much horsepower to make it slide through the air. One way to look at it is to view drag as if it is negative horsepower that has to be canceled out with positive horsepower. So, the fewer negative ponies there are pulling backwards, the fewer that are needed to pull forward. Or in Hertzler's case, push forward. Cut down the number of ponies needed to pull the airplane through the air and just that many less need to be fed. More speed, lower feed bill. That's Hertzler's magic but hardly original formula.

This is all pretty basic stuff which everyone knows. So what is Hertzler's secret? That is also pretty basic.

"Details," says Hertzler. "I'm not inventing anything new or coming up with any great new technology. I'm just doing everything I can think of to decrease drag while doing engine mods that increase efficiency without costing reliability."

The last comment, about engine mods, is important because horsepower is secondary in his mind. The trick is to make the engine generate its horsepower on less fuel. His original solution to the low fuel burn question was to use a tiny engine on a super clean, super light airframe.

Gary didn't originally build his airplane to go racing or set records. he says he originally built the VariEze because it looked like an airplane that would satisfy his urge to go fast with little horsepower. His old more-for-less way of thinking picked the VariEze. That and the fact it looked like an airplane he would finish.

In the 1960s he had started a metal bird, but didn't complete it.

"For me, metal was just too tooling intensive," he says. "But the plans for the EZ were so good and the material so easy to work with, the project moves along quickly and you don't lose interest."

Even so, it took three years, until 1980, before the airplane was flying. When he got it flying, it turned out to be one of the lightest VariEzes around. With the A-80 (actually an A-65 with A-80 pistons), it weighed in at 610 pounds. Asked how he got it so light, the same basics come to light.

He repeats himself, "Details, strictly details. If the airplane doesn't have it, the engine doesn't have to carry it. In the first place, all of the foam cores should be as perfect as possible, so no filling needs to be done to true them up. all the lay-ups should be as dry as practical. It doesn't make sense to carry around filler and resin that isn't needed."

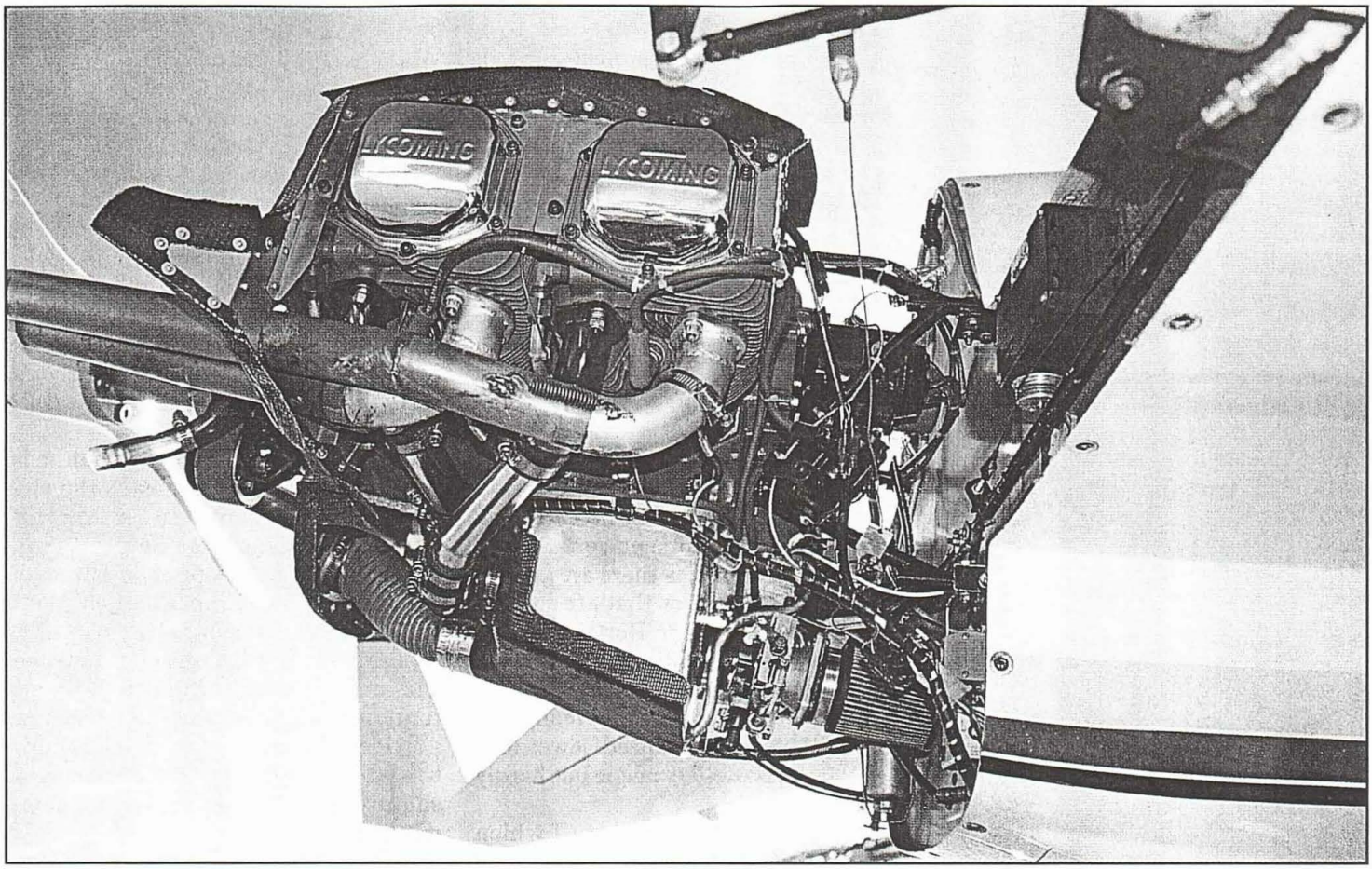
Without saying as much, what he is saying is extra weight means the airplane must generate extra lift to carry it. The lift means more induced drag. Which means more horses are needed. And those ponies must be fed. Isn't this where we came in?

Keeping the weight down reduced the induced drag, but Hertzler's attention to the airframe drag goes far, far deeper than that. He found, for instance, holding both rudders slightly out of line (they are independent on most canards) generated a noticeable drop in speed. He theorized the rudder displacement was making reflex that was already in the winglets much more pronounced and that apparently generated a sizable amount of drag. That being the case, Gary reasoned the reflex already in the winglet airfoils probably was generating drag all by itself.

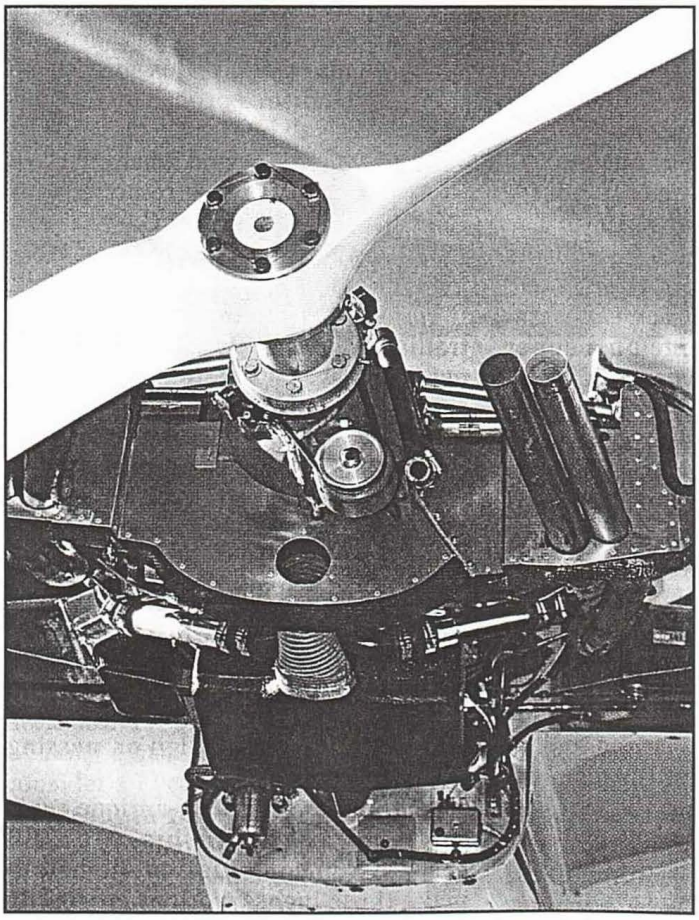
The only way to find what effect all that reflex had was to remove it, so the final winglet airfoil Gary is now flying has a nearly straight curve from the point of max thickness to the trailing edge. This meant moving the trailing edge slightly inboard, but the net result was a speed increase of at least three mph. At the same time, however, he says his low speed stability was slightly compromised. Nothing is free in aerodynamics.

Gary is very serious about the possible problems folks can run into when modifying airplanes and doesn't condone his type of program. "I'm almost afraid to talk about the changes I've made because not all of them have worked and it's possible to get into trouble changing a design or messing with the engine."

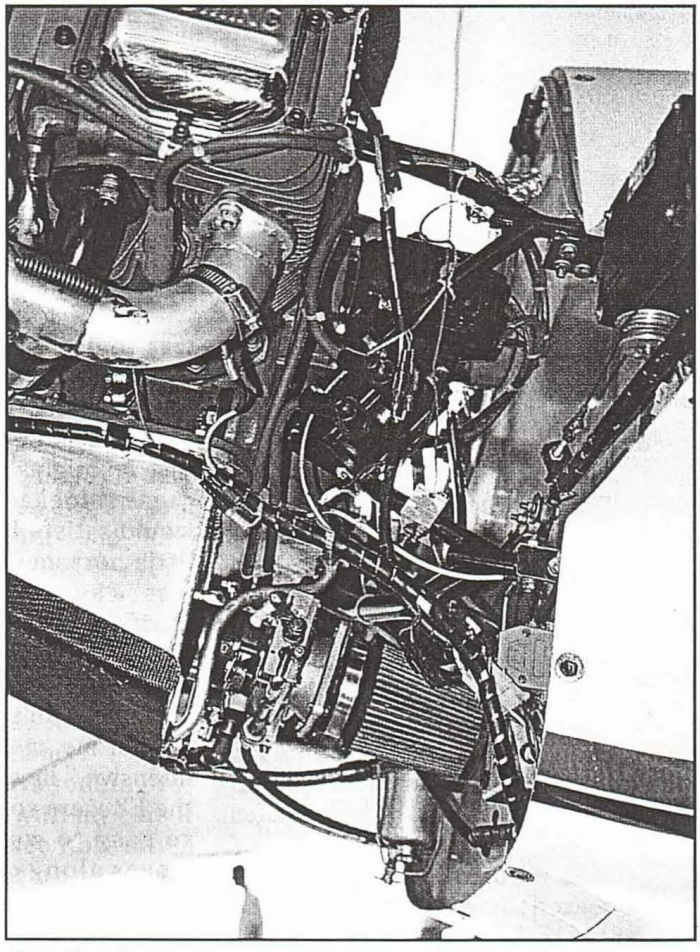
With only 170 nearly-antique cubic inches available in his A-65/80 case/piston combination, he had to make those inches work as efficiently as possible. Since thermodynamic efficiency is a function of compression ratio, he opted to do something about



The O-235-C1 has L2C pistons and Ellison throttle body. Light Speed Engineering electronic ignition is at upper right. Note hand made oil sump with induction tubes running around it, rather than through. Dark air scoop on bottom of sump holds air against it for cooling.



Low pressure draws oil sump cooling air through Scat hose on rear baffle. Prop is Hertzler's own composite creation over wood core.



Details of rear of sump. Note use of automotive aftermarket exhaust elbows to build induction and exhaust systems.

the 7.5:1 ratio of the original engine. He wanted to go to 9:1 but with newer technology pistons and rings.

It was the compression ratio mod that almost got him in trouble, hence his comments about careful experimentation. He didn't want to go with a set of stock Continental pistons, even though they could get him up to 9:1 with little effort. Stock pistons were heavy and of an old design. Being a designer, Gary sat down with his calculator and designed a set of pistons which were lighter and, therefore, more efficient. He then came up with a combination of automotive rings that would seal much better, making the engine even more efficient. He had the pistons made by a custom automotive manufacturer.

The pistons looked good on paper, but they had this one little problem. When hot, they were larger than the cylinders in which they ran. Proving once and for all that even the best designers in the world can't foresee all the unknowns, he found a combination of tight design tolerances and loose manufacturing tolerances had produced pistons that grabbed the cylinder walls and wouldn't let go.

But he didn't know that until the engine seized solid at 250 feet over a citrus grove on takeoff!

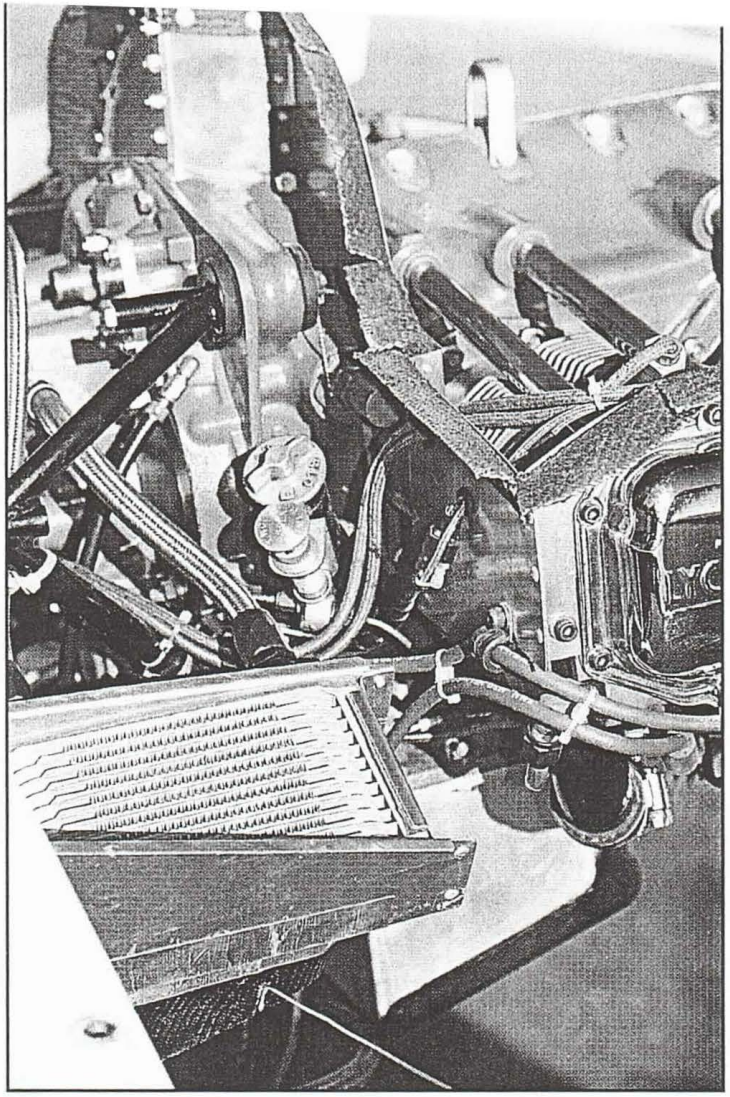
"Nothing but an EZ, a light EZ at that, could have made it back from that position," Gary says. He also admits his part in the problem, but the next set of pistons ran trouble free for nearly 800 hours.

He also completely replaced the induction and ignition systems, all of which have formed the basis for the mods to his current engine, the not-so-monster O-235.

The ignition was a combination of a magneto with fixed timing and an electronic unit from Light Speed Engineering. This has an electronic processor and sensor which reads manifold vacuum and adjusts spark advance up to a maximum of 17 degrees above the normal setting. This allows matching the ignition set-up to conditions that exist at high altitude. Gary says when he's at altitude and switches from the mag to the electronic ignition and back, there's a 50 rpm drop caused by the difference between the full advanced setting of 43 degrees and the nominal setting of 25 degrees.

Much of Gary's work has been aimed at truing up the airframe. One of those areas was in the landing gear. He went through at least three different iterations of cowling and cooling design starting out with Rutan's original P-51 type belly scoop and progressing towards his current cowling that brings the bottom of the firewall up and allows a tight, continuous curve from the belly right up to the prop.

Although that mod eliminates just about every scoop that sticks out into the airstream, it has the downside of changing the curvature of the fuselage where the gear legs enter. The intersection becomes much more acute and creates a spot that loves to tear at the air. To make matters a whole lot worse, the gear legs sweep forward which give them an effective positive angle of attack, when compared to the rest of the airplane.



Oil cooler is very necessary in Arizona temperatures.

Since Gary's airplane is about two degrees nose high at cruise speed, this means the gear legs present the wind with a surface which has a significant angle of attack all its own. Gary's solution was to create a square around the gear legs whose edges paralleled the relative wind. Then he simply airfoiled that square and made a fairing in that shape. That was good for nearly three mph.

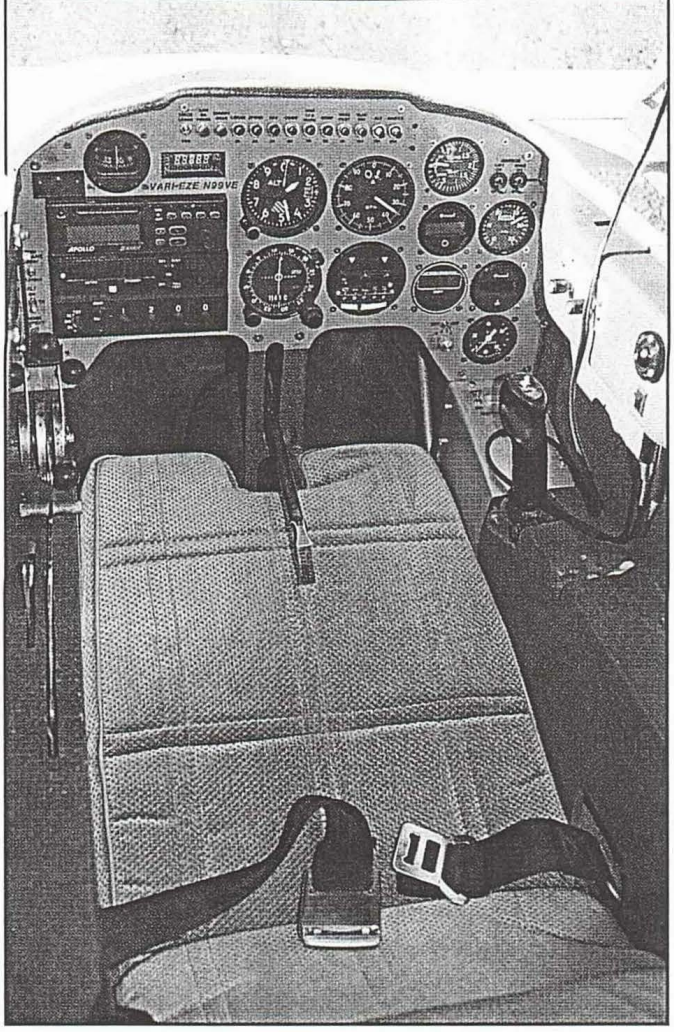
The wheel pants on Gary's airplane are more than simply wheel pants. Most of us visualize pants as something that makes the air think a wheel isn't a wheel. Anything is better than dragging a wheel through the air so most are satisfied with any kind of wheel pant.

Gary did some dirty-oil flow testing of the wheel pants and decided they needed some serious work.

The final shape was arrived at by making the planform that of a 25% 65 series laminar airfoil. The 25% was picked because that offers the 4:1 taper ratio which is usually considred to be optimum for an aerodynamic shape. Also by selecting a known airfoil, the airflow was possible to predict.

Then the pant's side view was carefully laid out. The side view was developed in such a way there was a constant pressure distribution at each station down the pant. This required that the angle the top and bottom of the pant made with the waterline be the same as the angle which the left and right side make with the line of flight. This not only maintains laminar flow but stops migratory airflow which in turn keeps the pants from throwing off any drag-producing vortices of their own. Gary says the pants' modifications alone accounted for just under 6 mph!

The canard is basically stock except for the down-swept tips which change airfoil section as they sweep to soften the vortex. Gary isn't sure which had the most effect, the down sweep or the shape, but he says a long piece of yarn attached to the tips of the original square canard would whip around in a three foot circle so fast it disappeared from sight. With the new tips the same yarn lazily rotates in a circle



Flight deck is neat and tidy.

that's only about a foot in diameter, which to Gary says there was a lot of energy being wasted in generating vortices.

With this super clean airframe and fuel-sipping little A-80 pushing it, Gary took six(!) out of nine CAFE 400s with his elbow-to-elbow racing buddies, Klaus Savier and Gene Sheehan, taking the rest. Then, however, the 400 was dropped in favor of the CAFE Challenge. The Challenge isn't a race so much as it is a challenge in which individual pilots pit themselves against a performance level that has been pre-established. The goal is go beat that datum point. This is no mean feat since the performance standard set was by Dick Rutan flying Burt's Cat Bird.

Basically, the airplane leaves Santa Rosa, CA, goes out 250 miles in any direction, as recorded by a high-tech GPS system, and returns. The hooker is that the aircraft has to be at 10,000 feet by the time it hits a line which circles Santa Rosa 25 miles out. That is a fairly steep climb gradient and makes it nearly impossible to do it in a cruise-climb configuration.

With the original A-80, the only way Gary could hit the 10,000 foot level in time was by circling in the climb. There is a limit to what lightweight and clean aerodynamics can do. At that point, horsepower has to take over. With a fixed pitch prop and only 170 cubic inches, Gary was stuck.

The old hotrod axiom "the only substitute for cubic inches is more cubic inches" fits here.

Gary needed more motor. But, he wanted an efficient bigger motor. Not one that simply generated horsepower. He went with a 108 hp, O-235-C1C Lycoming, one of the more popular VariEze powerplants. But, rather than hot rodding it beyond all recognition, he opted to do exactly the same things he had done to the old A-80: increase the compression ratio (using factory L2C pistons this time), clean up the fuel distribution and install a better ignition system.

Anyone familiar with airplane engines at all have to walk around the rear of Hertzler's VariEze and wonder how he got all the normal engine stuff in that incredibly tight cowling. There is obviously room for the engine, but what about those other gadgets, like carburetors and induction tubing that usually hang down.

It isn't until the cowling is dropped that the true extent of Hertzler's quest for aerodynamic cleanliness and engine efficiency comes to light. Nothing hanging from either the bottom of the case, nor the bottom of the jugs is stock.

As with most carbureted aircraft engines, the O-235 mounts its carburetor on the bottom of the oil sump and routes all the induction tubes through the sump. Not Hertzler's. The original sump is gone, replaced by one completely fabricated by Gray from aluminum plate. The carburetor has been replaced by an Ellison throttle body which is mounted on the back, er, magneto end, of the engine. The incoming fuel mixture is routed through the sump to a distribution spider featuring an entirely new batch of induction tubes which hug up against the bottom of the cylinders. The tubing work on the engine shows what can be done using the exhaust elbow page out of J. C. Whitney's latest catalog.

Incidentally, Gary says the Ellison is one of the most important contributing factors to his engine's efficiency. He says the normal carburetor doesn't atomize the fuel nearly well enough at the low throttle settings he is often running. At those flow rates the throttle butterfly is basically stalled which totally disrupts the flow and allows the heavier droplets to take the path of least resistance. This causes distribution problems with the near cylinders running rich and the far ones leaning out. The Ellison gives the ability to lean far past what a normal carburetor can and the longer induction runs give more time for the mixture to equalize between the cylinders. Gary credits the Ellison for at least 10% increase in fuel efficiency.

The bottom plugs don't have clearance so have been replaced by automotive units which are fired by one of Klaus Savier's electronic ignition systems. Gary says the electronic system works better with automotive plugs anyway, but he would have put them on top, rather than the bottom, if he didn't have clearance problems.

The oil pan has a composite scoop running its entire width leaving about a half inch of clearance for holding the cooling air up against the pan's lower surface. The front end (as determined by where the airplane's front end is) is open while the back flows into a two inch tube that exits on the baffle face right in front of the propeller. Gary says the system depends on the negative pressure area at the back of the cowling to pull cooling air across the pan. He also admits the oil system, which also employs a traditional oil cooler, still needs some tweaking to cope with Arizona's summers. But then, at 115°, practically every oil cooling system in Arizona has troubles coping.

Every bit of air the engine needs to breathe and cool itself comes in through a hand sized armpit scoop under each wing. Gary says the first time he ever saw that type of inlet was on an EZ belonging to Charles Airesman from Cumberland, MD. He says his airplane is not only beautiful, but is - along with his and Klaus Savier's -

among the fastest in the country. This type of scoop works in high pressure air and leaves the belly completely smooth and clean. However, Gary says the performance gains over the NACA inlet are minimal, especially when put against the huge amount of work involved. It does, however, make for a much nicer looking cowl which flows better up to the propeller.

The estimated 118 hp pushes the airplane through a propeller that is basically a Hertzler original. Although the core is that of an aftermarket wooden propeller, it has been completely reshaped and reconfigured using fiberglass and carbon fiber. It is the same prop Gary used for his record flight, but he changed the pitch from 64" to 76". The basic airfoil is built up using glass, which is overlaid by carbon fiber uni-cloth running tip to tip and overlapping in the middle. It is 14% at the root and tapers to 10% at the tip, so it is fairly thin. He says it lets him turn 2,350 rpm static and is giving him about 3,000 rpm flat out.

Did the extensive mods as the result of the engine installation work? Well, Gary broke the Cat Bird's mark by 5% (as calculated by the CAFE efficiency-based formulae) and found he had actually overcompensated for the climb. He hit 10,000 feet only 18 miles out. Using a flatter, faster climb or a different pitch, he would probably have bettered his mark.

Of course, there's always that one final question everyone who isn't into efficiency - which is practically everyone - asks: How fast is it? In a recent 120 mile, closed course race among VariEze owners, he clocked 228 mph at a density altitude of 5,000 ft. As originally built, the airplane did 176 mph, so he's added 52 mph to its speed!

What's next for Gary? Remember that 228 mph run? Amazingly, he wasn't the fastest! Klaus did it at 235 mph.

"Yes, I do have a few more ideas." He hesitates for a second before continuing, "But, I think I'll keep those to myself." ◆

NEW ALTITUDE RECORD SET

By DAVID W. TIMMS, EAA 160529, 2571 N. Parkdale Ave., Simi Valley, CA 93063

They say that men climb mountains because they are there. I think that in reality a person wants to accomplish greatness within one's lifetime for self-fulfillment, for recognition, or as a contribution to mankind. Perhaps it is for these reasons that when I realized my opportunity to set a world altitude record, I made the commitment to do so.

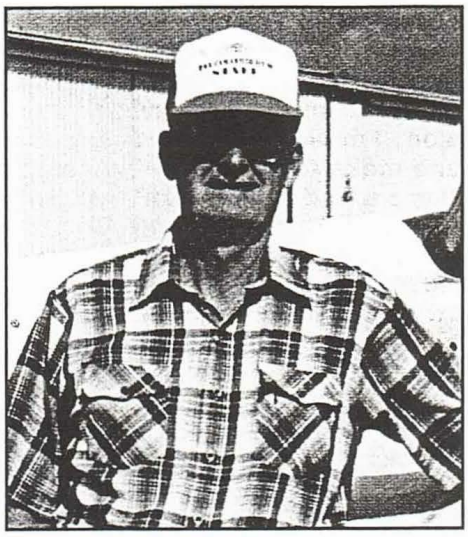
Aero and space world records are sanctioned by the Paris-based Federation Aeronautique Internationale (FAI) which is represented in the U.S. by the National Aeronautic Association (NAA) based in Washington, D.C. The FAI defines Class C.1.a Group I, Altitude in Horizontal Flight, as a light airplane with a piston engine and a takeoff weight between 300 and 500 kgs (661-1102 lbs.). The rules require the airplane to maintain the record altitude in level flight for 15 kilometers or 90 seconds.

The previous record was held by EAAer astronaut and space shuttle commander Robert L. "Hoot" Gibson, flying his modified Cassutt to 27,040 feet on January 31, 1991.

During the record altitude flight in my Long-EZ, N121DT, I attained 30,500 feet indicated, now ratified by the NAA as 30,407 feet, after allowance for instrumentation corrections.

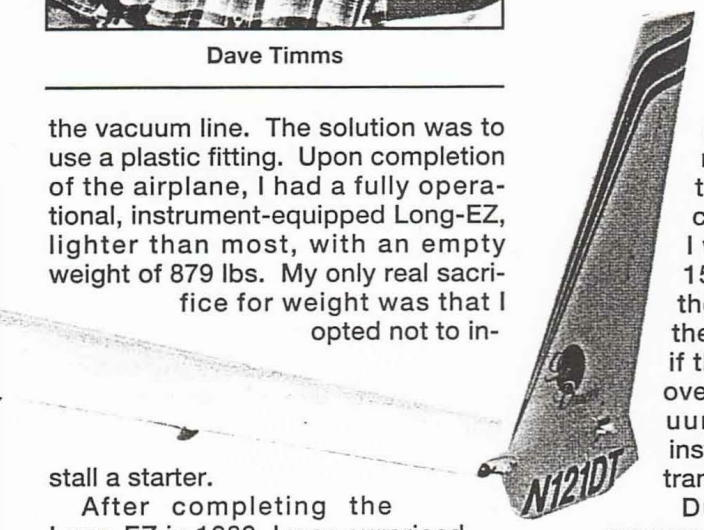
Building my Long-EZ took eight and a half years. I am sure that I must have developed a credibility gap with my friends as to whether I would ever finish this project. During the building process, I was frequently reminded of Rutan's test for adding anything to the airplane: "If you toss it in the air and it comes down, then it's too heavy."

I remember some of my friends laughing at me one day for trying to lighten the weight of a metal fitting in



Dave Timms

the vacuum line. The solution was to use a plastic fitting. Upon completion of the airplane, I had a fully operational, instrument-equipped Long-EZ, lighter than most, with an empty weight of 879 lbs. My only real sacrifice for weight was that I opted not to install a starter.



After completing the Long-EZ in 1989, I was surprised to discover that it performed as well as advertised in terms of rate of climb and speed. I appropriately named it the "Sundancer." Flying light, my initial rate of climb would typically be 1800 fpm. Full power at 8,000 feet would yield 175 kts. TAS while turning my Lycoming O-290 converted ground-power unit at 2750 rpm.

Altitude on cross-country trips was limited only by the lack of oxygen and by cold temperatures. I decided to install an oxygen system and dress warmly. After that, my legal limit became the base of the Continental Control Area (no DME), but my personal limit was still the cold (never could find a suitable heater).

In the spring of 1992, I decided to see just how high the Sundancer would go. With the airplane in its normal configuration, I flew out over the Pacific Ocean to clear the Continental Control Area and was able to climb to 27,000 feet in 55 minutes. The OAT was -32 degrees C; the inside of the canopy was frosting over; my hands and feet were cold.

Surprisingly, I still had three inches of vacuum, and my gyros were operating reasonably well. This was a new environment for me and I was anxious to get back down, landing with two hours of fuel remaining. Had I known at the time that the existing record was 27,040 feet, I probably would have climbed for another couple of minutes to unofficially break the existing record, although I was over weight by 50 lbs.

It was obvious that just as it stood the airplane was capable of braking the existing record. The hitch was that the pilot could weigh no more than 125 lbs. for the aircraft gross to be less than 1102 lbs. At my body weight of 175 lbs., I decided it would be easier for Sundancer than for me to shed some weight.

After getting an accurate weight on the aircraft and after listing the items that could be removed (including back seat, upholstery, fire extinguisher, alternator, ELT, radios, wing leveler autopilot, nav lights, and oil cooler), I concluded that I would have a margin of 15 lbs. grace. So I made the commitment to go for the record. I decided that if the canopy should frost over, I would need my vacuum pump and gyro instruments and maybe my transponder to work ATC.

During the months of preparation that followed, reducing my takeoff weight continued to be the biggest technical problem. That 15 lbs. of grace quickly vanished as changes were made to the aircraft. A flying buddy, Jack McDonough, reminded me that to be legal for VFR I would have to plan for a 30-minute fuel reserve. You must comply with all of the FAR's, or the record doesn't count. But McDonough had a solution for the added fuel weight: simply sand the paint off the airplane. You just can't afford to have many friends like Jack! I opted to go on a diet and save the paint.

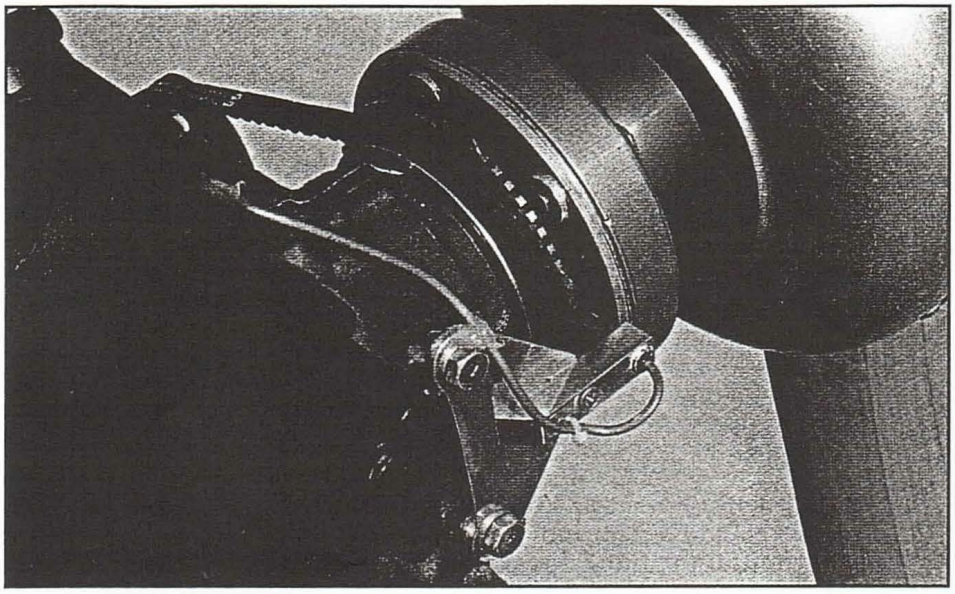
In the months preceding the attempt, numerous test flights were made. On each flight, I tried something different, recording data, solving technical problems and discovering more technical problems.

What happens to a plastic airplane at 30,000 feet with an OAT of -45 degrees C? Does the epoxy resin get brittle and let the wings break off? Will a wooden propeller get brittle and disintegrate? Will a rapid climb with air encapsulated in the wings cause the wings to explode? Will the magnetos arc over and stop firing the spark plugs? Without an oil cooler, will the engine and oil overheat during a sustained climb? Will the oxygen regulator freeze and prevent oxygen flow? Where do you find an inexpensive and lightweight oxygen mask with a built-in microphone? How do you mount a video camera free of vibration to record the resolution of the altimeter? How do you keep warm at -45 degrees C without a heater?

Rutan Aircraft assured me that I did not have to worry about the airplane's structure. They had built jet aircraft using the same process and had flown them over 30,000 feet many times without problems.

To achieve optimum rpm during the climb and especially at altitude, I ordered a longer but much flatter propeller (70d x 36p) from Performance Propellers. The pitch selection was based on estimated true airspeed at 30,000 feet. Luckily, the rpm was right on for the first cut of the propeller, with no additional trimming required. For better ignition and advanced timing, I replaced the right

NAA observer Dick Freeburg seals the canopy prior to flight.



The electronic ignition pickup. Note that there is no starter ring and the timing gear and split pulley are both one piece.

magneto with an electronic ignition made by Electroair.

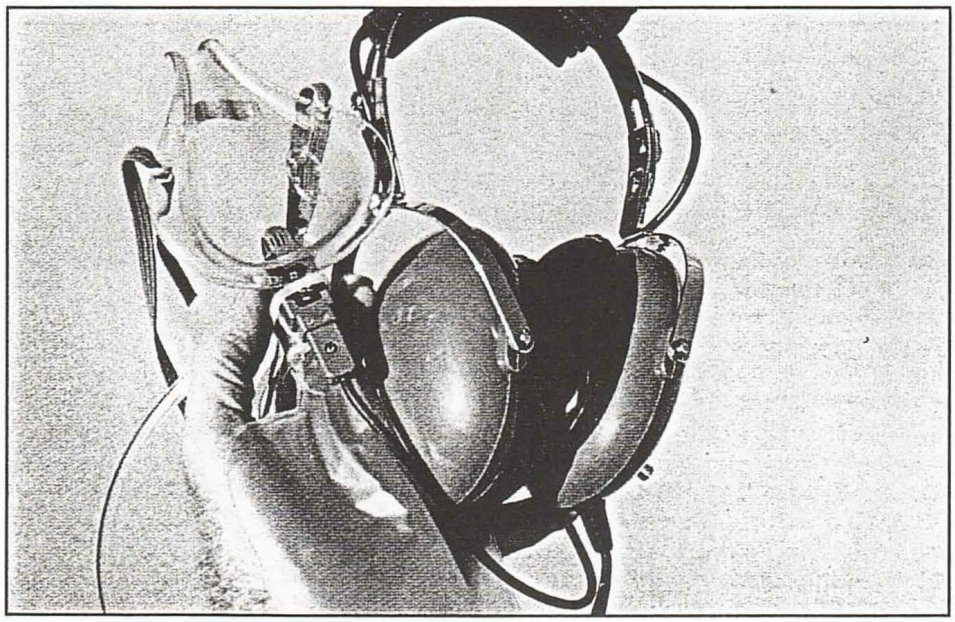
Each test flight was an experience in itself with the oxygen requirement and the cold. Unable to find an inexpensive oxygen mask with built-in microphone that worked well, I improvised my own.

Usually, I would try to work ATC for VFR traffic advisories. Los Angeles Center would sometimes seem puzzled when I would tell them that I was a Long-EZ and that my intentions were to proceed more than 12 miles off the coast to clear the Continental Control Area and climb VFR to 27,000 feet. O.K.?

Then the question arose . . . are the Channel Islands part of the U.S. continent and thereby the Continental Control Area? Yes! Go somewhere else!

Not all test flights were uneventful. On one flight my oxygen system failed, and hypoxia set in at 25,000 feet. I recovered as the aircraft descended through 18,000 feet. Upon landing, I discovered that because of the extreme cold the plastic oxygen hose had slipped off the mask fitting. My final test flight was to 29,000 feet, and it appeared that I could achieve my goal of 30,000 feet.

Finally, the day of the record attempt arrived. Before sunrise on December 5 it all came together at the Camarillo Flight Center, the host of the event and weigh-in. With the video camera and barograph in place, the Sundancer fueled, and with me in the cockpit, we were ready for the moment of truth. What was the gross weight? The ground crew and fellow EAA Chapter 723 members Ken Clunis and Jack Norris lifted one gear at a time onto the precision scales. NAA observer Dick Freeburg called out the weight: 1094 lbs. - 6 lbs. under my target weight of 1100 lbs. Losing that 15 lbs. on my diet had saved the mission. I could keep my transponder and make ATC happy. Clunis and Norris added another quart of oil for a total of six quarts. They added a half gallon of fuel for extra margin, bringing my takeoff weight up to 1099 lbs. I then had eight gallons in the right tank for climb plus two and one-half in the left for descent.



Improvised microphone built into oxygen mask using pilot headset and mic.

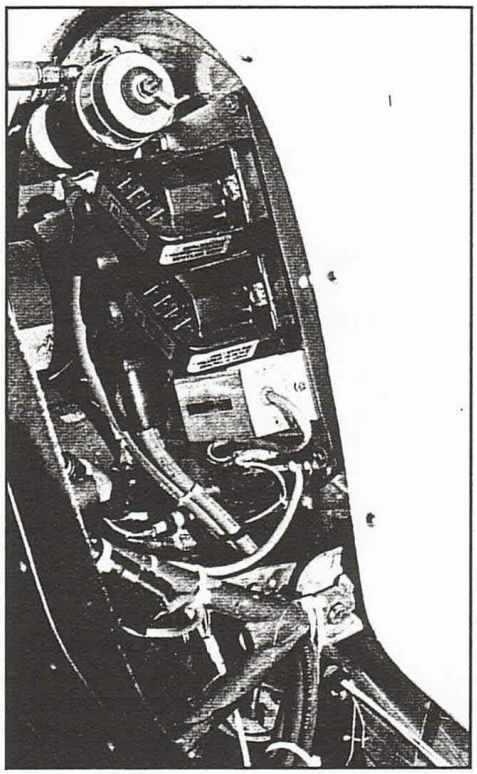
Still in the cockpit, I got pushed back out of the hangar. Cockpit check complete, I switched on the video camera and Freeburg turned on the sealed recording barograph. After closing the canopy, Freeburg sealed it shut with his own sticker. *He did the same to both fuel tanks* just to make sure that I didn't land somewhere and tinker with the airplane or recording instruments.

Clunis hand propped the engine, and in moments I was moving toward the run-up area. Having removed the alternator to save weight, I decided to switch off the electronic ignition during that long taxi to save my battery. But the remaining left magneto didn't carry the engine at idle. The engine quit, leaving me stranded in the middle of the taxiway with my friends and the press looking on. How embarrassing! They must have wondered if this strange-looking machine would even get off the ground. Soon my ground crew caught up with me. Another hand propping, and this time I left the electronic ignition turned on.

Takeoff was at 8:15 a.m. with an initial rate of climb at 2300 fpm, turning 2800 rpm full power and indicating 78 kts. The nose gear crank kept wanting to turn backwards to let the gear down a little. Finally, I held my knee against the crank. The tower handed me off to Point Mugu Approach Control. It was awkward pushing the buttons on my hand-held transceiver with cotton gloves over latex gloves, so each time I changed frequency, I had to remove my outer cotton gloves.

At about 5,000 feet the engine began slowing as though from fuel starvation - a problem I hadn't experienced in the test flights. Was my record attempt already in jeopardy? Could it be carburetor icing? Was the nose-high attitude cutting off fuel flow? Could it be because I removed the air filter after my last flight to give me added manifold pressure? Switching fuel tanks didn't help. Carburetor heat didn't help. But leaning the engine seemed to fix the problem.

Crossing the beach at Malibu, I got handed off to Los Angeles Center. They



Electronic ignition made by Electroair and mounted on the firewall.

were expecting me because I had phoned and faxed them the day before regarding my mission to show them where I would be flying. Center reminded me to stay below 18,000 ft. until 12 miles off the coast, so I leveled off momentarily before resuming my climb.

The engine was running well, but oil and cylinder-head temperatures were well above red line. That $6.25/quart synthetic engine oil should handle the high temperatures.

Center confirmed that my Mode C reply agreed with my indicated altitude. They reminded me to set the altimeter to 29.92 climbing through flight level 180. No, sir! I had to leave the altimeter set to the ATIS setting to read MSL which was being recorded on my video camera.

Climbing through 20,000 feet at 700 fpm was a bench mark that told me I might reach 30,000 feet. Not bad for a Lycoming O-290. (My first airplane was a Piper Tri-Pacer with a Lycoming O-290, and I couldn't get 700 fpm at near sea level.)

I asked Center for vectors to PERCH intersection so as to maintain a 12 mile distance from the coast line. Still feeling alert, I was constantly checking my oxygen system and increasing the flow to compensate for higher altitudes. The oxygen regulator began to frost over. I was glad to be using dry aviation oxygen that wouldn't freeze and plug up the regulator.

Lucky break in the weather - clear and smooth air. But the sight that I wanted to see was the location of the nearest airports, in the event that my engine failed. At that altitude, I could certainly glide to the beach and probably to either Point Mugu Naval Air Station or Santa Monica Airport. At 25,000 feet the moisture from my breath began to frost over the inside of the canopy, except for the areas where I had applied Automotive Rain-X.

My vacuum pump was still pulling almost 3 inches, and the gyro instruments seemed to be working well enough. A check of my battery voltage told me that I had enough battery power remaining to keep the electronic ignition firing for the remainder of the flight. I periodically asked Center for a momentary change of frequency to call Camarillo Flight Center and gave them progress reports. Leaning the engine for maximum rpm was critical at that time. The slightest control movement made a big difference in engine performance.

At 29,300 feet I leveled off momentarily, just to nail down an altitude record of at least 29,000 feet for assurance. I didn't know what technical problems might occur at higher altitude that might jeopardize the record.

Center called to ask, "We just want to verify that you are turbo-charged, aren't you?"

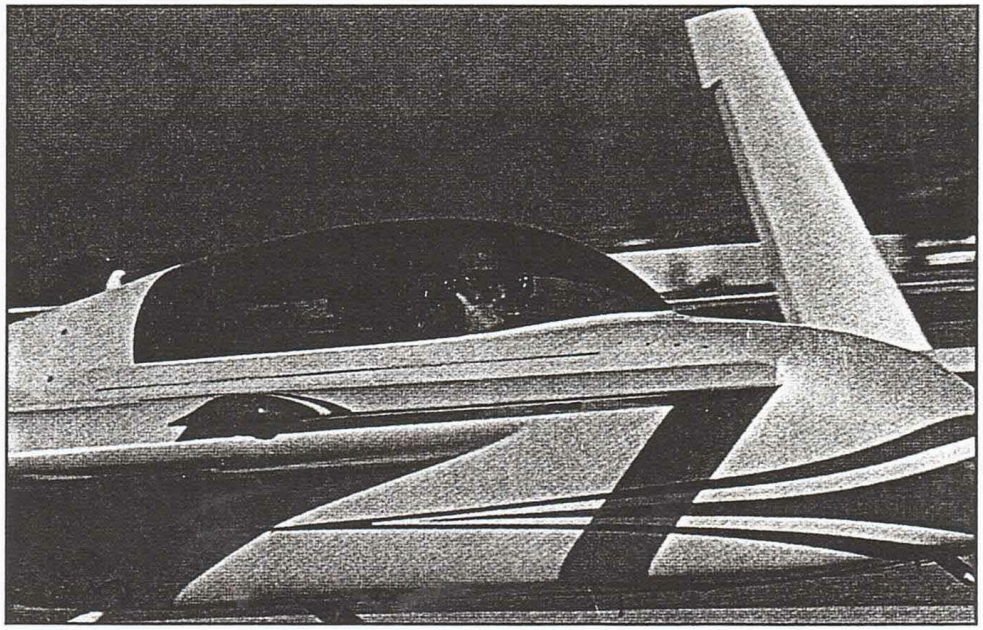
"No sir, just a normally aspirated Lycoming O-290."

After two minutes in level flight, I made a rapid descent of 400 feet to put a notch on the barograph recording. Then I resumed climbing. I momentarily switched off the left magneto, but the electronic ignition timing was far ahead of the magneto at that manifold pressure, and there was no perceptible change in engine performance. However, switching off the electronic ignition caused the engine to lose considerable power with only the magneto firing the engine, yet there was no evidence of magneto arcing or misfiring.

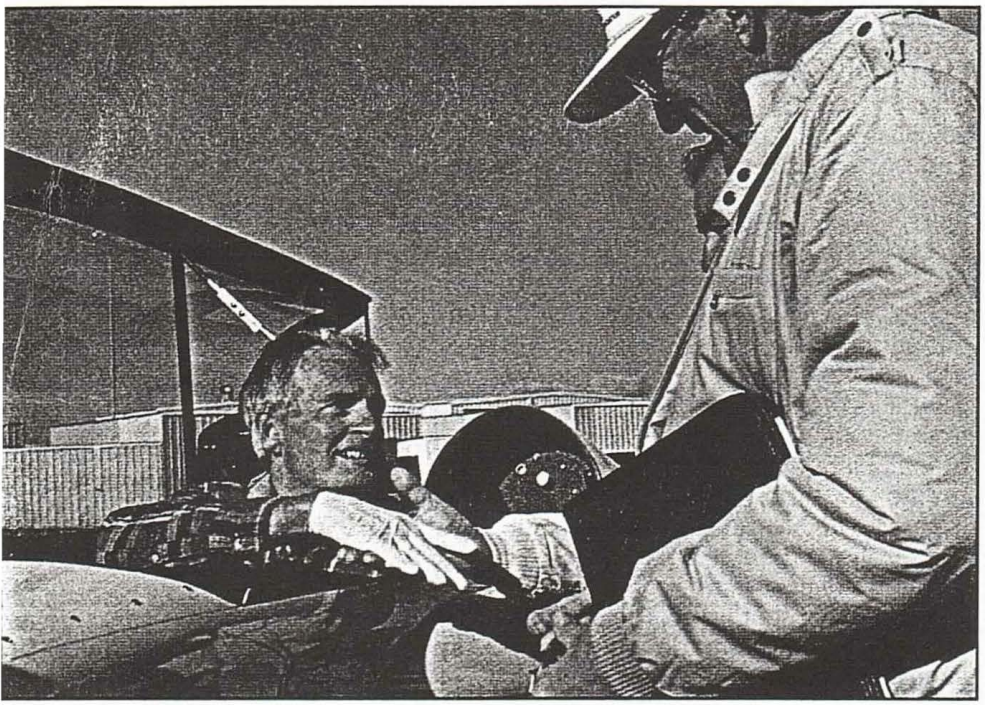
At 30,000 feet my rate of climb was fluctuating between 0 and 100 fpm. Outside air temperature was -40 degrees C. Even with my snow boots, two pair of socks, and my double gloves, my feet and hands were getting very cold. The plastic oxygen hose to my mask was stiff from the cold, so I was careful not to move around too much for fear of breaking the oxygen line. But my plastic wings hadn't exploded or broken off. Guess Rutan was right.

It took three or four minutes to climb the last 100 feet. The airplane was at minimum controllable airspeed indicating 58 kts. and was starting to dutch roll. Interestingly, my true airspeed at that altitude with an OAT of -42 degreees C was 96 kts. The engine was turning a surprising 2600 rpm with the manifold pressure gauge needle pointing below the lowest graduation of 10 inches on the scale; I interpolate 8 inches. I estimate that the engine was only delivering about 30% of rated power, and I suspect that much of that remaining power was used in just turning the engine, leaving little to torque the propeller. Both the CHT and oil temperature were still above redline.

A gentle turn to the west put the sun at my back so as to light the instrument panel for the video camera. I hoped that the camera was still running at that temperature, or it would all be a wasted effort. At 1 hour and 4 minutes into the flight, the Sundancer didn't want to go any higher. Having made my 30,000 foot goal, I leveled off at 30,500 feet indicated. Then I had to concentrate on holding that al-



December 5, 1992 . . . Dave Timms gives a thumbs up after a successful record breaking flight. Note the video camera over the right shoulder and the latex gloves.



NAA observer Dick Freeburg offers his congratulations to Dave Timms after his successful flight. The latex gloves were worn for warmth.

titude within plus or minus 150 feet for 90 seconds to make it official. The airplane didn't accelerate one bit, but the air was smooth, and I maintained plus or minus 50 feet for more than three minutes. Center confirmed that their Mode C readout was showing level flight at FL 305 and that it was being recorded on the computer tapes.

I radioed a status report to ground base and then contacted Los Angeles Center to report starting descent to warmer air. Immediately I lowered the nose gear, pitched the nose down, reduced power, made a steep turn back to the shore line and switched fuel tanks. With less than three inches of vacuum, my attitude indicator tumbled for the first time. I expected to see the airspeed pointer approach the yellow arc. But the airspeed indicator didn't even get up to my typical indicated cruise airspeed.

"Of course not, you dummy," I chided myself. "That big flat prop is holding you back, and at this high density altitude you're not getting much pressure on the pitot tube."

Landing was 1 hour and 34 minutes after takeoff. As I taxied back to Camarillo Air Center, Freeburg reminded me by radio not to open the canopy and break the seal. That was to be his pleasure.

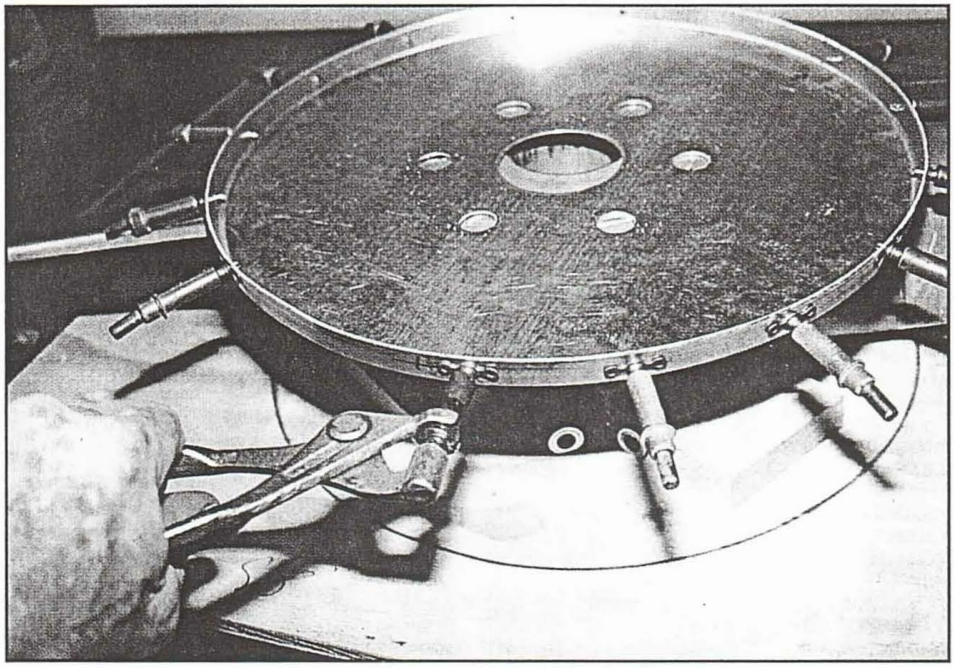
After shut down, Freeburg inspected the seal and sliced it with his fingernail. I opened the canopy for a hand shake with his congratulations and a rousing cheer from the crowd.

Oh, yes, McDonough saw that I landed with 4 gallons of fuel, nearly 40 minutes of flying time.

It just proves that a 54-year old man can compete with the astronauts on a shoestring - if the shoestring isn't too heavy.

(Editor's Note - Dave was recently notified by the NAA that his flight has been approved by the FAI as a world record. Congratulations!) ◆

ANCHOR NUTS . . . WHY? WHERE? HOW?



Here anchor nuts are clamped to the outside edge of a propeller bulkhead with 1/8" Clecos in preparation for drilling the rivet attachment holes. After the holes are drilled the anchor nuts will be transferred to the inside flange edge and riveted.

More than 15 years ago I wrote a chapter titled "Where and How to Install Nut Plates" for my book "The Sportplane Builder," (it's the blue one). Since that time I have learned a few more things about installing anchor nuts.

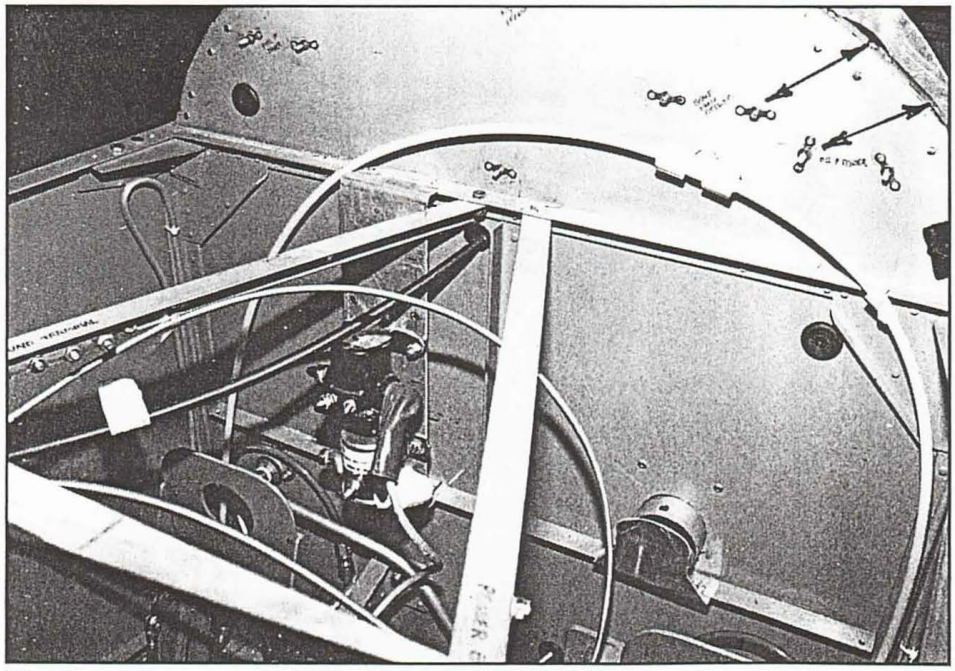
For some reason I like to call them nut plates. Be that as it may, I still don't like those pesky little things but, boy, are they important!

As the name implies, anchor nuts are captive nuts you can attach permanently to the blind side (backside usually) of an assembly. Often this is a removable accessory, component part, or cover, of some sort.

These anchor nuts, or nut plates, as they are often called, are usually installed where access to a regular hex nut with a wrench would be difficult, if not impossible.

With anchor nuts installed, it becomes possible to insert and torque your machine screws or bolts from one side.

Anchor nuts eliminate the need for groping around under an assembly in an attempt to install an ordinary hex nut.



These accessory mounting anchor nuts behind the firewall are too far from the edge making it impossible to set the rivets with a rivet squeezer. Instead, a rivet gun had to be used.

Where Do You Use Them?

You will find that anchor nuts are just about the only way you can make some installations. The most frequently affected problem locations are the following:

1. Inspection access covers and hatches.
2. Cowling attachment.
3. Installation of accessories on the firewall.
4. The installation of antennas.
5. Propeller spinner/bulkhead installation.
6. The attachment of wing root fairings.
7. Instrument panel installation.

If you think about it you will realize that the applications listed have this in common. Each is, for all practical purposes, a so-called "blind installation." That is, the part generally has to be secured with little or no access to the opposite side for installing and torquing ordinary nuts.

Substituting anchor nuts in these locations, therefore, not only makes the installation possible, they will also permit you to remove the part later for replacement or maintenance.

Keep this thought in mind. During the construction of your airplane you will enjoy much easier access to everything than will be possible later after the airplane is finished.

For example, after you complete your airplane, you will find it impossible to remove an accessory like the voltage regulator, gascolator, or air/oil separator from the firewall, single-handedly, if the unit was in-

stalled with ordinary hex nuts.

Obviously, without the aid of a second person inside the airplane manipulating a wrench on the opposite side, such a simple task is almost impossible.

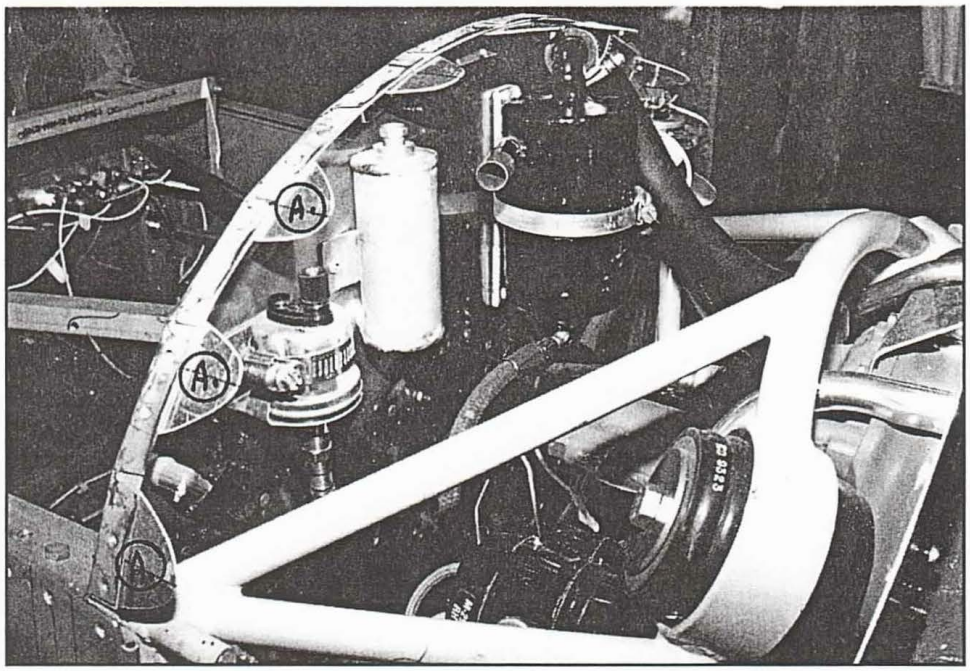
But, even if you have somebody to help, what do you do if you have a big fuselage fuel tank up front? You may still lack wrench access to the firewall unless the tank is removed first!

Of course, you would have missed all that fun had you anticipated the need and installed the accessory with anchor nuts.

The same problem can confront you should you have to remove an antenna. It would be simple enough to accomplish the task single-handedly if anchor nuts are installed . . . if not, you will need somebody outside the airplane with a back-up wrench.

In short, consider installing anchor nuts anywhere you find it impossible, or impractical, to install standard aircraft hex nuts.

Naturally, quite a bit of extra work (and cost) is involved in installing-anchor nuts, so it is not likely you will consider installing them just for the fun of it . . . not without a good reason.



These firewall mounted accessories are all mounted with the aid of anchor nuts to make them removable without access to the backside of the firewall. The rear portion of the cowling will be secured with machine screws. Note the installation of tabs (A) for mounting the anchor nuts.

Selecting the Right Kind of Anchor Nut

This is no big problem because almost any type of anchor nut (nut plate) you can get will most likely be suitable for the job. Assuming, of course, it is the correct size for the bolt or machine screw you intend to install.

Incidentally, many a builder has, on occasion, installed a wrong size anchor nut, simply because he failed to check it before installing it. That always means more unnecessary work as they have to be drilled out and replaced.

Here are a few thoughts you can mull over. It is not at all unusual for the typical all-metal homebuilt to have more than two or three hundred anchor nuts installed.

Two of the most commonly used anchor nut varieties include:

1. The two lug nylon insert locking type (AN366F).
2. The two lug all-metal anchor nut (K1000).

Other less frequently used types include the all-metal floating anchor nuts, one lug nuts, corner nuts, and even miniature nuts for limited space installations.

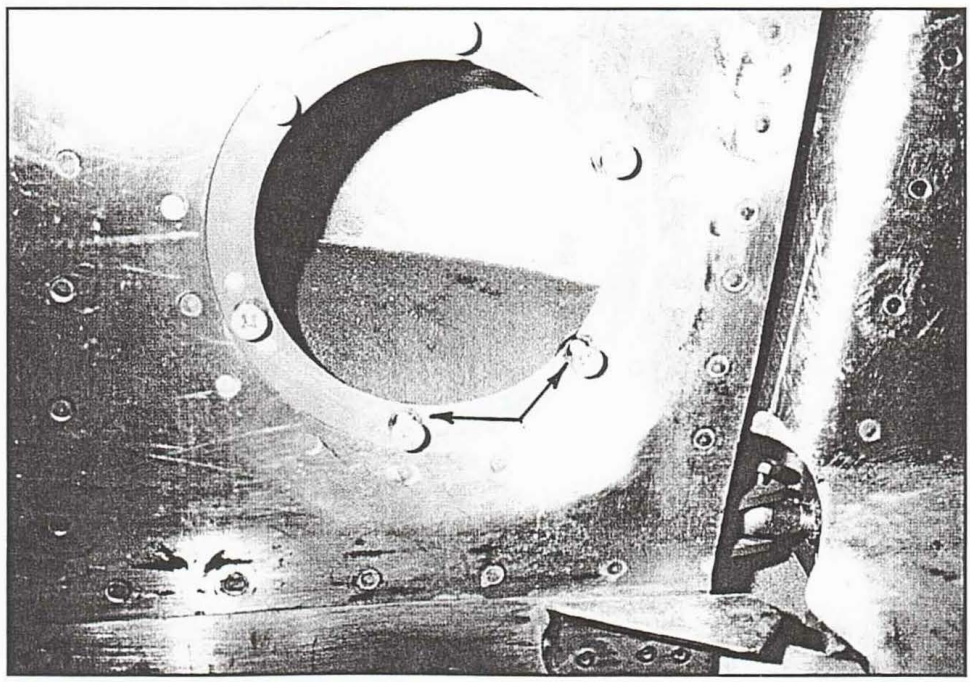
NOTE: Check your homebuilt supplier catalogs for the options and sizes they normally carry. Don't be confused by the specification numbers (AN, MS, NA, etc.). Look at the illustrations and select the bolt/screw size you need accordingly.

Cost is very definitely a factor to consider when selecting the type of anchor nuts you will use.

For example, according to one of my catalogs, I can see why the all-metal K1000 two lug anchor nut is so popular. For one thing, it is quite inexpensive (about 17 cents each). Besides that, it is very light, is lubricated lightly with a dry lubricant, has a self-locking capability, and can tolerate temperatures as high as 450 degrees F.

In contrast, the listed, nylon locking insert anchor nut (AN366F) is a heavier, bulkier, anchor nut that can only tolerate a maximum of 250 degrees F. And, in spite of these shortcomings, retails between $1.10 and $2.98 each. (In 1994, more than ever before, it pays to shop around.)

My little RV-3 has over 345 anchor nuts installed as of this date. Guess which variety of anchor nuts I am using? It is the 17 cent variety, of course. If I had to install the expen-



This aft fuselage access is essential for installing and connecting the elevator control mechanism. Anchor nuts make this possible. Note how the builder has temporarily installed the correct size screws to keep from misplacing them.

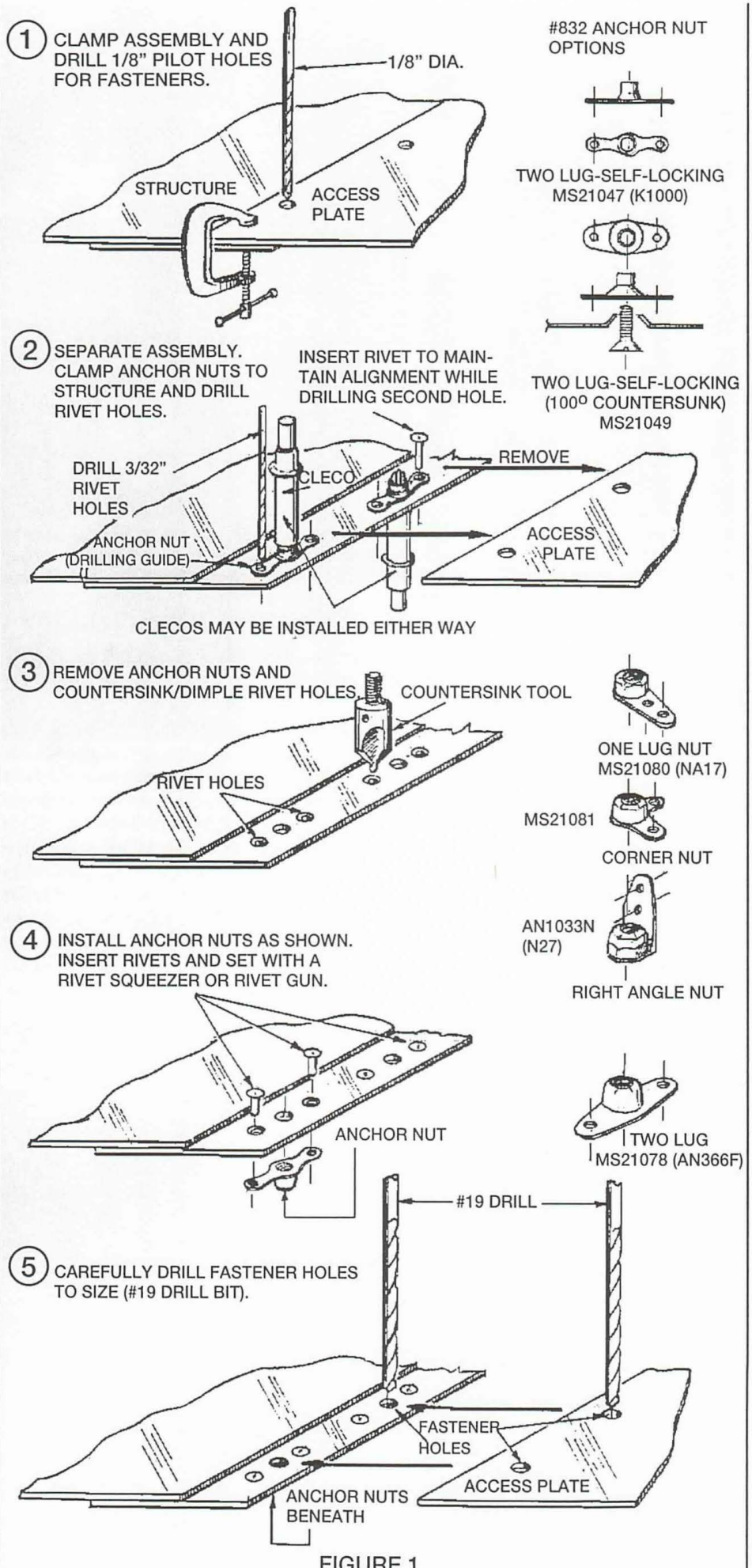


FIGURE 1
ANCHOR NUT INSTALLATION PROCEDURE (FOR #832 NUTS)

sive AN500F elastic-insert type, I would have had to obtain a bank loan by now.

Incidentally, I know you won't be able to resist the temptation to figure out how much 345 of the higher priced nylon locking insert anchor nuts would have cost me, so, go ahead . . . the numbers will shake you up.

Sometimes the space remaining for installation of an anchor nut is so limited that neither a standard two lug anchor nut or a miniature anchor nut will fit. Often a corner nut or a one lug anchor nut has to be substituted in these locations.

In other locations it may be necessary to install a right-angle nut, but these are rare exceptions.

Anchor nuts are also made with a floating captive nut which supposedly allows easier alignment on assembly. I find these to be conducive to sloppy workmanship and, therefore, merit little consideration for use in the average homebuilt. Besides, they are more expensive and more difficult to rivet in place.

Tips For Installing Anchor Nuts

Although anchor nuts are most frequently used to attach access plates, fairings and the like, they can also be used in structural applications with bolts.

Normal belief has it that the only way to attach anchor nuts is by riveting them to aluminum surfaces. This is not so.

You can also rivet these nut plates to plywood surfaces and fiberglass components. For that matter, anchor nuts may even be tack welded to steel parts.

On wood surfaces, anchor nuts are secured with nails or screws as well as by riveting. It all depends on the thickness of the surface material. In either case, it would be prudent to add a dab of epoxy adhesive between the nut plate and the wood surface.

The minimum acceptable diameter for aircraft structural bolts is 3/16" (AN3 bolts).

It is well to mention that larger anchor nuts are available and they are suitable for use in highly stressed locations.

The only noticeable difference in the anchor nuts used with larger bolts (3/8" dia. [AN6] and up) is that they are secured with larger rivets (1/8" rivets instead of the smaller 3/32" rivets) to better resist the higher torque limits imposed by such bolts during installation.

The most popular size anchor nut is the one that takes 832 machine

screws. This size is used almost everywhere you would need to install an anchor nut.

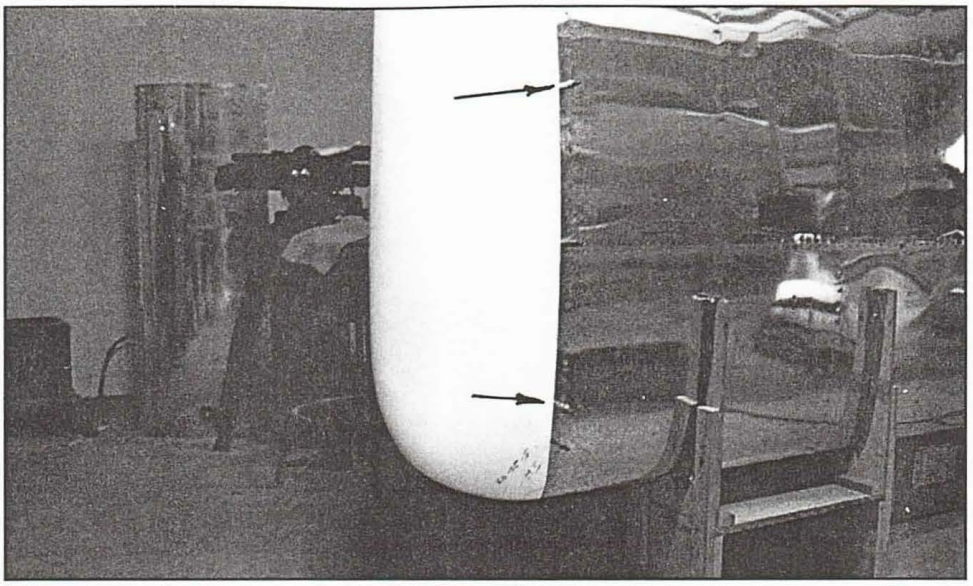
Fortunately, this is also the easiest of the anchor nuts to install. The reason being that a 1/8" Cleco can be used to temporarily clamp it in place while you drill the 3/32" attachment rivet holes.

Here is the basic procedure I use to install the 832 anchor nuts (see Figure 1).

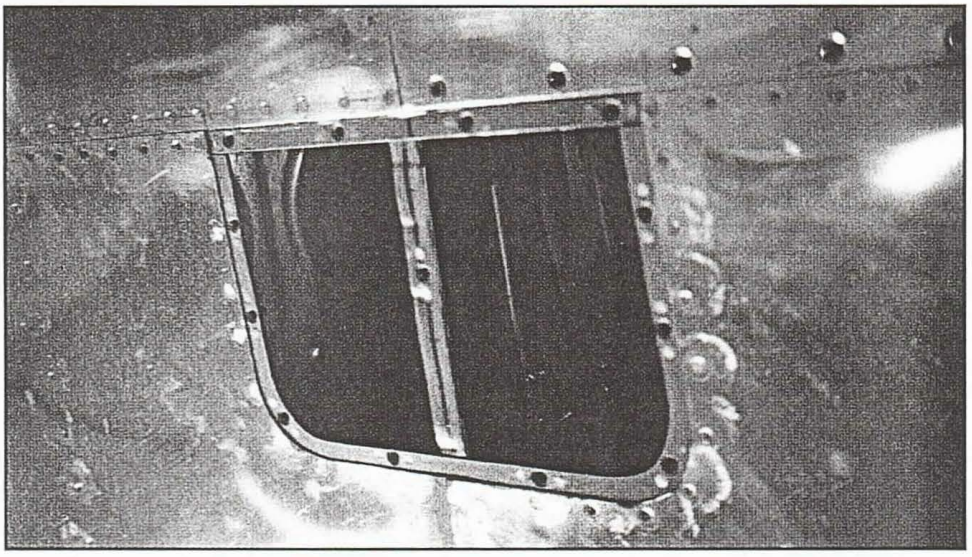
1. Clamp the two parts together and drill a 1/8" alignment hole through both of them where the attaching screw/bolt is to be installed.
2. Separate the two parts and set the top piece aside.
3. Place an anchor nut over the drilled hole in the bottom part and clamp it with a 1/8" Cleco. This will accurately align the nut plate with the drilled alignment hole.
4. Drill a 3/32" rivet hole through one of the anchor nut lugs.
5. Caution, don't ignore this step! Insert a 3/32" rivet in the hole you just drilled to prevent the anchor nut from twisting out of alignment while you drill the second hole through the opposite lug.
6. Remove the anchor nut and countersink the two 3/32" rivet holes.
7. Reinstall the anchor nut in its correct location (underneath now) holding it in position with a 1/8" Cleco or Cleco shoulder clamp. If Clecos won't reach, install a short temporary screw to hold the anchor nut in place.
8. Insert a flush head 3/32" rivet in each lug hole and set it . . . preferably with a rivet squeezer. Of course, if you must - use a rivet gun where a rivet squeezer won't reach - but it will be a trickier operation.
9. Remove the Cleco clamp and redrill the original 1/8" alignment hole to its correct diameter for the 832 screw with a #19 drill bit. Be extremely careful because the drill bit will tend to hog in and ruin the threads in the already installed anchor nut.

Also, don't forget to enlarge the 1/8" fastener hole in the removable access plate, if applicable, with a #19 drill.

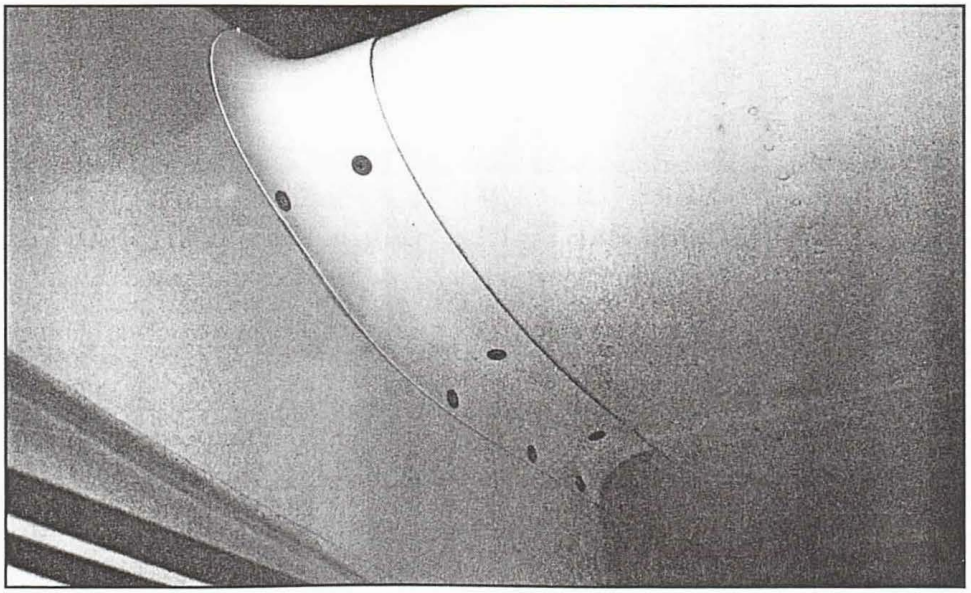
10. If the installation machine screw is to be a flush head type, you will have to dimple, or countersink, the surface skin. Dimpling the bottom metal part of the assembly after an anchor nut is installed is, naturally, impossible. However, when the metal is thick enough countersinking should present no problem. Naturally, with thinner material, the



Fiberglass wing tips may be installed easily and quickly with rivets, or with nut plates and screws to make them removable. However, wing tips rarely ever have to be removed so the extra work and cost is seldom justified. A little extra slack in the wing tip light wires works just as well.



Installation and inspection access must be provided wherever there are control connections. Here access to the aileron bell crank and push-pull tubes is made possible with the help anchor nuts. This opening in the bottom of the wing is large enough to get both hands in while manipulating wrenches.



The temptation is great with some builders to paint over the attachment screws. This, however, proves to be a mistake as the fasteners soon chip and look bad. Installation of new stainless steel screws after painting is completed is the way to go.

surface skin can only be dimpled as countersinking would unduly enlarge the drilled installation holes.

Making Difficult Installations

Gravity will be working against you when you have to insert the rivets from the bottom and attempt to keep them from falling out. At the same time, you will be trying to press down on the anchor nut as you grope for the rivet squeezer . . . a difficult feat at best.

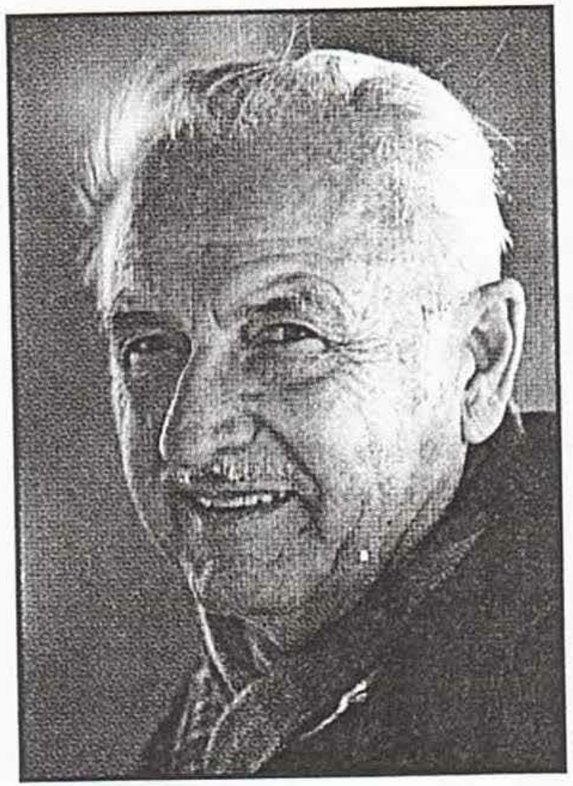
You will find that two hands are insufficient without resorting to a trick or two.

You can eliminate the need for a third hand by using bits of masking tape to hold the rivets in place. This is the same technique used to hold the rivets in place for other back riveting jobs.

However, when an anchor nut must be positioned from underneath while you insert the rivets from the top, masking tape can help but is not as effective. You may have to insert a temporary screw in the fastener hole if a shoulder Cleco won't reach. Of course, a 1/8" Cleco will work with an 832 anchor nut. However, its bulkiness may make it difficult to set the rivets with a rivet squeezer. In that case try inserting the Cleco from the opposite side or insert a 3/32" Cleco in one of the rivet holes. At any rate, think your problem through . . . there is usually a way to get the job done.

After the anchor nuts have been installed some builders run a tap into each nut plate to be sure the screw will go in easily during assembly. This practice, however, is not at all wise where the self-locking feature of the anchor nuts is important.

Installing anchor nuts, initially, is sometimes difficult and always time consuming. Nevertheless, the effort is worth it because they will always be there to simplify your future maintenance and inspection work.



If you wish to contact the author of this column for additional information, please send a SASE to:

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BOOKS BY TONY

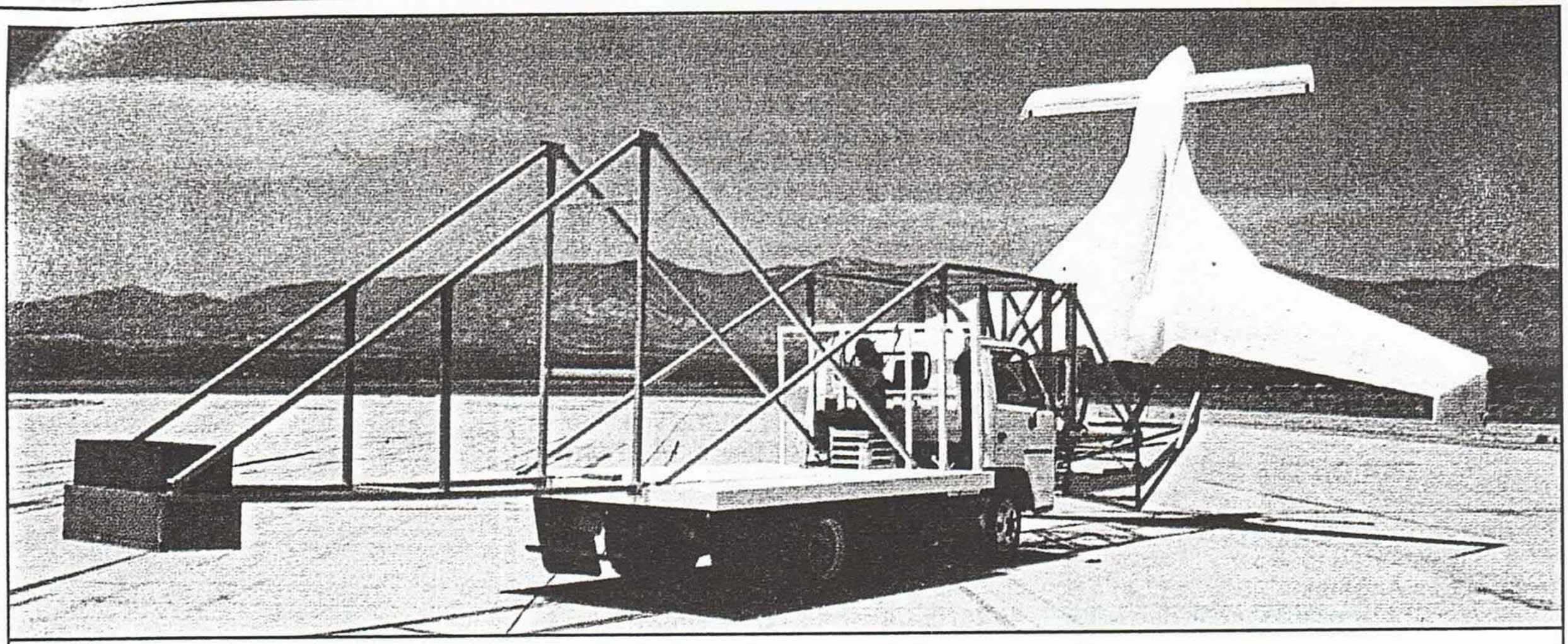
The following books by Tony Bingelis are available from the EAA Aviation Foundation, EAA Avia-tion Center, Box 3086, Oshkosh, WI 54903-3086, 1-800/843-3612. Major credit cards accepted.

-Sportplane Builders (Aircraft Construction Methods, 320 pages) - $19.95

-Firewall Forward (Engine Installation Methods, 304 pages) - $19.95.

-Sportplane Construction Techniques (A Builder's Handbook, 350 pages) - $20.95.

Add $2.40 postage and handling for each publication ordered . . . or order all three for **$52.97 plus $6.95 postage and handling.** Wisconsin residents add 5% sales tax.



Rutan Tests The Long-EZ For Deep Stall

Using a basic, plans-built Long-EZ donated by homebuilder Donald Douglas, Rutan Aircraft Factory has measured full scale data to investigate the behavior of the Long-EZ design at extreme angles of attack.

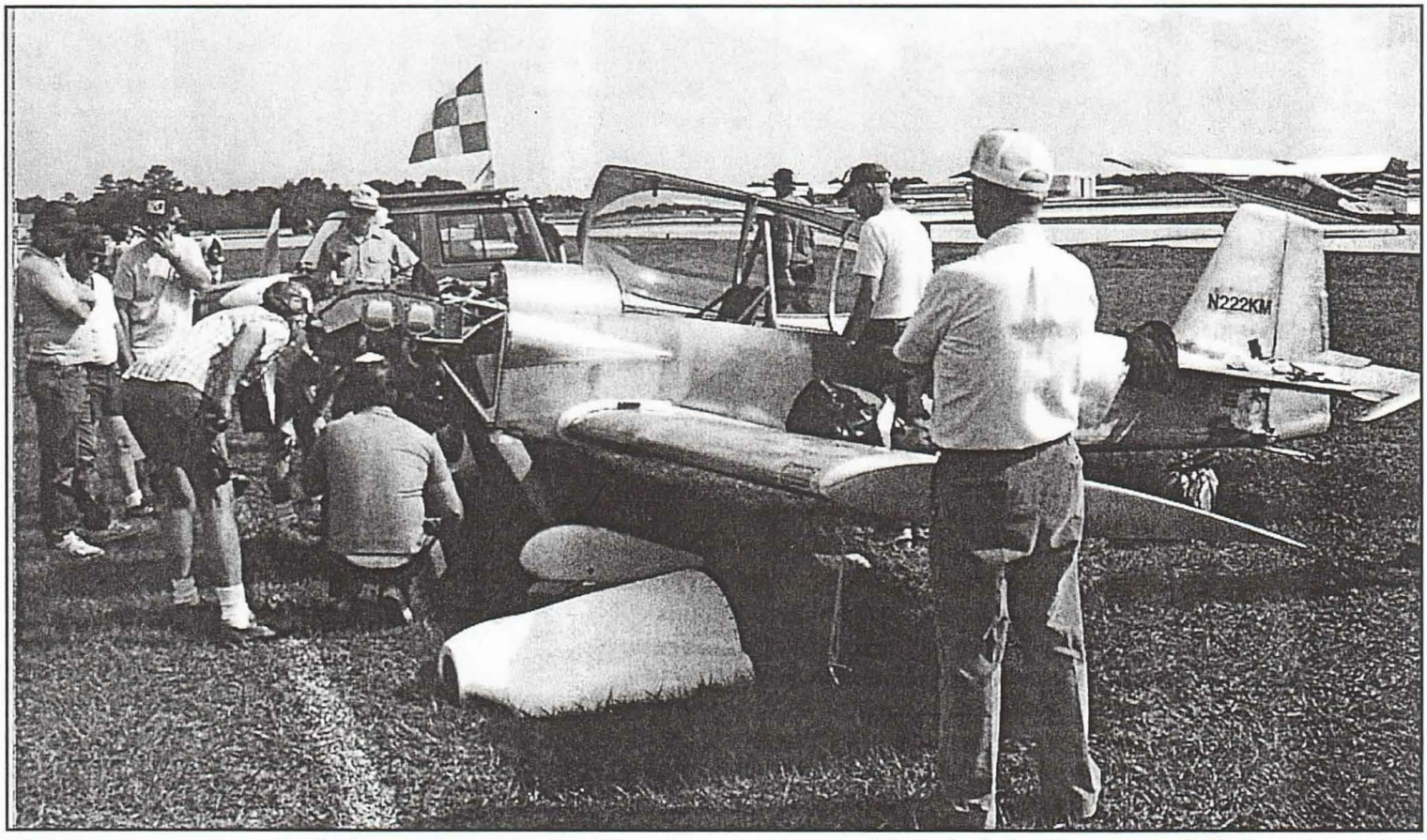
While Long-EZs are limited by aerodynamic design to achieving flight angles of attack above 16°, one Long-EZ is known to have become locked in a deep stall that resulted in an accident with injuries to the pilot.

To further investigate this phenomenon, Douglas' Long-EZ was mounted to a special 3-axes instrumented support on the front of a truck and was driven along the runways at Mojave while gathering data. These data show that the Long-EZ can recover from a deep stall when flown within allowable CG limits. The suspected, vortex-induced, extreme lift at high angles of attack did not exist. Data from these tests and a discussion of their implications to Long-EZ flyers will be published in the July issue of the RAF Canard Pusher newsletter.

For further information, contact Mike Melvill at 805/824-4541.

Builders Never Had It So Good

BY TONY BINGELIS



Attend and support nearby fly-ins whenever you can. There is much to see and learn by being there, especially if you take a few detailed photos of the type of aircraft you are building.

Building an airplane is a long term commitment in time and money, and yet thousands of first-time builders have managed to persevere and are now flying some mighty nice homebuilts.

How do they do it? Are they highly experienced engineers, mechanics, electronics gurus, and rocket scientists? Obviously, most are not.

Most serious builders are, however, highly motivated and determined individuals from all walks of life who are intrigued with the idea of building and flying their own airplane. Instinctively, they feel it doesn't take a mechanical genius, a highly skilled aeronautical engineer, or someone with a broad technical background to build an airplane. And rightly so.

As evidence, I offer the following abbreviated cross section of successful builders in my area. It includes a dentist, a plumber, several retired military pilots, a veterinarian, a number of computer employees and analysts, a chiropractor, an airline captain, an insurance salesman, a rancher, a contractor, a cabinet shop owner, a fire chief, a machine shop owner, a boat builder, a couple of flight instructors, a tech school instructor, and even a neurosurgeon who built a Pietenpol.

Obviously, these very busy individuals really wanted to build an airplane . . . and were willing to find the time to do so. Except for a few of these individuals, some didn't even have a two-car garage or a workshop area when they first started. Significantly, all were EAA members and were confident they would not have to singlehandedly fabricate all the components and parts for their projects behind closed doors in their own private "skunk works." Not when all kinds of help, guidance and resources were theirs — just for the asking.

O.K., so you don't want to ask for help. Well, you don't have to. There are folks (call them EAAers, homebuilders, aviation crusaders or whatever) who seem to share unique characteristics . . . they love to see others start their very own homebuilt projects and want to see them succeed . . . often so much so that they just can't help exuding optimistic encouragement.

So, if you are an aspiring builder but have some qualms about your ability or think you lack the time to successfully complete your dream airplane . . . read on.

FIRST THINGS FIRST

Study your plans and builders manual! Much more information is contained in the plans and builders construction manual than many a first-time builder would expect to learn.

You cannot find everything you want and need to know by casually glancing through the plans and instructions as you would a newspaper. Sometimes a detail may not be where you expect it to be.

Study your plans continuously during construction and you will eliminate a lot of unnecessary frustrations and telephone calls.

There are a number of other concurrent initiatives you can take that will help you develop your homebuilder skills and confidence.

One of the more important of these is to arrange to visit any nearby builders who may already be building or flying the same kind of airplane as the one you selected. If nobody has a similar project underway in your vicinity, try to establish contact with a few local homebuilders regardless of the type of aircraft they are building. You can learn a lot by visiting other projects. Don't worry about conversation. Conversation comes naturally when people of like interests get together.

WE NEVER HAD IT SO GOOD . . .

During the early years of homebuilding, a builder had to pretty much go it alone. There were no practical technical books or manuals that could be used . . . except for old military technical orders and manuals written for big military aircraft. There were no kits as we know them today and only a few (very few) designs were available to builders.

The so-called Fly Market or Country Store can be a homebuilder's treasure house where all kinds of hard-to-find parts often show up.

The plans were skimpy and lacked details for instrumentation, engine installation, propeller selection, and even for electrical and control systems.

As for designer furnished building instructions, they were as skimpy as the plans.

It was a rare sight to see a homebuilt on the airport or, for that matter, to see one under construction anywhere. This made it difficult for a first-time builder to visualize what homebuilts really look like.

How different it is today. There are thousands of homebuilts flying and they are a common sight on most any airport. And that's not all. Here is what else you have going for you today:

1. **The EAA — your best technical resource.** I can't imagine anyone wanting to build an airplane without joining the EAA. This organization, the largest of its kind in the world, was specifically started for folks who were interested in building and flying their own sportplanes.

The membership magazine you are now reading, ***Sport Aviation***, is the finest, most detailed, aviation magazine in the world featuring everything you as a sport pilot and aspiring builder would be interested in.

For example, through the EAA you can use your credit card to order "how-to" books, manuals and videos (1-800/843-3612) and obtain library services for almost any technical subject you may want to research.

EAA designated highly experienced volunteers (Technical Counselors and Flight Advisors) will gladly help you to realize your goal of building and flying safely.

Join the EAA now if you are not already a member . . . don't be a loner.

And there is still more . . .

2. **The local EAA Chapters.** By joining a local EAA Chapter, you can take advantage of the services and individual guidance available from the Chapter's Technical Counselor or Flight Advisor. The monthly Chapter meetings are where you can meet other builders and mingle with interesting individuals with like interests in homebuilts and sport flying. These members, collectively, know the best sources of supply (reliable and not so reliable) for whatever aircraft parts, components, instruments, avionics, and construction materials you may need.

I don't know what kind of aviation related know-how you may have, but in the typical EAA Chapter there is an amazing amount of diversified expertise. In a larger Chapter, you are quite apt to find information, guidance, and advice from highly skilled engine specialists, avionics gurus, machinists, dope and fabric experts, welders, wood craftsmen and maybe a "guard house lawyer" or two . . . most anything a builder might need.

Jigs, wing racks, engine stands are often passed from one builder to another . . . often free for the hauling.

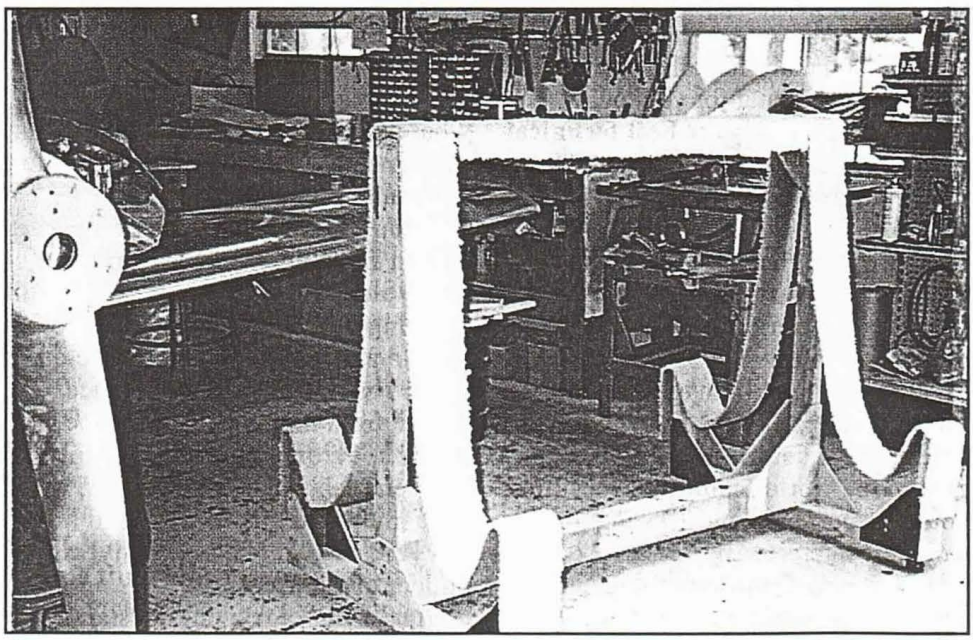
Here a few experienced local EAAers are helping a fellow builder rivet his metal wing spar.

Think of the time and money saved by not having to build your own.

The Chapter may have weighing scales and can help you with your aircraft weighing.

Certainly, there always seems to be plenty of willing manpower to give you a hand with the weighing, moving and even the assembly of your aircraft.

3. **And then there is the FAA.** We have a FAA that is very helpful in providing detailed guidance for builders who want to have their aircraft registered, inspected and certificated in the Experimental Category.

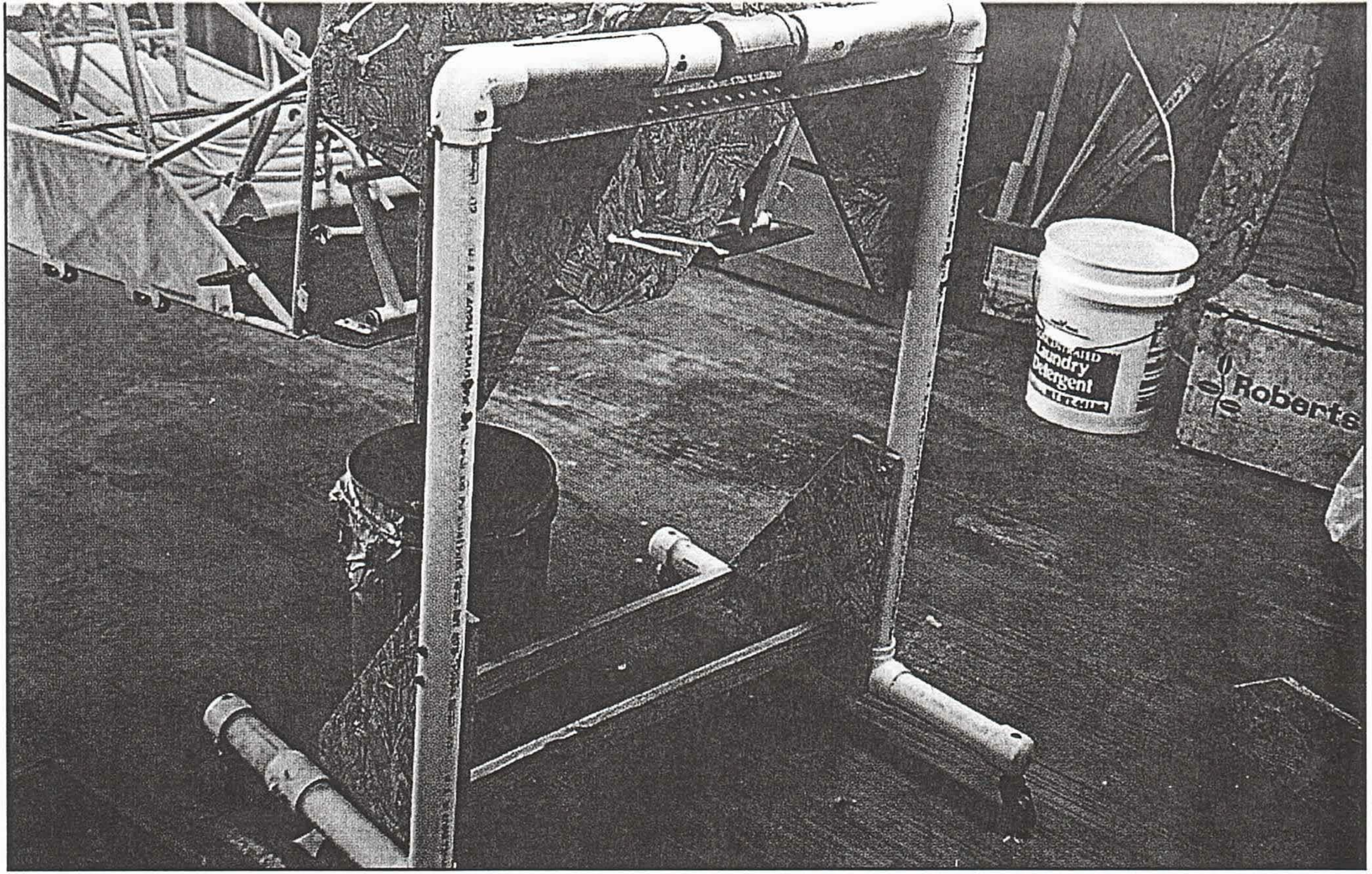


Jigs, portable wing racks and engine stands are often passed from one builder to another . . . often free for the hauling.

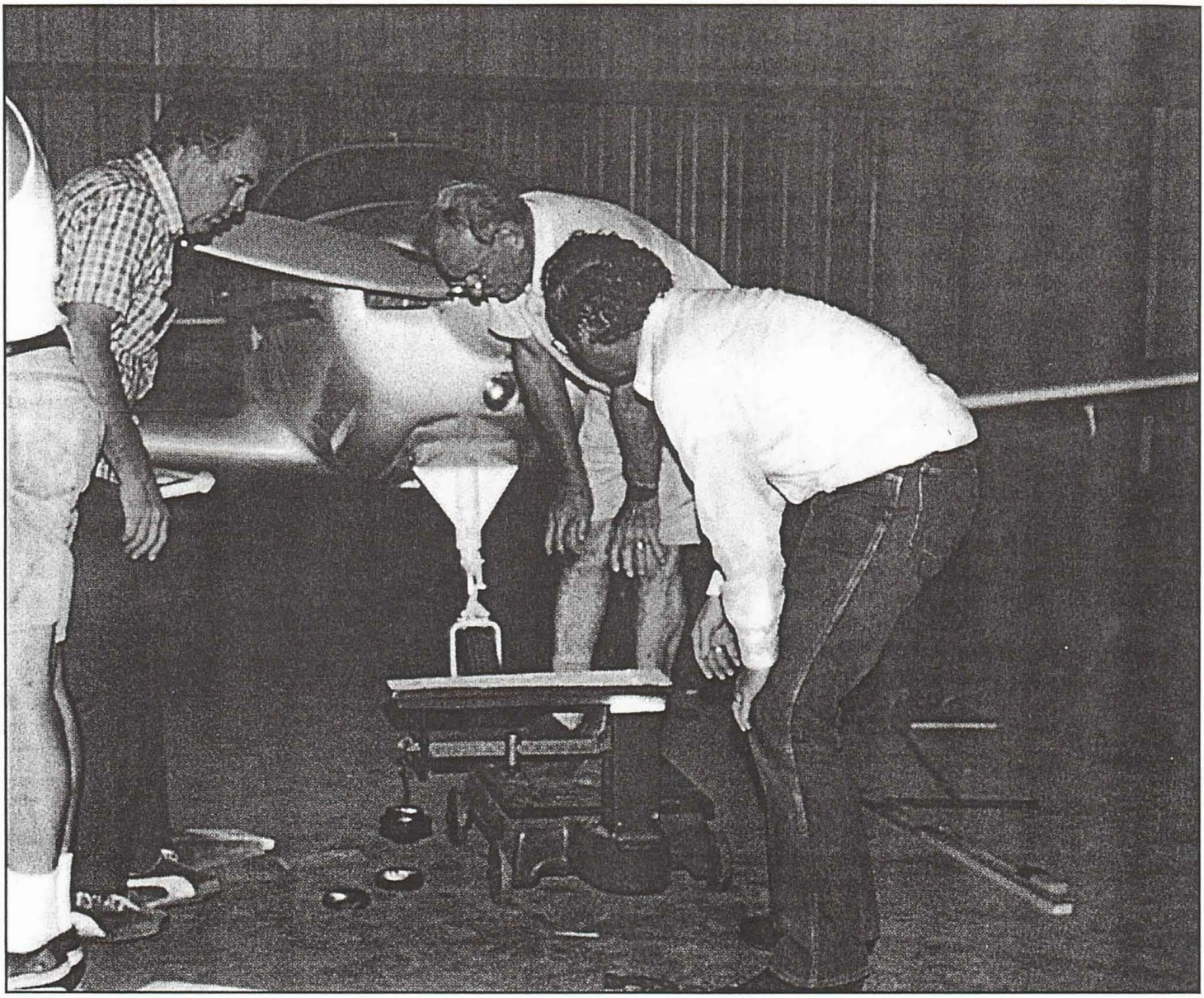
You can contact your nearest FAA Manufacturing Inspection District Office (MIDO) and ask them for their information package for homebuilders. They will be happy to send it to you. After all, it is a good way for them to familiarize you with FAA requirements and services, and at the same time to minimize their own workload.

The information package will most likely include Advisory Circular AC No. 20-27D (Certification and Operation of Amateur-Built Aircraft). This publication was written specifically for the homebuilders, spelling out in detail the rules and requirements regarding the certification and operation of homebuilt aircraft.

There is more. Included among the information currently being sent out by our local San Antonio FAA office are the various forms and guidance



Good ideas abound among builders. This rotatable fuselage, or wing stand, was assembled from PVC pipe, plywood and common plumbing connectors.



The local Chapter may have a set of weighing scales and can help you weigh your aircraft. Somehow there always seems to be plenty of manpower to give you a willing hand with your weighing, moving and even assembly tasks.

necessary to successfully launch your dream airplane.

4. **Plans and Kits — hundreds of them.** Can't decide what to build? Today, you have many more choices than the original few plans available years ago. Actually, there are well over 500 different homebuilt designs and kits to choose from.

Most of the popular highly engineered designs are being built in ever increasing numbers as is evident from numerous successful completion reports.

You can expect most plans sold today to be far more detailed than those that were available to the earlier homebuilders. Although many plans and most kits are furnished with detailed construction manuals and parts lists, some builders still fuss over the lack of detail and clarity . . . a good sign of progress, I guess.

5. **Technical references.** Forget about the dusty old WW-II technical books. You now have available dozens of books, manuals and videos especially created for the homebuilder and stocked by the EAA. Some describe the building process for a specific design while others are devoted to technical subjects such as fabric covering, welding, woodwork, etc.

It embarrasses me to blow my own horn, BUT . . . my four highly illustrated books, as offered by the EAA, are about as complete and detailed a source of technical information a builder can obtain for constructing any kind of homebuilt aircraft.

Compared to the cost of construction plans or the cost of building the airplane, your book costs will represent a minor expenditure.

A book, unlike a computer or video, can be referenced time and time again in your workshop while you work. Just dust it off and check the index for the details you need at the time.

Here is another tip. Get in the habit of reading the classified ad section of ***Sport Aviation*** to familiarize yourself with ever changing important sources of information, parts, services and supplies.

6. **Help from the designer/kit manufacturer.** Most designers are willing to help their builders because they have a stake in the successful completion of each project. After all, they have a reputation to protect. He will want you to succeed with your project and he knows the best incen-

tive for a builder is to learn who else is building. Builders addresses and phone numbers are, therefore, often a part of the plans package. Take advantage of it. Remember, the other builders are just as curious and interested as you are.

All designers will look with disfavor on a builder's attempt to structurally alter his design. In addition, he may view frivolous questions that are adequately covered in the builders manual or instructions to be quite annoying. It doesn't take a designer long to learn if a builder has even bothered to thoroughly read the instructions.

Most designers and kit manufacturers will gladly answer telephone queries. When you call, call at a reasonable time (consider the time zone differences between the east coast and the west coast) and get right down to the question you have. It helps if you jot down a note or two before calling.

Stay in the good graces of the designer by enclosing a stamped self-addressed envelope each time you write (to anyone) expecting an answer . . . postage costs add up.

7. **Builders newsletters.** Almost all designs being built in any number will be supported by some sort of a builder's newsletter. Many of these contain a wealth of information from other builders exchanging views, tips, and means for solving a particular problem they encountered.

The better newsletters, as you might expect, are those put out by the designer/manufacturer and those having a close rapport with the designer who sometimes acts as an advisor regarding matters concerning structural integrity or speculated changes.

Other newsletters may be a rather poor effort to disseminate information on a regular basis but even these may contain useful information.

Anyhow, if there is a newsletter for the type aircraft you are building, it would be worth checking into it. Subscription rates generally range from $7.50 to $15.

8. **Fly-ins.** Oshkosh, Sun 'n Fun, EAA Regional and dozens of local fly-ins are where you can see and examine real homebuilts and talk to their proud builders. Attend and support nearby fly-ins whenever you can. There is much to see and learn by being there, especially if you take a few detailed photos of the type aircraft you are building.

9. **Fly Markets and Country Stores.** These are usually regular features of most larger fly-ins. A Fly Market can be a homebuilder's treasure house where all kinds of hard-to-find aircraft parts may be found. Check these sources out. But be careful . . . know what you are buying.

10. **Computer "On Line"?** It figures. The latest information source for homebuilders is the computer . . . "surfing the web," that is.

Love it or hate it, if you have a computer and subscribe to an on line service, it can be a useful source of information for aviation matters and for specific homebuilt designs.

Those of you who can tear yourselves away from working on your projects long enough to "surf the net" can pick up all sorts of aviation information.

Most of the builders in my area are of the opinion that America On Line is a better and faster service than Compuserve because, I am told, you can log on at 28.8 Baud vs 14.4 Baud for Compuserve.

Be advised, though, that much of the conversations you monitor, and advice you garner, may not be as accurate as you would like it to be. Remember, the comments are from builders and individuals who may or may not be qualified experts, engineers and designers.

And, finally, the information you get may cost you more than you realize in time spent away from your project . . . to say nothing of the monthly on line bill you pile up.

11. **Builders' Workshops.** The better known two day workshops are those jointly sponsored by EAA and the Alexander company. These hands-on workshops are offered in different parts of the country and are very popular with first-time and/or aspiring builders.

The courses are well thought out and provide the opportunity to practice fabric covering, work with composites, sheet metal and even welding.

The cost has been about $199 for the two day work session. Check the latest issues of ***Sport Aviation*** or the Kitplanes magazines to see when workshops are scheduled nearest to you.

12. **Supply sources for builders.** I

don't know anyone who has built a homebuilt without ordering the $5 (refundable) supply catalogs from each of the two most popular homebuilt suppliers:

• Aircraft Spruce & Specialty, 201 W. Truslow Ave., Fullerton, CA 92632, phone 1-800/824-1930.

• Wicks Aircraft Supply, 410 Pine St., Highland, IL 62249, phone 1-800/221-9425.

These are not the only two suppliers, of course. There are others. However, these two reliable suppliers have large catalogs unique in that they are educational and contain technical tips as well.

Other special item supply sources are sometimes provided by the designer and may be included in your plans or instructions.

13. **Why not take advantage of these resources?** Sure, that's a lot to absorb. Many more sources for information and help than you might want to explore in a short period of time.

That's O.K. Remember, your project will last for a couple of years or so . . . just knowing where you can find help and information in the event you need it should be looked on as a valuable resource. ◆

EZ RUDDERS

Some of Aviation's More Interesting Moments

Conventional airplanes have a single rudder, usually attached to the trailing edge of a fixed vertical stabilizer. Together, they comprise the vertical tail. The stabilizer provides directional (yaw) stability by weathervaning the plane into the relative wind. Properly designed, it should perform this function without pilot participation. It always works to eliminate sideslip, which is a relative wind not "on the nose" but from some angle to the left or right of the airplane's longitudinal (nose to tail) axis. The vertical stabilizer is, after all, a wing, and the sideslip angle is analogous to the angle of attack on the main wing. Increasing the sideslip (say, from the right, as in a left yaw) increases the lift of the vertical tail (to the left), swinging the nose back (to the right) into the relative wind. If the sideslip angle is too great, the vertical tail can stall, and the airplane would lose the major contribution to directional stability provided by the vertical stabilizer.

The rudder provides directional control. It is used to yaw the airplane either to assist the stabilizer with minimizing the sideslip, as in turn coordination, or to intentionally cause sideslip, as in a slipping approach to land. While the rudder's primary function is yaw control, deflecting it causes several other things to happen to the airplane.

A quick look at the effects of rudder deflection in a conventional airplane should lay the groundwork for a similar look at the EZ rudder configuration. (The term "EZ" is meant to convey the generic design with these features: canard, swept wing with tip-mounted vertical tails, rear-mounted engine with pusher prop. It is not a statement of design credit or particular manufacturer.)

FORCES AND MOMENTS

Airplanes are said to have six degrees of freedom. Three translational: up/down, left/right, and fore/aft. Three rotational: pitch, roll, and yaw.

Step on the left pedal and the rudder deflects trailing-edge-left. This creates a force, or lift, to the right. Since the lift can be treated as a single force acting through an airfoil's center of pressure (CP), and since the airplane rotates around its center of gravity (CG), a yawing moment is created. The magnitude of this moment is the force of the rudder lift times the moment arm or horizontal (longitudinal, actually) distance between the rudder's CP and the airplane's CG as depicted in Figure 1. More pedal — more moment — more yaw (sideslip, actually). The sideslip does not continue to increase because an equilibrium, or balance of yawing moments, is reached. The airplane's overall directional stability provides a restoring yawing moment equal and opposite to the one caused by the rudder deflection. So, a constant rudder displacement should result in a constant sideslip, although the airplane may continue to yaw (as in a flat turn).

Suppose the rudder's CP is above the airplane's CG as it is on most conventional planes. The same rules apply, so a **rolling** moment to the right is created. The strength of this moment is determined by the lift force of the rudder and the vertical distance (moment arm) between the rudder's CP and the airplane's CG (Figure 2). Since this moment arm is generally much shorter than the longitudinal one, the roll due to rudder deflection is usually a much lesser effect. The airplane's dihedral effect and other less significant effects, which act in the opposite direction, also help to mask the roll due to rudder deflection.

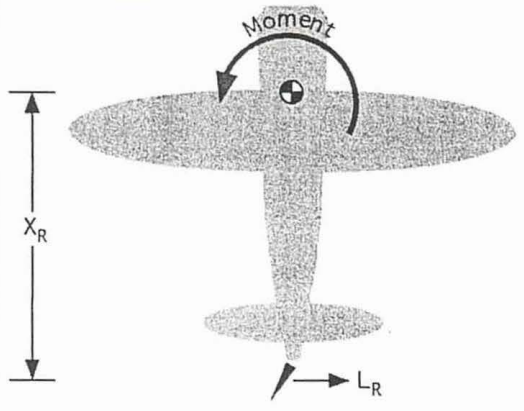


Figure 1
Yaw Moment = $L_R \times X_R$

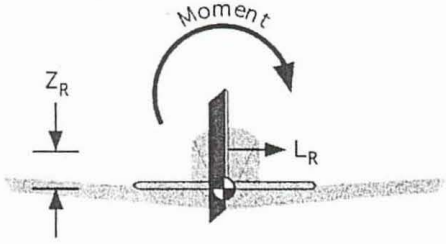


Figure 2
Roll Moment = $L_R \times Z_R$

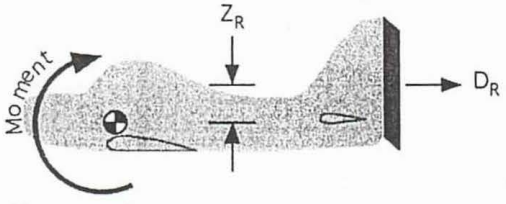


Figure 3
Pitch Moment = $D_R \times Z_R$

Rudder deflection causes an increase in drag of the vertical tail. This additional drag force acts parallel to the relative wind. Since this force acts above the airplane's CG, a nose-up pitching moment is created as shown in Figure 3. Again, due to the short moment arm involved and the typically small drag increment, pitching moments due to rudder deflection are usually not noticed. *That is not to say such moments are always insignificant. The F/A-18 uses rudder toe-in for just this reason. Its twin rudders are deflected inboard with weight on the wheels to provide the additional nose-up moment crucial to aircraft carrier operations.*

That takes care of the three rotational effects, but the translational results remain. The lift force to the right caused by left rudder deflection acts on the entire airplane, moving it to the right. This one is very difficult to observe because it is masked so well by the yaw effects.

To paraphrase a teacher who knows a lot about the subject, drag is drag. As such, the drag added by rudder deflection acts to slow the entire airplane. It better slow the **entire** airplane.

Finally, there's the up/down degree of freedom. The vertical orientation of the rudder precludes any direct contribution in this axis. If the rudder is canted, however (for example, on a twin vertical tail airplane), rudder deflection directly applies a lifting force in the up/down direction as well as the left/right direction. A deflected canted rudder provides a pitching moment due to its vertical lift component in addition to the pitching moment addressed earlier caused by the drag increment.

To summarize the non-canted, single vertical tail situation, every rudder deflection causes a sideways lift force and an aft drag force which cause translations. Because the rudder's CP is behind the airplane's CG, rudder deflection generates a yawing moment. If the CP is above the airplane's CG, a rolling moment is also generated. A pitching moment occurs if the drag force acts above the airplane's CG.

THE EZ STUFF

Now, take the vertical tail and put it somewhere besides the aft end of the fuse-

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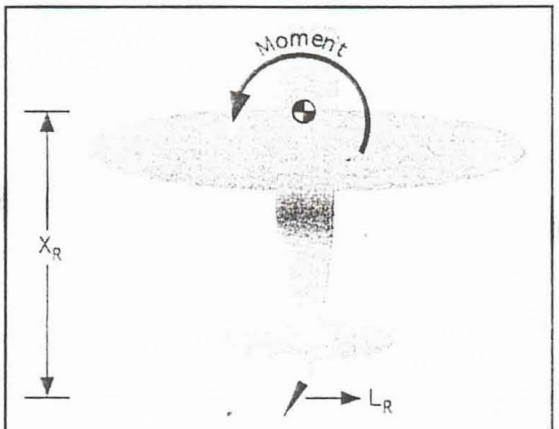

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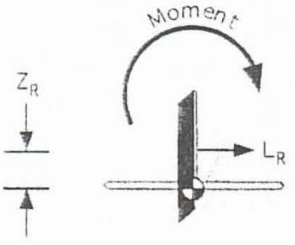

Figure 2
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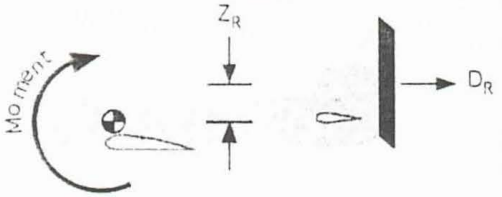

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THE EZ STUFF

Now, take the vertical tail and put it somewhere besides the aft end of the fuse-

lage. Why? Because in the case of EZ designs, there's a propeller in the way. EZ's have swept wings. For the speeds most EZ designs fly, sweeping the wings back is not in the best interest of wing performance. It is, however, a way to get the vertical tail far enough back to provide the necessary directional stability. Of course, symmetry is a factor, so these designs incorporate two vertical tails.

In conventional airplanes, stepping on one pedal causes the other to move aft. This makes sense since both pedals control a single rudder surface which can be deflected both directions. EZ designs incorporate two separate yaw control systems. The left pedal deflects only the left rudder outboard, and the right pedal deflects only the right rudder outboard. Rudders do not deflect inboard for good reasons.

Rules are rules, so everything about forces and moments, translations and rotations which were cited for the conventional airplane also apply to the EZ's. Suppose the left pedal of an EZ design is displaced. The left rudder deflects outboard or to the left. The drag and (sideways) lift forces still act above and behind the airplane's CG, so the airplane experiences the same translational and rotational effects as the conventional airplane. In this design, however, the vertical tails are also displaced laterally, introducing additional effects.

The drag increment of the deflected rudder causes the airplane to yaw to the left, because it has a moment arm which is half the wingspan. There was no yaw caused by rudder **drag** in the conventional airplane, because it was located on the plane's centerline, i.e. no moment arm. The rudder-drag-induced yaw of the EZ design is favorable for coordinating turns. That is, left pedal causes a left yaw due to the left rudder's drag acting to the rear at a lateral distance from the plane's CG in addition to the rudder's lift acting to the right at a longitudinal distance from the plane's CG (see Figure 4).

If the right rudder were also to deflect left when stepping on the left pedal, its drag would attempt to yaw the plane right. Its lift is still providing a left yawing moment, but the drag moment would work to oppose it (Figure 5). There would also be a rudder/wing-trailing-edge physical interference issue to contend with if the rudders deflected inboard. *Rutan's Voyager had two vertical tails, one at the left end of each nacelle, but only the left one had a rudder. This was a weight saving measure which sacrificed some handing qualities. The rudder deflected both ways, but the airplane was better suited to left turns.*

Toe brakes are not required in the EZ design. This design allows wheel brakes to be actuated by continued pedal displacement after full rudder deflection has been achieved. This is one way to ensure maximum "rudder drag" during landing rollout prior to brake use. Perhaps landing with a high crosswind could inhibit use of both brakes because of rudder requirements. *The space shuttle's split rudder deflects both ways to help slow it down after landing.*

Another toe brake issue is discriminating between that last little bit of rudder deflection and the first little bit of wheel brake. In a toe brake set-up, which control the pilot is using is fairly obvious. Good design in an EZ configuration should provide tactile cues regarding this transition. That is, end-of-rudder/start-of-brake should be readily evident through pedal feel.

Some pilots like to fly with a significant force on both rudder pedals all the time. Because one can't be moved without moving the other in conventional designs, it is sometimes easier to modulate tiny displacements this way. This obviously won't work with EZ designs. In fact, several guest pilots admit readily to flying with the rudders deflected for most of the flight. Taken to an extreme, the opportunity to land with the brakes on exists. *The Australian-designed Eagle X-TS had a single, bidirectional rudder, and stepping on one pedal caused the other to move aft. The wheel brakes, however, were actuated by applying force to both pedals simultaneously, regardless of pedal displacement. This arrangement required a careful, conscious effort to step on only one pedal at a time to avoid unintentional braking.*

Removing the rudder from the propwash can also remove some early takeoff roll controllability. The rudder of a conventional airplane typically affords some degree of directional control almost as soon as the throttle is pushed forward. EZ-design rudders are not bathed in the propwash, so their effectiveness is delayed until the airplane has gained sufficient speed.

On the more advantageous side of tip-mounted vertical tails is potential vortex control. Properly installed, they can serve as winglets. Winglets use wing tip vortices to the airplane's advantage by garnering a lift component in the forward direction, adding an increment of thrust. For this thrust effect to outweigh the drag penalty, strong wingtip vortex activity is generally necessary, for example — higher angles of attack or high altitude operations. Considering the number of new business and airline jet designs incorporating winglets, this is no small factor in fuel consideration (for jets, anyway).

Perhaps a bit of a stretch, but two independent systems offer a degree of redundancy although each rudder deflects only in one direction. A jammed or otherwise incapacitated rudder on one side should not affect control of the other rudder. While not truly redundant, this arrangement may be exploited during an emergency crosswind landing.

Independent rudders offer a speed brake or air brake possibility. Deflecting both rudders equally negate each other's yawing moment but still provide the drag increase. Of course, pitching moments and vertical translations (for canted vertical tails) are still there. *Simultaneously deflecting both rudders in the Velocity produces virtually no pitching moment. Doing the same thing in the Berkut, however, causes a mild nose-down pitch. Yes, nose-down. Although the rudders' CP is slightly above the airplane's CG, there's a more dominant effect. Outward-deflected rudders increase the effective camber of the inboard vertical tail, causing lower pressure on that side. Since that lower-pressure flow affects the flow over the outboard section of the main wing, the lift of the main wing is affected. In this case a lift increase occurs at the outboard section of the main wing which is behind the plane's CG, and that causes the nose-down moment.*

Figure 4

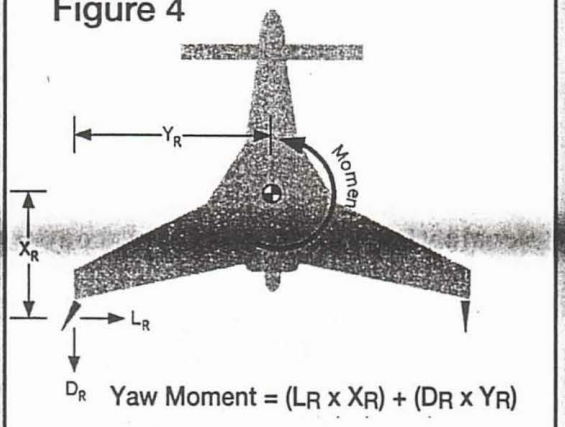
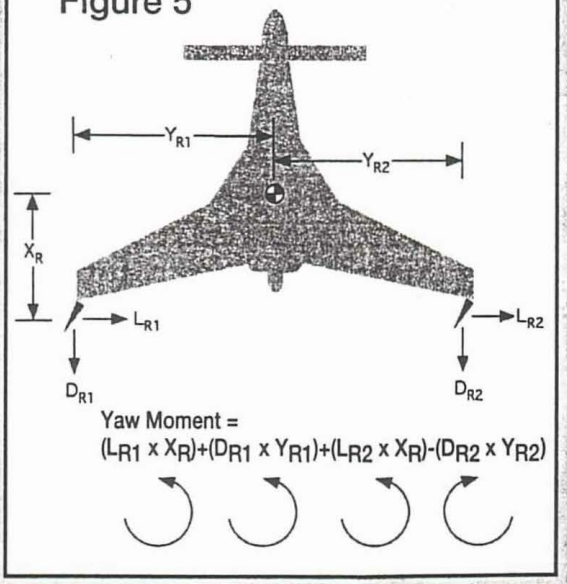


Figure 5



SUN 'N FUN SPRINT AIR RACE

And the winner is . . . Klaus Savier!

BY DAVID GUSTAFSON

PHOTOS BY KARL JENSEN

On the morning of Friday, April 12, the first annual Sun 'n Fun Sprint Air Race, sponsored by Aircraft Spruce & Specialty, was launched in Troy, Alabama. Half the participants were flying homebuilts, the other half had certificated aircraft. The finish line was 322 nautical miles to the southeast at Bartow Municipal Airport, about 15 miles east of Lakeland, site of the Sun 'n Fun Fly-In. The Fly-In was set to start on Sunday, April 14, so that turned out to be the final destination for almost all of the race pilots.

With three race categories, a total of 33 entries showed up to participate. The class breakdown was according to horsepower. There were Sandpipers, Pelicans and Flamingos. The first group was for any aircraft with 75 horsepower or less. Pelicans could be 76 to 120 horsepower and the heavyweights went up to 160 horsepower.

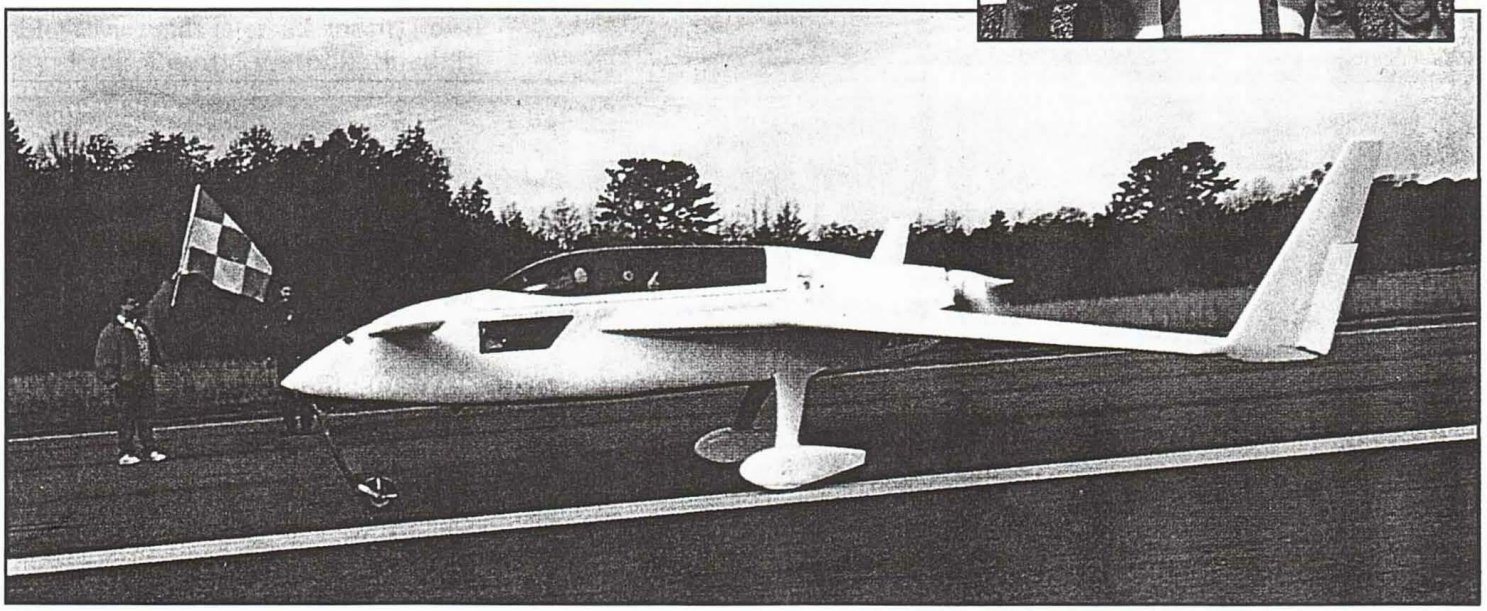
Five years ago, when Aircraft Spruce set up the much longer Great Cross Country Flying Race, the Unlimited class drew entries with up to 550 cubic inches. The smallest category was for 360 cubic inches or less. Understandably, pilots with smaller engines wanted an opportunity to compete in a cross country race, as well. So Jim Irwin, who heads up Aircraft Spruce, stuck on the idea of holding a Copperstate Dash in the fall and the Sun 'n Fun Sprint in the spring. It has provided people with something to do on their way to a fly-in. It's a great way to experience flight, and one has only to tune to 122.75, and listen to the enroute chatter between air race participants, to discover a sense of humor and camaraderie that cannot be beat.

With this year's introductory race, the Sandpiper category drew two Pulsars, a KR-2, Aeronca Champ and Taylorcraft BC12-D.

There were five VariEzes in the Pelican class, a Cassutt, Quickie, Bellanca 7ECA, Cessna 120 and 150, and the Davis DA-9. Over half the race entries were in the Flamingo category. Piper Warriors and Glasairs seemed to be the dominant type.

Jim Irwin (left), president of Aircraft Spruce & Specialty, and Klaus Savier, winner of the Sun 'n Fun Sprint.

Klaus Savier and his award winning Continental powered VariEze.



Race winners, front row, left to right, Rich Levitsky, Howard MacFarland and Ken Shugart. Back row, left to right, Brooks Robinson, Troy Petteway, Dale Schonmeyer, Jim Irwin of Aircraft Spruce, Charles Airesman and Klaus Savier.

What was interesting was that there were quite a few familiar faces from the first Copperstate Dash, which was run last October.

Pilots began arriving on Thursday morning, the day before the race and they kept coming in all day. Trent Crawford, who runs Pike Aviation at Troy, was kept busy pumping avgas, handing out quarts of oil and assisting with the occasional mechanical glitch. One of the VariEze's had problems with his nosewheel, and Trent took the gear off a local customer's aircraft to allow the race pilot the opportunity to fly in the race. He shipped the gear back later.

At 7:00 Thursday evening, the group came together for the first time at the Holiday Inn in Troy. At that point, officials went over the procedures for the race, covering every detail from the final briefing in the morning, wave off procedures, enroute activity, crossing the finish line and the awards ceremony which was held at Sun 'n Fun on Sunday morning. Air race numbers were then handed out and that's when it became known that 33 of the 40 people who had signed up for the race actually showed up to participate.

In the past, weather briefings were provided at Copperstate and Denver by FSS. Since Troy is 100 miles from the nearest FSS, it wasn't possible for anyone to make the trip, so each pilot had to obtain his own weather by calling Flight Service at O'dark-thirty, Friday morning.

CATEGORY A — SANDPIPER

Place	Pilot	Aircraft	Speed
1st	Troy L. Petteway	KR-2	136.96
2nd	Howard MacFarlane	Pulsar	112.85
3rd	Dale A. Schonmeyer	Pulsar	98.46
4th	J. Kevin Lacey	Taylorcraft	72.30
5th	Joseph Mark Smokovitz	Aeronca 7AC	49.14

Troy Petteway's VW powered KR-2.

Brooks Robinson and his Glasair IRG.

Following a buffet breakfast, the pilots boarded shuttle buses to the airport. The excitement began building, as anticipated, at the 7:00 a.m. briefing. Fortunately, the weather was perfect, the winds were favorable for most of the route, and aside from a radar balloon on a 15,000' tether at Cross City (it was almost on the ground when everyone flew by), the course presented no obstacles.

An hour, 35 minutes and 50 seconds after Trent Crawford waved him off with a checkered flag, Klaus Savier, Santa Paula, CA, flew his highly refined VariEze over the finish line at Bartow, FL. His ground speed from releasing his brakes to overflying the finish line had averaged 201.60 kts.! EAAers Neil Holmes and Patricia Morrison were there to log him in . . . with the help of tower chief Eddie Roberts. Nine minutes, 50 seconds later, Ken Shugart streaked across Bartow in the yellow DA-9, fondly referred to as the "crotch rocket", "flying banana" or "yellow cigar." His ground speed: 182.84 kt. The third pilot to cross the finish line was Charles D. Airesman, who also flew a VariEze. He was 20 seconds behind Shugart, with an average speed of 181.69. That's cutting it close.

The significance of these three pilots is that they were all in the Pelican or middle category. They outran everyone in the higher horsepower Flamingo class!

Brooks Robinson, Jonesboro, GA, led the Flamingos in his 160 hp Glasair IRG, which covered the course in 1:47:20, averaging 180.00 kts. Fayette McElhannon, Jr., was second, also in a Glasair IRG, with 1:56:05/166.43 kts. Eleven seconds later, a Lancair, flown by Rick Levitsky, took third in 1:56:19/166.1 kts.

In Sandpiper, Troy Petteway, Columbia, TN, took first in his KR-2 with a half hour to spare. He logged in at 2:21:04, averaging 136.96 kts. Considering he did that on a 65 hp VW engine conversion, it's a pretty remarkable showing. Two Pulsars finished second and third: Howard MacFarlane clocked 2:51:12/112.85 kts. and Dale A. Schonmeyer did it in 3:16:13/98.46 kts. Bringing up the rear was the Aeronca Champ. With two fuel stops, Joe Smokovitz took 6 hours, 33 minutes and averaged 49 kts. That didn't detract from the fun he had par-

CATEGORY B — PELICAN

Place	Pilot	Aircraft	Speed
1st	Klaus Savier	VariEze	201.60
2nd	Ken Shugart	Davis DA-9	182.84
3rd	Charles D. Airesman, Jr.	VariEze	181.69
4th	Rob Martinson	VariEze	181.13
5th	Richard Desportes	Cassutt 111M	153.66
6th	James Gabrick	VariEze	153.07
7th	Lester Hildebrand	Q-200	143.04
8th	Josh L. Rubin	VariEze	134.71
9th	Gerhard Defner	Bellanca	81.15
10th	Jeffrey Ferraro	Cessna 150	80.14

CATEGORY C — FLAMINGO

Place	Pilot	Aircraft	Speed
1st	Brooks Robinson	Glasair IRG	180.00
2nd	Fayette McElhannon, Jr.	Glasair IRG	166.43
3rd	Rich Levitsky	Lancair	166.10
4th	Roger Crupper	Long-EZ	160.53
5th	Claudio Tonnini	RV-4	160.33
6th	Steve Cummings	Glasair TD	158.40
7th	Eddie Elland	Thorp T-18	155.68
8th	Eugene Plazak	Grumman	147.33
9th	Charles Duncan	RV-4	138.91
10th	Richard King	PA-28-160	115.24
11th	Paul Nopper	PA-28-151	105.53
12th	Chuck Schroll	Maule	102.77
13th	Michael Mansfield	Cessna Cardinal	102.33
14th	Joseph Bell	Piper PA-22	99.40
15th	G. A. Newhouse	PA-18-160	85.32
16th	Nick Saum	Piper PA-18	85.05
DNF	Martin Hill, Jr.	PA-18A	
DNF	Milton R. Buls	Glasair IRG	

ticipating. Only one pilot dropped out and landed safely, but couldn't complete the race.

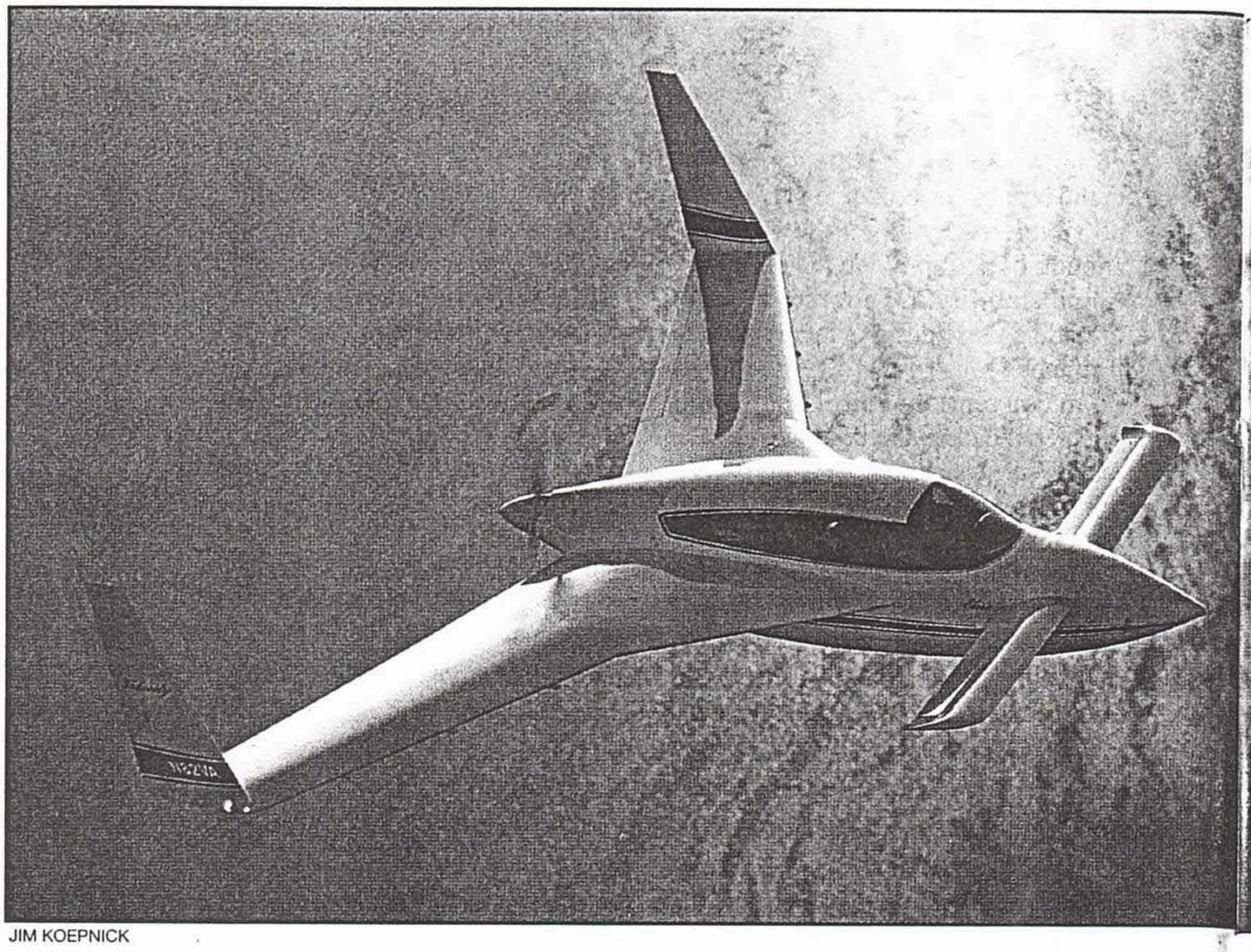
In case you didn't notice, all of the prize winners were homebuilts. In fact, the first eight places in Pelican and the first nine places in Flamingo were won by homebuilts. There's a message in there somewhere.

Because of the final standings, Aircraft Spruce is changing the Copperstate Dash and Sun 'n Fun Sprint next time around. Each of the three race categories will have two divisions, one for homebuilts and the other for certificated aircraft. There is just no way the factory builts can compete with the homebuilts.

On Sunday morning at 11:00, all the race pilots reconvened at Sun 'n Fun's interview circle as plaques and $4,000 in cash awards were handed out to the winners. Response to the race was enthusiastic and nearly everyone indicated they wanted to return next year.

The race wouldn't have been possible without help from Bill Cocker, who heads up air ops at Sun 'n Fun and found Neil and Patricia for us. Billy Henderson, executive director of the fly-in, also pitched in, as did EAA and King Schools.

The next race on Aircraft Spruce's schedule is the Great Cross Country Flying Race, set for July 29 running from Jeffco, near Denver, to Oshkosh. Then in the fall there will be the second Copperstate Dash, which runs from Apple Valley, CA to Phoenix. If you'd like more information on any of these races, contact Aircraft Spruce & Specialty at 1-800/824-1930, Fax 724/871-7289 or write them at P.O. Box 424, Fullerton, CA 98632. ◆



JIM KOEPNICK

STALLING THE LITTLE WING FIRST

The Velocity has probably had, if not the most, then certainly the most interesting aviation press coverage about its stall characteristics. Referring of course to a deep stall phenomenon, the manufacturer reports preventive redesign has been incorporated into all models. The two models flown for this evaluation were "stalled" in a controlled fashion, and exhibited very nice manners. That stiff elevator centering spring alone is almost sure to preclude an inadvertent stall because of the very high pull force required to slow from cruise speed to stall speed. The same applies to accelerated stalls — the pilot just has to pull too hard to get there by accident.

Retrimming both airplanes for 100 kts. (55-60 kts. below normal cruise speeds), the pilot must still apply more than a 30 pound pull on the stick (25-30 pounds in the 173 RG) to stall the canard. That's a lot of tactile warning for the pilot. There's also the buffeting canard to cue the pilot to the approaching stall. If he ignores these two blatant warnings, the stall is simply a 3°-5° pitch break as the canard loses lift — no roll off, no nose wander in yaw. Relaxing the stick recovers the airplane. Holding that 30 or so pounds of pull results in a pitch oscillation of about 5°, once per second. These values reflect a 1 kt./sec. deceleration into the stall. Faster decelerations result in more dramatic pitch oscillations, but hardly threatening. Of course, beginning a stall with a 45° nose high attitude may be an entirely different experience — one which is not recommended.

Accelerated stalls have the same character. The pitch breaks are smaller, but the stick force needed is even higher.

Lowering the landing gear in the 173 RG with the airplane trimmed for 100 kts. can be a hands-off event. There is virtually no pitching moment generated. The airplane maintains its 100 kts. after the gear comes down, but it develops a rate of descent as a result of the extra drag.

Establishing a landing pattern speed of 80 kts. indicated, both models remain well behaved in pitch although longitudinal stick forces continue to be substantial. Roll forces lessen to around 10 pounds for a full stick deflection, but control stick harmony seems okay.

A WHOLE NEW (BALANCE) BALL GAME

Those light aileron forces come in handy, because the roll rates at 80 kts. are quite low. A full-stick effort yields an average roll rate of 40°/sec. in the standard model if augmenting rudder

(rudder in excess of what's required for coordination) is used. In the 173 RG the same technique yields only 20°/sec. At this lower speed/higher angle of attack, both models exhibit a strong dihedral effect, permitting the planes to be rolled quite effectively with rudder inputs. In fact, leading the roll with a substantial rudder input seems to produce the fastest roll rates.

With the necessarily large aileron deflections come a good deal of adverse yaw, making rudder use mandatory in the landing pattern. While this is true for many airplanes, the roll-yaw coupling of the Velocitys presents a coordination challenge. Since aileron deflection causes both roll and (adverse) yaw, and rudder deflection causes both (proverse) yaw and roll, getting it all sorted out and settled down requires practice. When the airplane yaws a dutch roll is initiated which takes several oscillations and several seconds to subside. Most pilots won't or can't afford to be that patient on final approach, so they must possess the skill to actively suppress it. Five hundred flight hours are not required, but a couple of hours in the pattern with the factory pilots is a good idea.

Much has been written about having to "fly the Velocity onto the runway." This seems to be more of an admonition than a conscious effort. Clearly, the prospect of stalling the canard close to the ground is not appealing. Using a normal landing flare technique works just fine as long as the pilot realizes there's a limit on the nose-up attitude he should achieve. Once there, the airplane settles nicely onto the runway on a landing gear that can take quite a beating should the settle be a little firmer than expected. The distortion of the earlier windshields complicates the height above the runway estimation; with the newer windshield, there is no problem.

Rollout is uneventful. "Feeling" for the brakes may result in an initial asymmetric application, but once the pilot is sure he's "on" both brakes, precise directional control is regained.

Although it may look like a starfighter, the Velocity is a cruiser. Quiet, comfortable, fast and room for four, the airplane is meant to go someplace. Sure, sightseeing is okay, and so is flying it for the fun of flying. Its forte, however, might just be found in its name — Velocity: a vector, identified by both speed and direction.

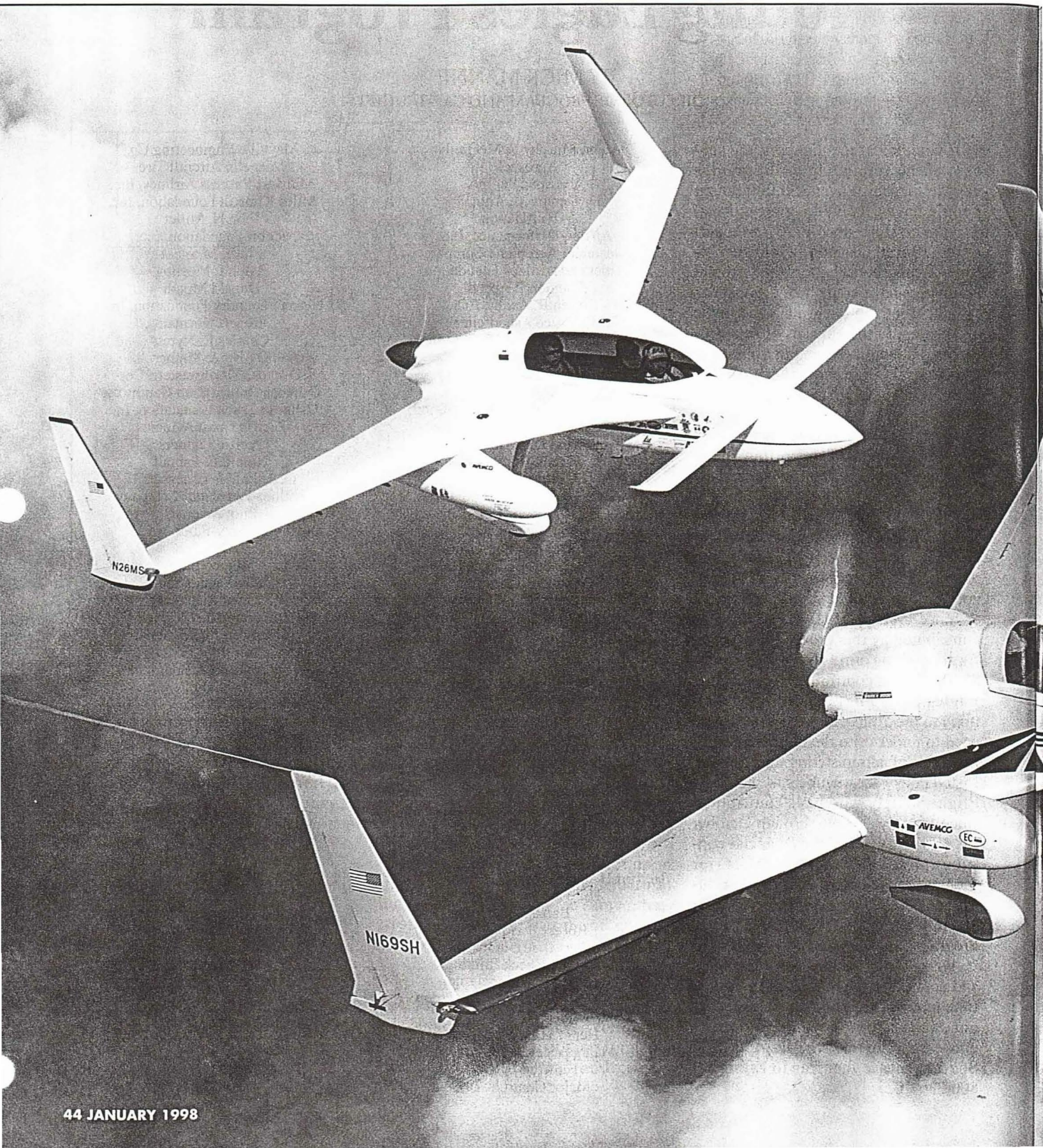
CONCLUSION

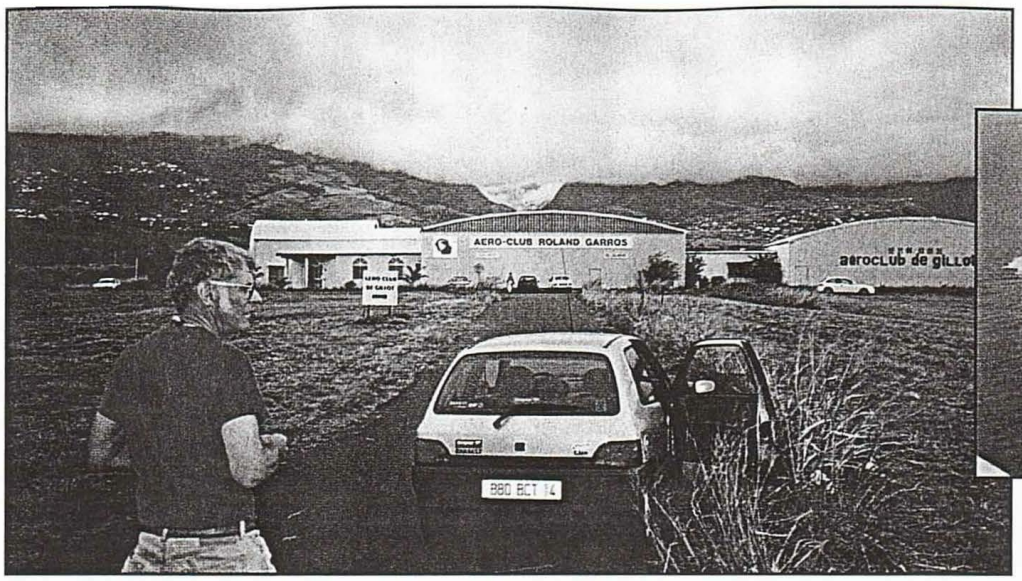
Most of this discussion concerned primary consequences of rudder location and deflection. Other, equally significant effects such as dihedral, dutch roll frequency, roll and yaw damping, etc., haven't been mentioned but are all players in the rudder placement game.

Conclusion? There is no conclusion except possibly to re-state the obvious. Namely, there's a lot of stuff going on around that (those) rudder(s). ◆

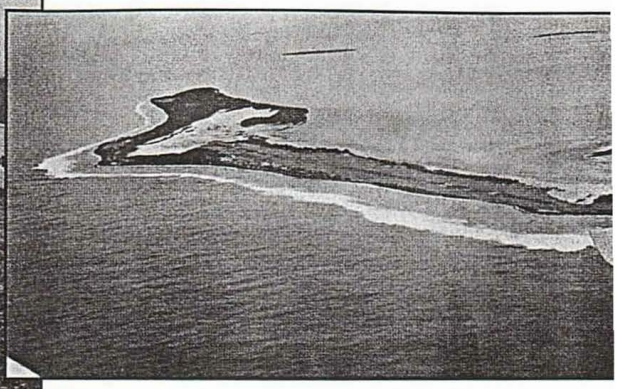
Mike and Dick's

'ROUND THE WORLD EAA





The Aeroclub, St. Denis — Reunion Island, Indian Ocean



The runway and town — Cocos Island in the Indian Ocean — a stepping stone to Australia. Mike and Dick arrived at Cocos after a 17-1/2 hour all night leg!

tures came back down to close to normal.

We had some heavy weather to contend with for the first couple of hours so we spent a lot of time weaving in and out of the build ups, mainly to protect the props from rain erosion. We had had no significant tailwinds since we had departed the U.S., but now, for the first time, we were looking at 47 knots on the tail! This was great news and we were hopeful that we might arrive in Perth in daylight in spite of our late start. I knew Sally, along with Sciona Brown, was anxiously awaiting our arrival, so I sent them faxes every hour letting them know our time to Perth, winds and endurance remaining. It was great to receive email from them, too. Soon we were out of the weather and we could see a very rough ocean below. For me, this was one of the most anxious legs of the whole trip, due to having to use auto fuel which really was an unknown for us. Every five gallons or so we would switch to the avgas and run a gallon or two, which immediately lowered the cylinder and oil temperatures, so we elected to follow this routine for the rest of the trip.

I had an overwhelming desire to turn left and head for the northwest tip of Australia, but the shortest route was to fly direct to Perth, so that is what we did. We knew we were going to run into weather as we got closer because what remained of Cyclone Rhonda was moving east towards southeast Australia, and might even get there before we did. As we got closer, we started to see the west coast on our Flitemap programs, even though we could not see it with our eyes, and it was comforting to know we at least were getting closer to land. Harry Maybeck was guiding us relative to the approach, and we did do well avoiding a lot of it, but we finally ran into a solid wall of clouds. We decided to try to climb over it. We went to over 16,000 feet and still were not high enough, but we were now talking with Perth approach and a British Speedbird heard us and told us he was climbing in our general vicinity. He was through 21,000 feet and was still IMC, so we headed down to see if we could scud run under the weather. We were somewhat successful, but eventually were in the clouds in moderate rain, only 400 feet above the ocean. Dick had the lead, and I was flying right on his wing, having to stay within only a few feet so as to be sure not to lose him, and we flew the last half hour into the Perth area like this. ◆

— Continued Next Month —

FRIENDSHIP TOUR

BY MIKE MELVILL

(PHOTOS COURTESY MIKE MELVILL AND DICK RUTAN)

JIM KOEPNICK

I began planning this trip almost two years ago. My goal was to fly my Long-EZ, N26MS, from Mojave, CA to the land where my wife Sally and I were both born, South Africa. I thought it would be really neat to be able to visit with family and friends, and be able to show them the plane that we had built from scratch with our own hands. Sally and I began checking on best routes to fly and best time of the year to visit the Southern Hemisphere, with regard to weather, winds, etc. I designed and fabricated two external under wing mounted fuel tanks, necessary to allow us to cross the Atlantic Ocean. I designed and fabricated a new carbon fiber cowling, with "armpit" air intakes, which worked really well. I also removed my old existing instrument panel, and designed and fabricated one which incorporated all of the equipment I felt would be necessary to accomplish such a flight.

About two months before our planned departure date, Sally decided she would not make the trip; it was not really her thing, and she was unhappy with the idea of crossing the Atlantic Ocean. I almost gave up at that point, because I did not think it would be any fun alone. Then I got the bright idea to ask Dick Rutan if he would go with me. He thought about it for a day or two, then he came over to my hangar and we discussed what my plans were; that is to say, just to fly to South Africa and back. He said he would go, but since he was an around the world sort of guy, he thought we should go to South Africa, then press on around the world. I readily agreed, and plotted a new course.

Mike (left) and Dick model their life jackets prior to leaving Mojave.

Dick and his dad, "Pop Rutan," conduct a last minute check before launch time.

The last time Dick and I took a flying trip together there was about a 12 knot difference in the cruise speed of our two Long-EZs. We decided that this would be a problem, and that the way to remedy it was for Dick to install a cowling like my new one, and to install a pair of Klaus Savier's excellent wheel pants. Dick had recently installed the same (Klaus Savier/Light Speed Engineering) electronic ignition, and we now found that the two planes were very close, performance-wise. Since time was now of the essence, Dick built his external fuel tanks as slipper tanks, rather than the way I had done mine, and they worked great. We each built a large back seat fuel tank, using 1/4" foam and fiberglass panels. These tanks, plus what we already had, gave each of us approximately 150 U.S. gallons total fuel capacity. This meant that if we wanted to we could slow down and fly for 25 hours, or 4,000 statute miles! This was good news, because we would not have any fuel problems crossing even the largest ocean. This eliminated one of the two biggest concerns of the over-ocean flyer, and we fixed the other—navigation—with three GPS units in each plane. We each worked hard on our planes, right up until we departed from Mojave, with little or no time to really test many of the modifications we had done.

We said goodbye to friends and loved ones and departed from Mojave on April 4, 1997. We flew in good conditions to Midland, TX where we spent the night. The next morning we headed for Indianola, MS where we stayed with Long-EZ builder Jim Hightower and his wife Margaret. We ate great food at the Eat Place in Greenville, and enjoyed the super hospitality of Jim and Margaret.

Bright and early, we set out for Sun 'n Fun in Lakeland, FL, and we had to work hard to get there due to a strong squall line across the top of Florida. There were a few hairy moments before we broke out north of Lakeland and were cleared to land as a flight of two in the middle of the airshow! Tom Poberezny hosted us and we spent a most enjoyable two days answering questions and looking at beautiful airplanes. Our friends at Mattituck, who had rebuilt both of our engines, suggested borescoping the cylinders before we left the USA, and we were very happy to hear Phillip Haponic pronounce both engines ready for the trip.

We left Sun 'n Fun just in front of a nasty looking storm and flew to Boca Raton where we were hosted by Long-EZ flyer, Dr. Tom Fields, and Weldon Case. We changed oil and filters there before jumping over to Fort Lauderdale, with its much longer runways, for our departure from the U.S. Although not all the way full of fuel, we were heavier than we had ever flown for our takeoff. We were nervous, but the EZs handled it well and we were soon flying over the Bahamas, Puerto Rico and many other Caribbean Islands, including the British Island of Monserrat where we saw an active volcano beginning to do its thing. In fact, it erupted just a few weeks later. This was an exceptionally beautiful leg, with enough islands that we were never very far from a safe landing site, a good introduction to over water flying for me.

We landed on Grenada at the St. George airport. The people were friendly and all of them spoke good English. Customs and immigration were a snap, thanks to our Jeppesen agent. In the morning we took off and flew around the island, taking photos and video. We crossed Trinidad on our way to the coast of South America, where we descended to 200 feet to get a good look at the expected jungle. We flew for hundreds of miles like this, enjoying the view of a completely uninhabited coastline from a few yards off shore. We flew past the French spaceport, at Cayenne in French Guyana, equivalent to our Cape Canaveral. Soon we could see the mouth of the Amazon River and we crossed at the widest point where it was 184 nm across. In the middle of the river we watched our GPS latitude readout count down to zero latitude as we crossed the

Mike and Dick at Sun 'n Fun '97.

equator. I couldn't cross the equator for the first time in my own plane upright, could I? Rolling inverted as we crossed was irresistible! The river is full of floating debris, very muddy, and reportedly you can get fresh water out of the ocean for more than 100 miles off shore.

Soon we were talking to Belem Approach, and they informed us that the Belem airport was closed due to a thunderstorm over the field. We held north of town for nearly 30 minutes before we were cleared into the Class B, and we ran through some serious rain flying to the airport. They would not allow a formation landing, so we landed separately. Clearing customs and immigration here was the most time consuming of anywhere around the world. We figured

Phillip Haponic of Mattituck checked both engines while at Sun 'n Fun.

it took just over three hours from cockpit to taxi cab. We spent two days in Belem, visiting all points of interest. The first morning we were awakened to the sound of gunfire and my main memory of this area is that it was hot and humid!

From Belem we flew south across Brazil via Brasilia to San Jose dos Campos, which is just east of Sao Paulo, a huge city of more than 16 million souls. Here we met Luiz Miguez and his wife Sibella. They had been in touch with us before we left Mojave, via the Internet. Their son, Fabio, picked us up and drove us to their beautiful home. Fabio was a great asset and spoke perfect English, having been partially educated in the U.S. Luiz had built a Long-EZ some years before and had flown it across the Atlantic, from Recife to Dakar, Senegal. As a result, he was an extremely useful source of information—and because he is a corporate pilot, flying a Hawker business jet, he had an enormous amount of weather, routing and flight information at his fingertips, which we were very lucky to have access to. He was the one who discouraged us from flying from Rio to Cape Town, direct. We certainly had the range, but we were unable to get any reliable weather or winds aloft information at the flight levels we would have to fly. Luiz tried every contact he had to find this information at 10,000 to 12,000 feet, but could find nothing. This worried him (and us!) greatly, and he spent the next several days persuading us to change our flight plan to depart from Recife and fly directly to Abidjan, Ivory Coast. He flew regularly to Abidjan, and could get us very accurate weather and wind information, so it was an easy decision to make.

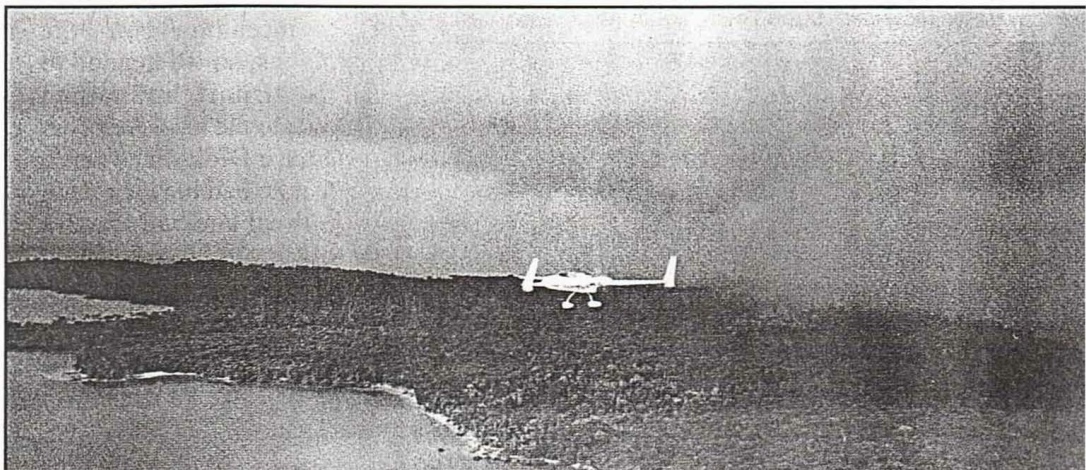
We spent three days with the Miguez family, and they were marvelous. Sibella cooked us wonderful meals, Fabio drove us anywhere we needed to go and Luiz was a constant source of critical flight info. Luiz also was responsible for the Air Force allowing us to hangar our planes, and for getting us a tour of the Embraer Factory where we saw the new dash 145 jet and the rest of the Embraer aircraft line being built. Luiz had worked there for 25 years as a production test pilot and was very well known. I was in dire need of a haircut and was able to get it done by the Air Force barber, right there in the hangar where our planes were housed! We changed our engine oil and replaced the spin-on filters, which were mounted directly on the engines using Bill Bainbridge's new 90° oil filter adapters which, incidentally, performed flawlessly.

Due to the relatively short flight to Recife, we did a partial fueling and departed early the next morning. The weather was IMC, so we had to file IFR, but this turned out to be easier than trying to fly VFR! We overflew Rio de Janeiro on our way up the coast and were amazed at the size of the cities along the way. Recife is an enormous city, with high rise hotels along the coast for many miles. We stayed in a beautiful hotel there and spent two days working with the Brazilian ATC trying to get them to understand that our Satcom transceivers were as good or better than the HF radio they wanted us to have. We could not have gotten around this problem without the help of a local pilot, Captain Almeida, who really went to bat for us and persuaded the authorities that the Satcom was indeed an excellent way for us to do our routine position reports as we crossed the Atlantic Ocean.

After many frustrating hours of delay, we were finally cleared for takeoff. We had hoped to depart before dark, negotiate the known bad weather off the coast while it was still daylight, then fly through the night to Abidjan and land there in daylight the next morning. This was not to be; we took off into a very dark night at the heaviest weight we had ever flown and were almost immediately in the weather, in heavy rain and moderate turbulence. With our wood fixed pitch props, it is essential to reduce prop rpm in rain, otherwise the rain will severely erode the prop leading edges. So, when we most needed the power to climb at our heavy weights, we found ourselves climbing through the darkest cloud I have ever been in, at very low power (2,200 rpm). It took what seemed like a lifetime before we broke out on top to a beautiful moonlit night.

We joined up as soon as we could and tried to settle down for the 15 hour flight. I put on a cheerful CD, and concentrated on the many small tasks I had to do to keep my mind off the fact that I was over the Atlantic, with 2,000 nautical miles to fly before I would see land again. Our Satcoms were a wonderful help here. We found ourselves so busy

Cruising along the coast of Surinam enroute to Belem, Brazil ... typical weather off the right wing.



typing messages to ATC and to friends and family that we hardly had time to be scared! I cannot tell you what an uplifting experience it is to see the flashing "Incoming Message" on the computer screen. You wait with great anticipation for the minute or two it takes to download from the satellite and then there it is: "I am with you and will stay up all night to be with you. Fly safe. Love, Sally." I don't believe I could have completed the trip without this incredible piece of equipment. To be able to let loved ones know where we were and what we were doing any time we wanted to from anywhere on Earth was an incredible thing, and I constantly marveled at my luck at being alive at such a time in history. For example, just eight or ten years earlier, we would have had no GPS. Our biggest problem would have been navigation. Now it was literally our smallest problem.

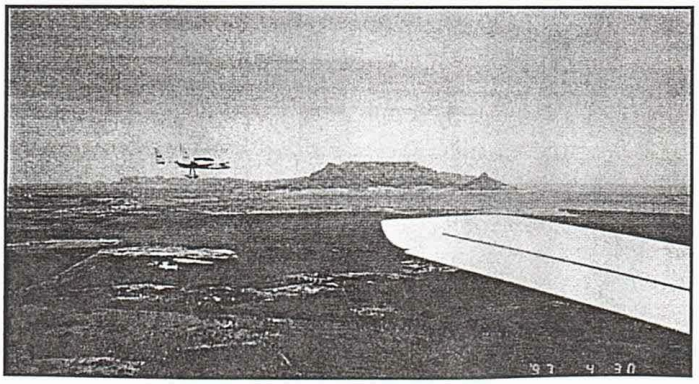
Recife, Brazil... departure point to cross the Atlantic.

Our primary navigation was the Mentor FliteMap software installed on Toshiba Portege laptop computers, driven by Trimble Flightmate Pro hand-held GPS units. Unless you have flown with this system, you cannot appreciate how incredibly user friendly and simple it is to fly. We each had KLN-90 panel mounted GPS units, as well as the GPS built into the Satcom unit. The hand-held was primarily in case of an electrical failure. The Flightmate Pro runs on AA batteries and we each carried a bag of those! Thank heaven we never needed them!

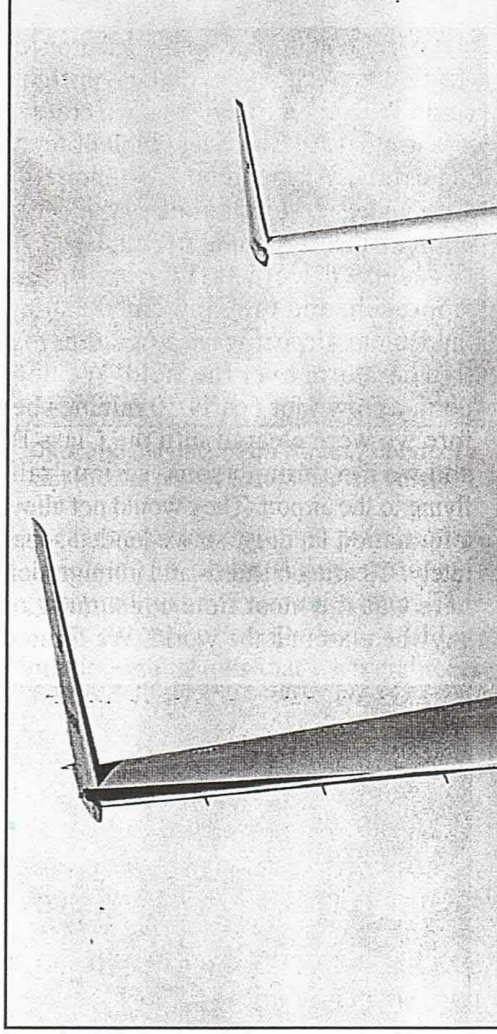
The Atlantic crossing was a learning experience and was flown mostly on top of a broken to solid overcast in bright moonlight for all but three hours of the night. The last three hours were very nerve-wracking—we could not see the buildups in order to avoid them as we had while the moon was up. I could not believe how dark it was. I literally could not see the canard only 24 inches from my eyes! With no radar, we could not tell where the buildups were, so we just cinched up our seat/shoulder harnesses, and hung on! This was a long three hours and Dick, who was flying off my left wing, had the experience several times of seeing me disappear into a cloud, hearing my cry of warning/fear, but not being able to do a thing to avoid the same fate. We were very fortunate because we never hit a really big one. Eventually, a glow appeared in the east and slowly it got light enough to see and avoid—and not a moment too soon; right in front of us was the biggest thunderstorm either of us had ever seen! We passed south of it on our way into Abidjan, where we landed safely after a 14.8 hour flight.

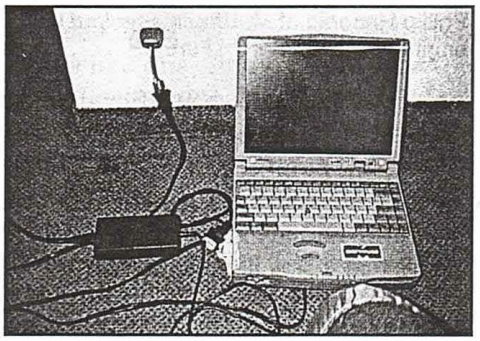
We were met by a Jeppesen agent, who whisked us through customs and immigration, and dropped us off at an excellent hotel. We were tired and hungry, but our tiredness won and we lay down on our beds, and did not move again until 8:30 a.m. the next morning! We had slept for more than 17 hours!

Table Mountain, Cape Town, South Africa.



We needed to do some maintenance on the planes, so we headed to the airport, and taxied over to the local Aeroclub where Dick discovered that he had blown a main oil seal and had lost 2/3 of his oil! Unbelievably, our host, Patrick Dufaud, had the correct seal in stock and he even installed it himself! We

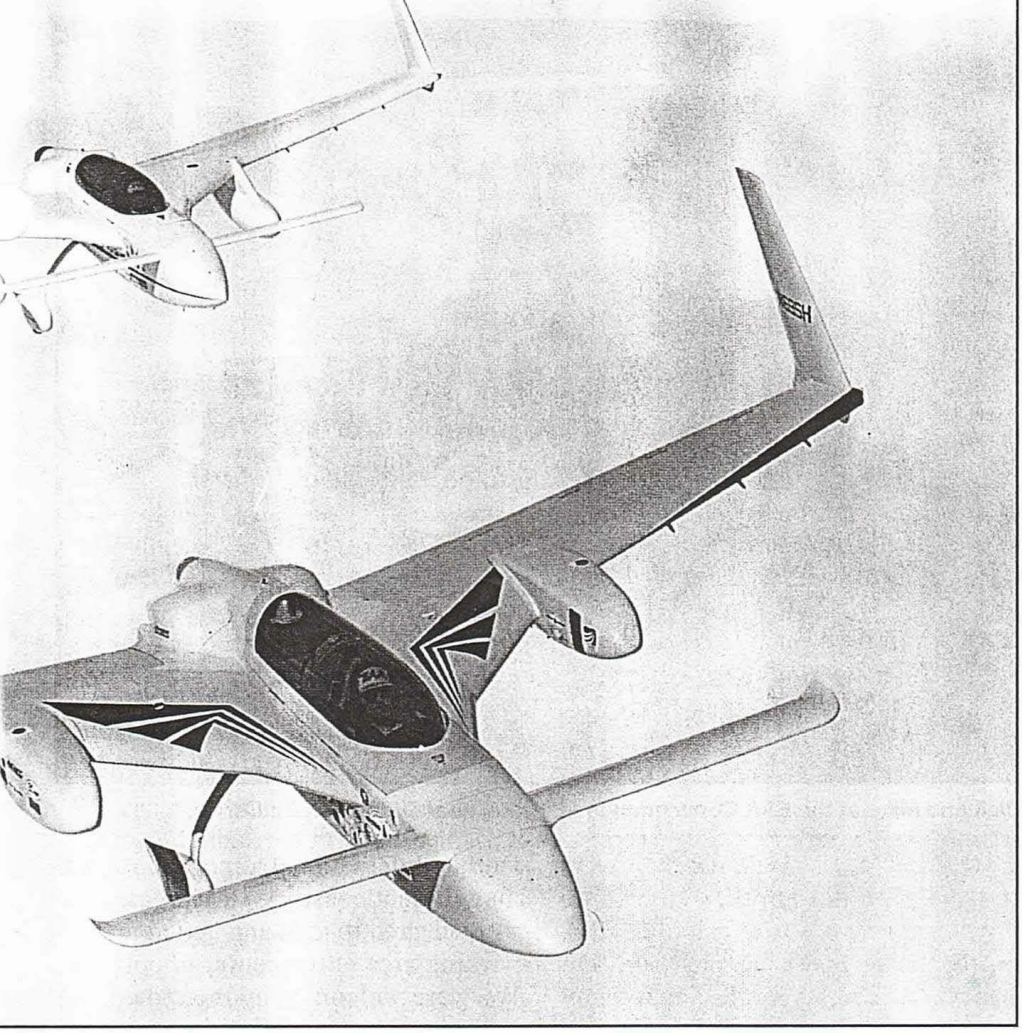




Abidjan, Ivory Coast... charging the computer battery. We did not have a proper adapter!

both changed our oil and filters before taxiing back to our allocated parking places out on the huge concrete ramp where there were no tiedown facilities... we simply had to leave them sitting there. It rained all the following day, at times reducing visibility to just a few feet!

The food at our hotel was among the best we ate anywhere due, of course, to the Ivory Coast being a French Colony and, as everyone knows, French cooking is fantastic. We were fortunate to meet an airline pilot at the Abidjan airport who took us into their briefing room where we were able to see satellite photos of the surrounding area, as well as the upcoming route to Windhoek, Namibia. This was critical for our safety on the



JIM KOEPNICK

next over-water leg because we were in the inter-tropical convergence zone with no weather radar and, therefore, were blind as far as knowing where the thunderstorms were once we were in the clouds. After fueling, we filed our flight plans, and spent a lot of time studying the satellite weather, especially the IR (infrared) picture. There were two solid lines of storms off the coast, right across our course line. We saw we would have to fly at least 100 miles east to try to get around these squall lines, and we would be clear of the nasty weather by the time we were 400 miles south of Abidjan.

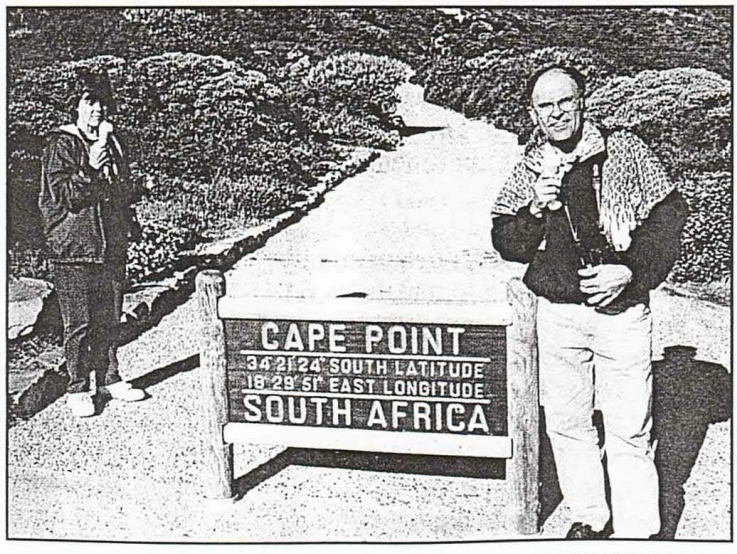
We departed around 4:00 p.m. and flew right up to the nastiest looking wall of weather I have seen, so we turned to the east and flew parallel to this squall line for what seemed like an awfully long time before we were finally able to turn right to head south. We still had to get through the second line of storms... and we were running out of time. The sun was getting close to the western horizon and we had to be through this weather before it got dark. The idea of trying to penetrate this type of weather in the dark was abhorrent to both of us, so we desperately searched for a hole. I found myself down on the deck less than 100 feet above the Atlantic, and for the first time I could see what we would be facing if we had to land in the water... and I didn't like what I saw! Just as it was getting fully dark, I saw an opening, a lighter area, so I turned and flew under the clouds through some heavy rain and, to my delight, I could see that we were in the clear. I called Dick, and told him I was through, and climbed up into a clear night sky. The full moon was just rising, and the view was fantastic with the moon reflected in the ocean and showing off the scattered clouds far below.

This was a long leg—it took over 14 hours to reach Windhoek, and when we did we were in for a shock; the airport was closed and would not open for two more hours! It was still dark as the inside of a cow and we really had no idea what the terrain looked like, so we stayed up at our cruise altitude of 11,000 feet as we circled around the sleeping city of Windhoek. Slowly, the glow in the east got brighter and we were able to see more and more of the rugged terrain. We were talking to the controller all the while, and he assured us that we would each be fined $900 U.S. if we landed before the airport opened! We continued to circle, and then he told us there was a smaller airport much closer to the city that would be open at 8:00 a.m. local time. We headed over there and began our descent, timing our arrival for 8:00 a.m. They did not allow us to land until it was eight o'clock... more than 16 hours since our departure from Abidjan. We still had enough fuel on board to fly to Cape Town with adequate reserves.

We were met in Windhoek by Len McKay, a local pilot and good friend. He got us through customs and immigration in less than 15 minutes, then delivered us to a magnificent hotel. Another local pilot, Peter Hartman, offered to hangar our planes and was extremely helpful as far as local rules for flying, etc. We loved Windhoek, and would definitely go back. The skill of some of the local craftsmen, sheet metal workers, mechanics, etc. beat anything either of us had ever seen. The quality of the average planes parked out on the ramp was amazing... all of them looked new! Airplanes are really important to the people of Namibia, and they certainly do take care of them. We stayed here for three days, then departed for Cape Town, South Africa.

Enroute we saw some of the world's most desolate countryside. We flew for more than two hours over unending

Cape Point, the tip of Africa. Mike and his sister, Bunny, enjoy ice cream cones.



A local television station interviewed the world travelers while at Margate.

Dick and Mike at the EAA Convention in Margate, near Durban, South Africa.

400 foot high red sand dunes, then flew down the Skeleton Coast across the border into South Africa. As we drew closer to Cape Town, almost at the southern tip of Africa, the terrain became more and more mountainous and beautiful. Finally, there it was: Table Mountain, the backdrop behind the city of Cape Town, one of the most beautiful cities on earth. I called the tower and we were cleared to land in formation behind a British Airways 747. This was my moment, this was my goal... to land my Long-EZ on the soil of the country of my birth. We taxied to a spot where my sister, Bunny, a bunch of friends and several TV and newspaper reporters were waiting and it was quite an emotional time. We cleared customs and immigration in a matter of a few minutes, thanks to a dear friend, Stiaan Viljoen, who also provided a hangar for the planes. It was wonderful to see my sister and she was as excited as I was to see my plane and me on the ground in South Africa! The TV people were anxious to get some air to air video, so they climbed into a Navajo, and we all took off in formation for the short flight to Stiaan's hangar on the beautiful Stellenbosch airport. We enjoyed an hour or two of meeting all the folks at Stellenbosch, and then we joined Bunny who drove us in to the city of Cape Town where we stayed at a friend's apartment for the next four days.

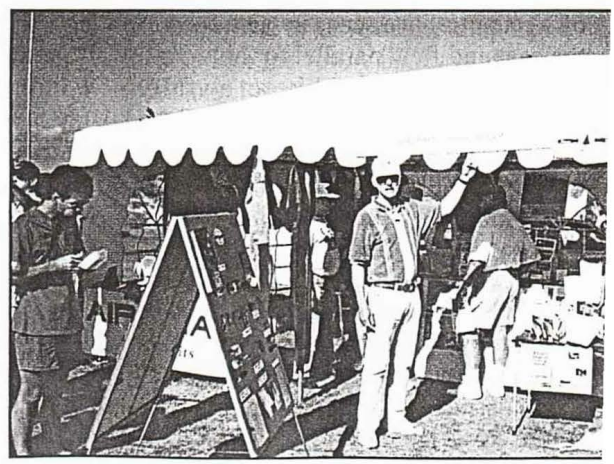
We were treated to a wonderful sightseeing tour of the most beautiful city that we saw anywhere around the world. We hiked to the very tip of the Cape of Good Hope, as well as to Cape Point. We ate wonderful food at Boschendal, tasted great wines at Groot Schuur, visited the monument to Cecil Rhodes (of Rhodes scholar fame), as well as his farm and home. There is a lot of history in the Cape, and I would dearly love to go back there for another visit some day. We gave a talk to a really fun EAA Chapter on the Stellenbosch airport, and then we were ready for the flight to my hometown of Durban. Bunny flew up on an aluminum tube, while Dick and I flew the almost 1,000 nm trip in our trusty Long-EZs.

On the way up the coast, we flew over the southernmost point on the African continent, Cape Agulhas, where the Atlantic Ocean becomes the Indian Ocean. The flight up this magnificent coastline brought back a lot of memories of my childhood, and it was a really special moment to touch down on Durban's Virginia airport where many of my friends from my school days were on hand to greet us. We stayed at my late mother's apartment and visited friends and Hilton College, where I was educated nearly a million years ago. It was fun showing Dick the place where I was raised, and we spent a great couple of days swimming in the very powerful surf on the beautiful Durban beaches.

The 1997 Margate EAA Fly-In was held on the Margate airport on the coast, 76 nm south of the Virginia airport in Durban. Dick and I departed from Virginia early on the morning of May 12 and flew in close formation past the Durban International airport, along the magnificent coastline to Margate. We were cleared to land and taxied up to a parking area at the center of activity. We were welcomed by the crowd and interviewed by the press and TV. A lot of time was spent at our two Long-EZs, answering questions and talking to many pilots and homebuilders, including several Long-EZ and VariEze flyers. We visited the Aircraft Spruce Africa booth, where we met Fran Venter, owner of this branch of Aircraft Spruce. She was great and offered to help us with anything we might need. She was thrilled to see the Aircraft Spruce stickers on both our planes and invited us to visit her company just outside Johannesburg.

There was a surprisingly large variety of aircraft on display, and some great aerobatic performances were

A touch of home! Aircraft Spruce Africa had a booth at the Margate EAA Convention.



flown while we were there. The quality of the homebuilt aircraft we saw was very high, and we could see that the EAA was certainly alive and well here in South Africa.

Unfortunately, we were unable to stay over night, as we had to get back to Durban where we were to give a presentation to the engineering class at the University of Natal. We departed late that afternoon with a formation takeoff, followed by a high speed low pass. We then flew low level up the coast to Durban's Virginia airport, skirting some nasty looking storm clouds building up to the north.

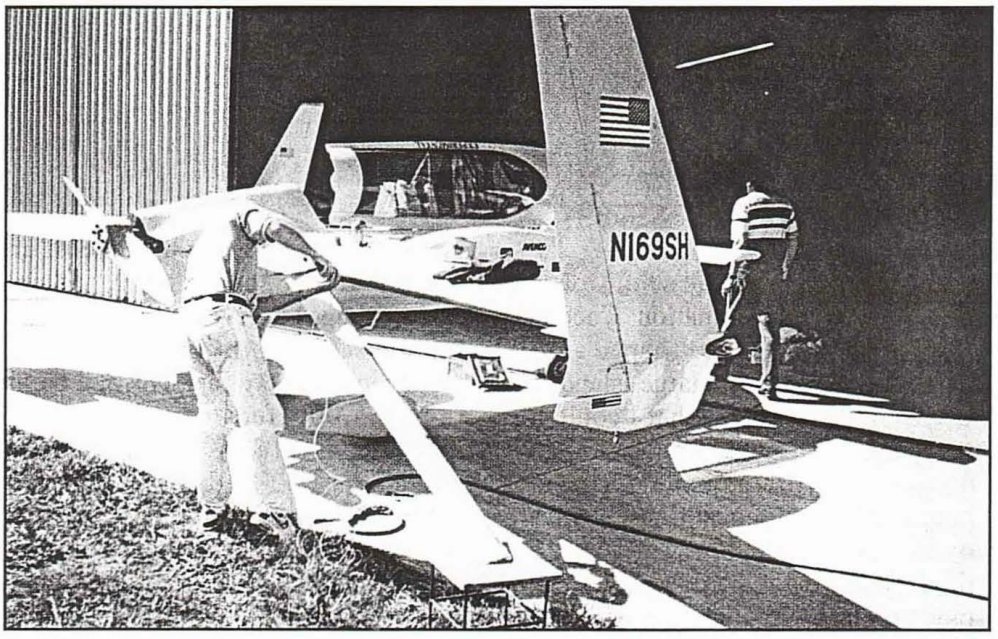
Flying inland to Johannesburg where I was born, we landed at the Springs airport and stayed with David O'Neill and his lovely family, close to the Capitol City of Pretoria. We spoke to a great crowd of EAAers here, who then took up a collection to fill our fuel tanks for the next leg. What incredible generosity! We visited all the historic sites, including a gold mine, before heading back to Durban. On the way we overflew Hilton College, which truly is an incredibly beautiful school as seen from the air. We landed at Durban International Airport where all landing and parking fees were waived. We fueled up for the 10 hour flight to the French Reunion Island, east of Madagascar, in the Indian Ocean and spent our last evening in South Africa at a great dinner with old school friends.

Bunny drove us to the airport at 3:00 a.m., helped us load up and after an emotional goodbye, we taxied out for takeoff. We picked up our IFR flight plans and departed into a very dark night. Several hours later, after the sun came up, we ran into the first of two squall lines. Dick and I joined up in close formation, descended to 300 feet over the ocean, then penetrated the lightest looking area. Heavy rain was encountered, but only light to moderate turbulence before we broke out into the clear on the other side of the line of storms. An hour or so later we had to repeat this procedure as we encountered the second squall line, a little heavier weather than the first but not too bad. We thanked our lucky stars that we had not had to do this in the dark! Soon after reaching the southern tip of Madagascar we ran into heavy clouds with rain, and we lost sight of each other. For the next four hours we flew in moderate rain with zero visibility, and we were both very concerned about the ability of our wood props to take this kind of abuse. I reduced my engine rpm to 2,000, tightened my seat belt and just plowed on through the rain. Dick initially tried to get low enough to be able to see forward, but eventually gave up and climbed to within 1,000 feet of where I was.

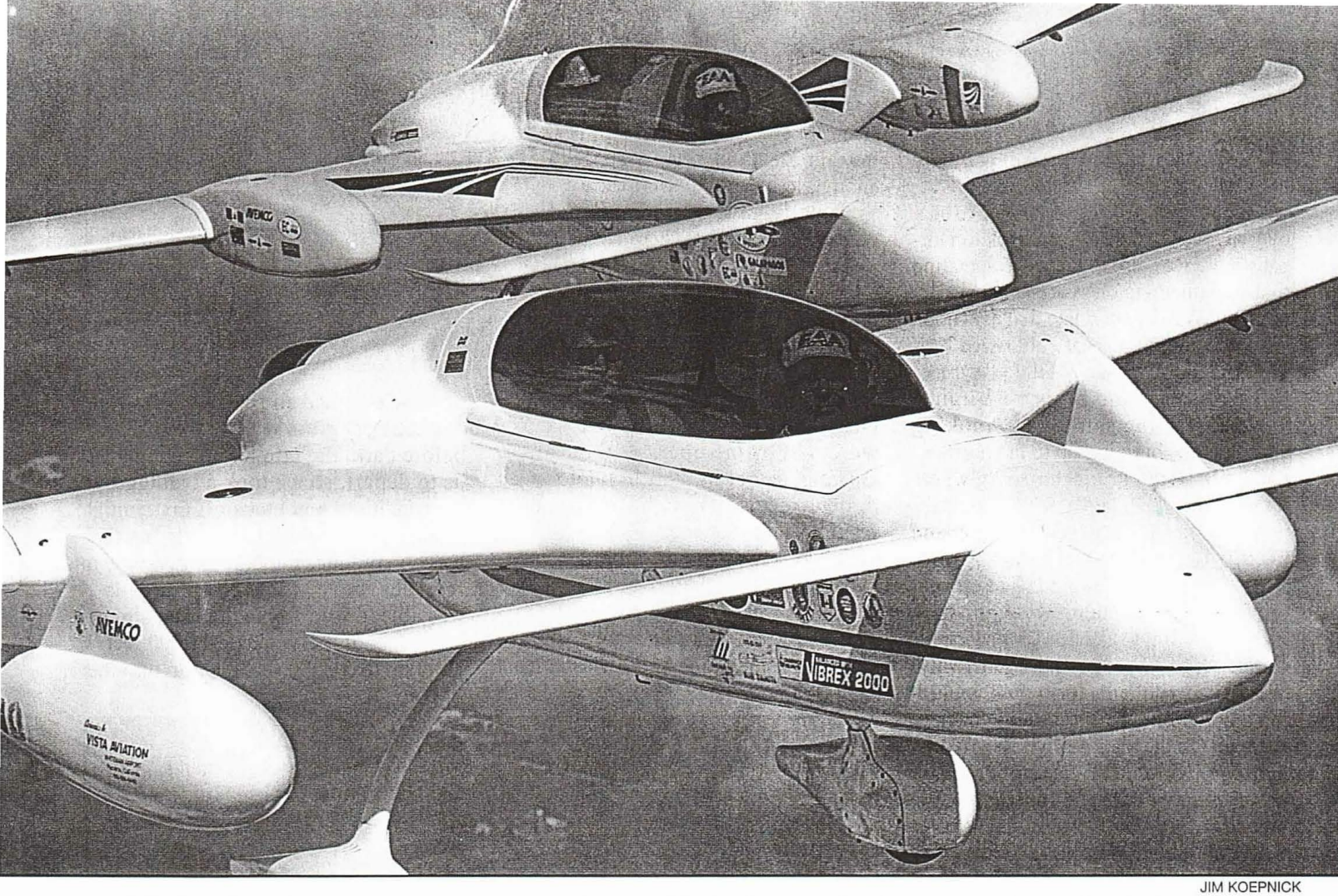
Finally, we broke out between layers, only 60 miles from Reunion Island. Soon we could see the nearly 10,000 foot high volcano on the south end of the island, then we were descending toward the airport on the northern tip of the island near the town of St. Denis. We were met by members of the Roland Garros Aeroclub who helped get us through the usual customs/immigration mess, then led us via several narrow unlighted taxiways to their hangars. We were amazed to find over 100 people waiting to welcome us, including TV and newspaper reporters. We found ourselves drinking champagne and it was at least two hours before we were able to get the planes put away in one of the club hangars and have one of the members drive us to a really fabulous hotel, Hotel Mercer, run by a very neat person, Daniel Merelle, who put us up free of charge! We spent four happy days here, renting a small car one day and driving it all the way around the island. It rained on and off the whole time we were on the island, due to Cyclone Rhonda which was located between us and Perth, Australia, our planned destination.

We managed to get the planes refueled, in spite of the rain, by holding umbrellas over the fuel caps. This was to be our longest leg and would be the first time we ever had all five fuel tanks full, our heaviest gross weight takeoff. Just before dark, the rain let up enough for us to depart, so we took advantage of the conditions and I took off first. Initial acceleration was very sluggish, but this was a very long, smooth runway, only a few feet above sea level. Eventually I was able to lift off, having used almost 8,000 feet of the available 11,000 feet. I climbed to 11,000 feet and ran into the same kind of rain we had flown in on the crossing from Durban to Reunion. Dick had remained low and was headed toward the Island of Mauritius. He said there was less rain down there, so I headed down to join him. We flew up the west coast of Mauritius in some of the nastiest weather we had seen so far, but it cleared up just as we turned east around the northern tip of the island. By now it was almost completely dark, and as we climbed to our assigned altitude of 11,000 feet, a solid undercast began to build. It was a beautiful night, and the brilliant Southern Cross was hanging overhead and looked incredible! We flew all through the night with only one

Refueling both planes at Johannesburg, South Africa.



Installing the HF antenna in Dick's Long-EZ—Johannesburg.



JIM KOEPNICK

period of rough weather.

The sun came up and soon we were approaching our destination, Cocos Island, a small horseshoe shaped atoll. I was expecting to see a large island, but was astonished to find that I could not see it until I was only 15 miles out based on the GPS flitemap. This was a 17 hour flight, the longest flight we made on the whole trip, and we were very tired when we got there. We were in no mood to deal with immigration bureaucrats and were lucky to meet with a very kind customs officer who recognized just how exhausted we were. He helped us get through this ordeal by filling out forms for us and keeping us from having to deal directly with an unreasonable immigration officer who did not seem to care that we had been flying for 17 hours and had had no sleep for 30 hours. It was hot and humid on Cocos Island, and it rained a lot! We were shown to our quarters where there was no air conditioning, but where we were able to get a few hours sleep.

When we went back to the planes, we prepared to flight test some auto fuel, which was the only fuel available on the island. We had arrived with plenty of avgas from Reunion, so we planned to use this for the takeoff and climb portion of our next leg, and only use the mogas in level cruise flight. We ran our test by putting 10 gallons of mogas in an empty fuel tank and climbing to 5,000 feet over the island, leveling off and allowing the engine temperatures to settle down. Then we switched to the mogas and carefully monitored the engine parameters. It was a no brainer; nothing seemed to change, so I did a little sightseeing and then returned to land.

We spent the rest of the day pumping more than 100 U.S. gallons into each plane by hand, and it was hot work! We had a light dinner and went to bed, planning to be off at 4:00 a.m. When we got up it was raining. We could not even make it to where the planes were parked. We sat around for more than four hours waiting for the rain to let up. Finally, there was a break, so we ran out, threw our stuff into the planes and took off. We climbed to 13,000 feet trying to get above the weather, and after leveling off, switched to the mogas. To our chagrin the engines did not like the fuel at this altitude; we had cylinder head temperatures rising more than 20° and oil temperatures doing the same thing. On top of that, we found that we had to run our boost pumps virtually continuously in order to keep the fuel pressure in the green. Later, after the fuel had time to cool down to ambient, this problem virtually went away. We had been warned to run our engines 25 to 30% richer on mogas than what we had been running them on avgas, and we were very grateful for the warning. Once I set the fuel flow from my normal 7.5 gph to 9.5, the tempera-

A champagne arrival in Reunion Island at the Roland Garros Aeroclub, St. Denis.