CONTACT!

EXPERIMENTAL AIRCRAFT AND POWERPLANT NEWSFORUM FOR DESIGNERS AND BUILDERS

CONTACT!

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MISSION

CONTACT! Magazine is published bi-monthly by Aeronautics Education Enterprises (AEE), an Arizona nonprofit corporation, established in 1990 to promote aeronautical education. *CONTACT!* promotes the experimental development, expansion and exchange of aeronautical concepts, information, and experience. In this corporate age of task specialization many individuals have chosen to seek fresh, unencumbered avenues in the pursuit of improvements in aircraft and powerplants. In so doing, they have revitalized the progress of aeronautical design, particularly in the general aviation area. Flight efficiency improvements, in terms of operating costs as well as airframe drag, have come from these efforts. We fully expect that such individual efforts will continue and that they will provide additional incentives for the advancement of aeronautics.

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Switch on!

Sun-n-Fun is just around the corner. This event usually signals the beginning of the fly-in season for us at CONTACT! Magazine We will once again be at Sun-n-Fun, in our usual spot; Building C, space 63, but for the first time, Associate Editor John Moyle will be joining me. We will again be hosting the engine forums this year. We'll be in tent #10 all week long.

I'd like to try something a little different this year, and ask for some volunteer assistance. We can always use some help in the booth, as it gets difficult to get away and actually see the planes we'd like to showcase in CONTACT!. So if you'd be interested in helping a minimum of 2-3 hours per day, each day of the show

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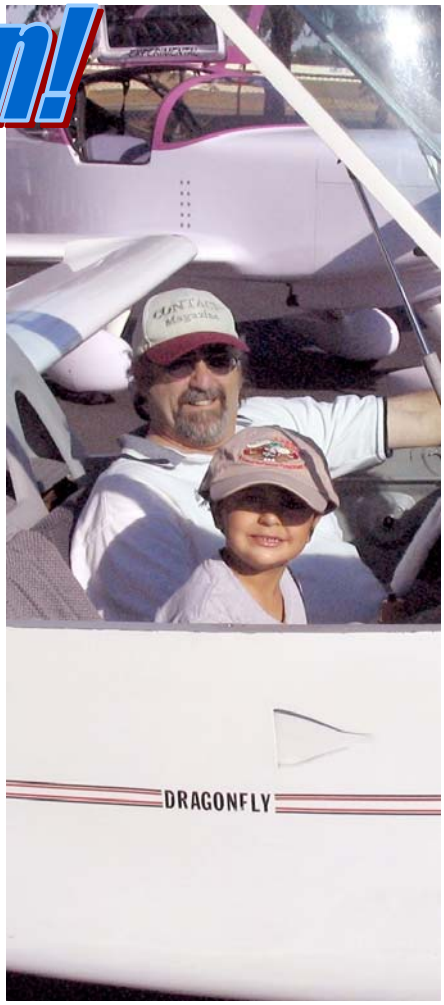

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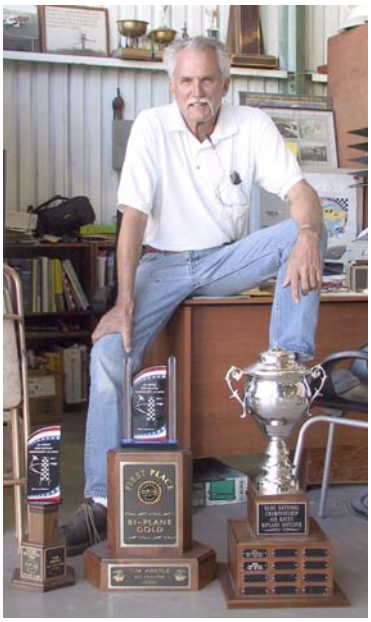
Tom Aberle's PHANTOM

By John P Moyle and Pat Panzera
Photos by Pat Panzera

In most cases it takes a team effort to break new ground in any field, and air racing is no exception. The requirements of adequate funding, enlightened engineering, meticulous preparation, and skillful piloting must be brought together to form an alliance which can compete effectively, let alone win the National Championship. This story is about one such group, put together by Tom Aberle of Fallbrook, California.

Tom is a graduate of El Rancho High School in Pico Rivera, (Los Angeles County) California. After graduation he attended the nearby Northrop Institute of Technology where he earned his Airframe and Powerplant ratings. Tom then acquired an Inspection Authorization two years later. He's been involved in aircraft construction, modification, and maintenance ever since and currently operates Aberle Custom Aircraft, where he and his son Jerry dabble in all things aviation. Their company slogan is, "We are purveyors of fine aircraft. We build, maintain, overhaul and modify in nearly any way one might conceive- to provide for the improvement of the general aviation aircraft upon which we work." The first plane Tom ever built was a 200-hp Pitts S1S.



Tom astride his desk in his office/hangar in Fallbrook CA. In front are his trophies from Reno 2004.

Before his time of education in the mechanical aviation arts, while still in high school, Tom took flight instruction from a man with a brand new CFI rating, his father, Harry Aberle, and was the first student his dad ever signed off for solo. That was on the occasion of Tom's 16th birthday. Harry soloed Tom's son Jerry as well, many years later.

At that time, Harry Aberle had an aircraft rental and flight school business at Compton Airport, and leased hangar space to some operators of aerobatic biplanes, including Harwood (Skip) Hellen who owned a Stolp Starduster, and the late Bob Herendeen, who kept his first Pitts S-1 there.

A NEW RACE DIVISION IS BORN

Back during these early days, air racing promoters thought it would be a good idea to feature some less expensive type aircraft at the feature races, something to help introduce pilots to the field and initiate them into pylon racing, as well as rounding off the racing schedule. Consulting with the best acrobatic pilots (who during the mid 1960's were sharing the Reno Air Race venue at Stead Field) a new class of biplane racers was conceived.

Biplane Division restrictions which all entries must adhere to, included an engine not larger than 290 cubic inches at the time of the first biplane races in 1964. This was later increased to 320 cubic inches, and ultimately to the current maximum of a 360 cubic inch displacement. A fixed pitch propeller, a minimum weight of 500 lbs. and wing area of at least 75 square feet (of which neither wing could be less than 30% of the total wing area), as well as several other physical attributes define the limits. By the time the class was fully outlined, and several years into

Photo courtesy Aberle Custom Aircraft

This 1987 photo of Tom and the highly modified "Long Gone Mong" was shot just after the return from a victorious time at Reno. The paint color was an accidental, coincidental match to Tom's 1976 Corvette.

actual racing, the class began to look like the "Pitts Race", as about the only preexisting biplanes on the market (other than Pitts) that fit the design criteria were Smith Mini Planes, Mongs, EAA Biplanes, the original Knight Twister, and the Starduster I. None of these were really as popular nor as prevalent at the Pitts. The Knight Twister had been eliminated from the class by virtue of its wing area failing to meet the minimum criteria of 75 sqft. The Mongs were somewhat excluded, but only because they had a slightly narrower fuselage than the rule specified. It was found after the rules were formally drawn that the cockpit dimensions were often less than the rules allowed, so the Mong was 'grandfathered' into the class when class officials discovered their error. The Mong was the only existing design grandfathered in "as is", the Knight Twister was only accepted after a new version was created with its wing area increased to 76 sqft. Additional modifications to a grandfathered design are allowed however, as long as those changes do not in themselves violate the rules.

As stated previously, the exception allowed for the Mong under the "grandfather clause" is the fuselage width. The Mong Sport Biplane was designed, built, and first flown in 1953 by Ralph E. Mong of Tulsa, Oklahoma. Mr. Mong was a very slight man, less than 5'3" tall, so the plane features a very small cockpit, narrower at the shoulders than most other designs. The Mong Sport is a single place open cockpit steel tube and fabric biplane, typically powered by a Continental C-85 and capable of top speeds around 115 mph. The aircraft featured a 16' 10" wingspan and an empty weight of 550 lbs. Tom chose to start with the more slender fuselage the Mong allows when he designed the #62 Phantom, as it benefits from the lower drag produced by less frontal area.

If you compare the early photos of the original Mong Sport (pictured on the opposite page) with the Phantom race plane, it appears to be a completely different design; but there is a core section of the classic homebuilt aircraft right in the center. From the firewall aft to the seat back, the Phantom is pure "Mong". The balance of the plane however is completely unique to this version, but wholly within the regulations for the Biplane Division.

THE NEED FOR SPEED

The appeal of going faster than the other guy is one that touches many pilots, but some find a way to pursue those dreams and live life a little further out on the edge than the rest of us. Tom Aberle and his partner Andrew Buehler, of Port Orchard, Washington, are two such fellows, and they have surrounded themselves with a small cadre of very hard working, highly motivated associates. **Bob Busch** was a consulting engineer on the project and made four trips from his Pacific Northwest home to work on the race plane, a week and a half per visit during the 7 months of construction. **Andy and Stewart Paterson**, owners of Paterson Motorsports, applied their talents to various airframe and propulsion issues. Stewart became the liaison between the engine builder, Ly-Con, and the Phantom race team during the preparation of the powerplant. **Ted Von Hirsch** took responsibility for the horizontal and vertical stabilizers, and **Thomas E. Harper** was the primary wiring and electrics man. **Jerry Aberle**, Tom's son (an A&P & IA his own right with a repair and maintenance shop right next door) stepped in to lend a hand as well. This talent pool makes up the Phantom Biplane Race Team.

The itch to race first got "scratched" in 1966, when Harry Aberle took his family to the Reno event as "crew" for their two hangar tenants. Herendeen was flying his Pitts S-1 in the Aerobatic competition (he was named U.S. National Champion that year, and again in 1969) and Skip Hellen was piloting the Starduster in the early races for biplanes. Tom Aberle was afforded the opportunity to fly Hellen's plane around the course during the practice trials, and gained his "race qualified" permit as a result.

This photo is courtesy of Ken Dayer Curator of the Jay Miller Historical Aviation Collection Aerospace Branch Library Central Arkansas Library System

Here's an example of a bone stock Mong Sport. You can plainly see that there's not much resemblance between "Long Gone Mong", and virtually no resemblance to "Phantom".

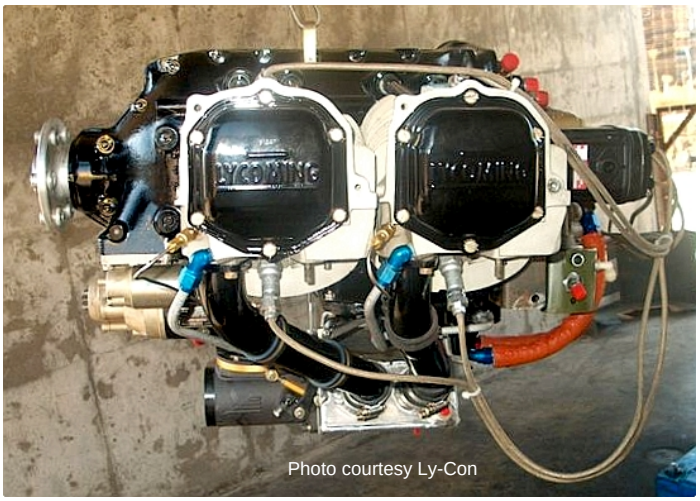
He got to compete in a 1967 heat race and then in 1968 to race in the major event at Reno, in Skip Hellens' Stardust. Other race venues, including St. Louis, MO. in 1969, Porterville, CA in the late 70's and Mexicali, Mexico in both January and December of 1980, served as great experience for Tom's competition career.

Tom purchased Bill Boland's old #3 "Gone Mong'" and later damaged it, resulting in a rebuild by Tom, after which he then renamed it "Long Gone Mong". Tom then campaigned at Reno in the late 1980's, winning the National Championship in '87, placing second in '88, and once again taking home the Championship trophy in '89. (This plane was later raced by Patty Johnson under the new name of "Full Tilt Boogie"). In 1999 and 2000 Tom was piloting a Pitts known as "Class Action" for an ownership consortium, and following that Tom and Andrew Buehler started talking more seriously about a long held desire to work together to create a highly competitive Reno air racer.

THE 2003 SEASON

The commitment was finally made on Feb 28, 2003. A deal with a sponsor was initiated that made it possible to consider competing in the Reno 2003 Air Races. When we asked Tom about the inspiration behind Phantom, he simply said, "I have been racing for a long time and I wanted a winner". A basket case Mong Sport had been purchased previously by Mr. Buehler, and Tom had already built the inverted gull center section into the fuselage truss. The intention was to rebuild the plane with enough modifications to give her an edge against the other very competitive entrants.

A master planning session revealed that there simply weren't enough work days available, while running an active aircraft repair and modification business, to get the entire project completed "in house" within the limited time frame. Less than eight months remained before the 2003 competition at Reno. The obvious solution was to subcontract some of the critical component work to qualified specialists.



The expertly built Ly-Con engine, in the concrete reinforced test cell, ready to be hung on the test stand. Note the hand made, custom, cool air intake system.

THE ENGINE

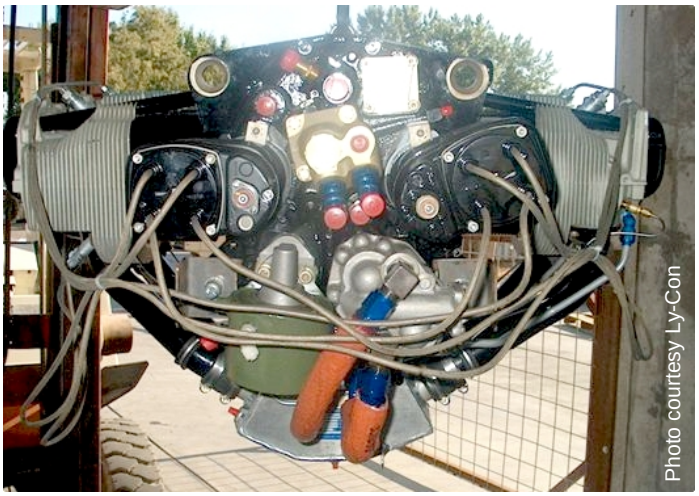
Ly-Con, Inc. of Visalia, California is one of the most respected builders of aircraft engines in the world. www.lycon.com Their state-of-the-art facilities include two dynamometer test cells. They accepted the challenge of co-developing a race ready, fuel injected Lycoming O-360. This powerplant is fully balanced, ported, polished, and flow bench tweaked as one might expect. Some of the features of this engine also include:

- 12:1 Compression Ratio
- Teflon Polymer coated piston skirts
- Ceramic coated domed piston crowns
- Ceramic coated dual valve springs
- Chrome rings
- Custom made intake plenum and runners

The standard horsepower for a stock engine of this type might be 180 @ 2700 rpm, measured without accessories. Phantom will turn this engine at anything from 3200 to 3570 revs (depending on the situation) and the owners will only state that it makes "markedly in excess" of 250 horsepower, at least for the duration of a six lap tour of the pylons.

This engine was converted from the typical Lycoming cast sump system (which also pre-heated the induction air) to a remotely located oil sump and cold air induction. "We put a flat plate where the sump goes with a small pocket at the back and an AIO-360 scavenge pump onto the accessory drive, and that evacuates the crankcase. The thing runs dry as a bone as a result", Tom told us. The system is ventilated from the case to the external oil tank and utilizes an aluminum oil tank "borrowed" from the high performance automobile aftermarket.

One of the major advantages with the dry sump system and the new remote oil tank is not mechanical in nature, but rather aerodynamic. By removing the factory sump and moving it up and aft, behind the engine, Tom estimates that 20% of his flat plate frontal area is reduced.



The rear view of the engine, showing a little more of the intake manifold.

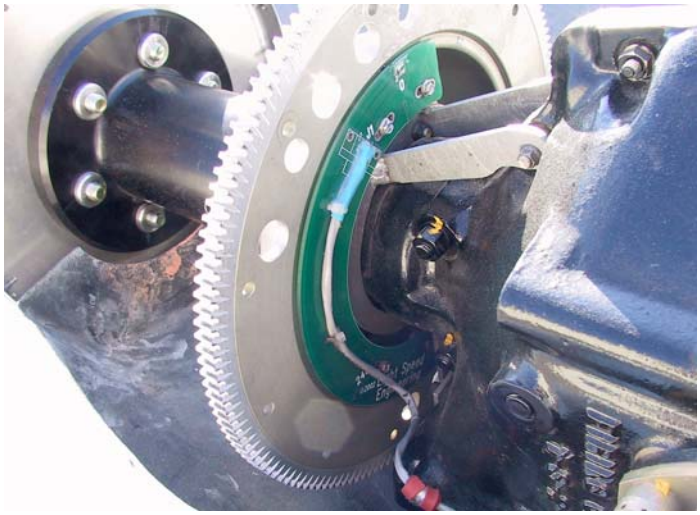
The conversion was completed by the Phantom team while Ly-Con was finishing their expert magic on the custom build. Team Phantom traveled to Visalia, added their components to the long block, and Ly-Con moved the engine to their high-tech dynamometer test cells where the Aberle team observed the tests and results.

Special note should be made that the class rules do not allow angle valve heads, which would normally be the choice of someone seeking higher power output. Parallel valve heads were used as required, but much attention was paid to optimize the flow of the air/fuel mixture. As a summation of the results of their expert head modifications, proven by the dynamometer results, we quote Kenny Tunnel of Ly-Con, who's been dubbed "the king of understatement" by Tom, "Wow, I guess we got these heads figured out !!".

The weight of the engine with all accessories (Tom doesn't run an alternator), and not including the remote oil sump itself, comes in at about 235 pounds.

IGNITION

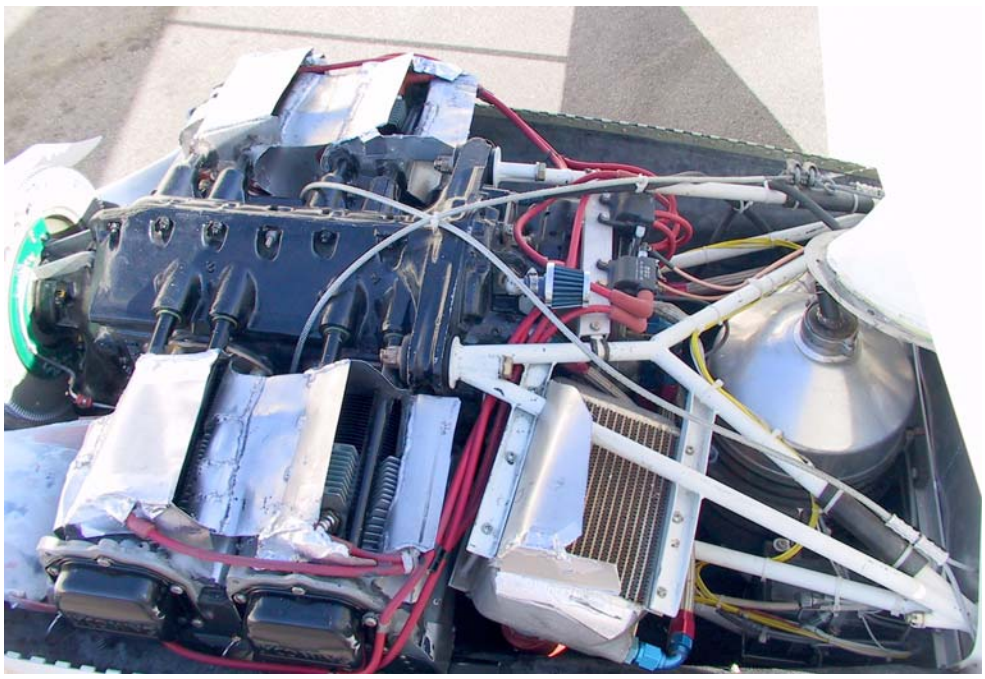
Spark is provided by a combination of one Light Speed Engineering Plasma Ignition System and one Bendix 1200 series magneto. The 1200 is the choice over the 200 as Tom told us, "Because it's got a hell of a lot more voltage than a 200". The complete electronic ignition system consists of two pick-ups at the prop, two coils, noise suppression ignition wires and unshielded plugs. Tom said, "I used Light Speed on the last airplane I was running; I wasn't all that convinced that it was a big advantage until I got this engine. Compression ratio on this one is such that it'll blow out starters if it kicks. The limitation of the spark retard of the impulse coupling design, along with the possibility of non impulse coupling action- ignition at normal advance, can be tough on starters".



With the Light Speed Engineering ignition system, a printed circuit board with a crank position sensor is one option used for timing. The other option (not shown) uses a Hall Effect Module which is installed in the accessory case and senses crank shaft position by means of the non-impulse magneto gear.

INDUCTION

The fuel injection system is an off-the-shelf unit from Airflow Performance, Inc. (API) of Spartanburg, SC. The API system is not approved for certified aircraft but is specifically approved for the biplane class at Reno. In



This overview shot of the engine shows the updraft cooling system, the LSE ignition coils, the oil cooler, as well as the dry-sump oil reservoir.

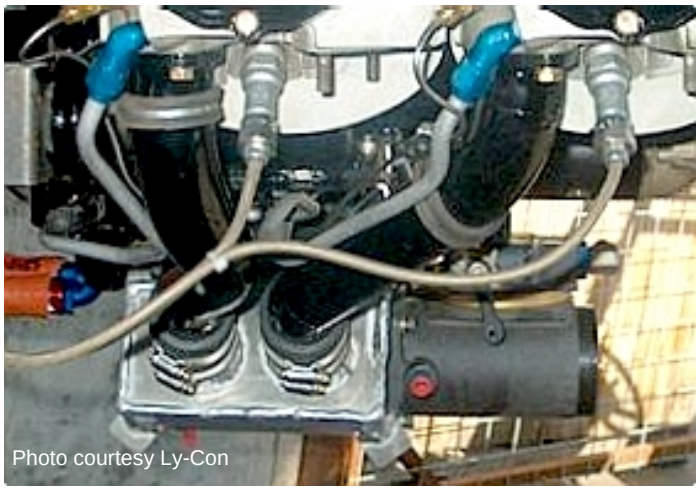


Photo courtesy Ly-Con

fact, anyone who is competitive in the class runs the API system. When considering API, Tom conferred with Kenny at Ly-Con and asked why he should run it. Tom was politely told, "It flows more air". That's all Tom needed to hear. www.airflowperformance.com Phantom uses the standard model that Airflow Performance recommends for any Lycoming IO-360. This was chosen because it offers superior performance to the typical factory installed Bendix RSA-5 fuel injection system. The API injection system has been proven completely equal to the task for this race engine.

Tom gave us a brief education on his injection system. "The Bendix fuel injection system that's used on aircraft and the continuous flow port fuel injection that's synonymous with mid fifties Corvettes are very similar. All they really do is monitor the air flow through a throttle body, through the use of venturis and ram air sensing, and control the air with a butterfly; so now you know how much air is going through the servo and you're controlling it. You vary fuel pressure across orifices that are in the nozzles themselves. That's it. You feed the fuel out of the servo through a flow divider, the flow divider goes to the nozzle, the nozzles have an orifice in them that says, under "x" PSI, I will flow so many CC's. It's simple and trouble free". The typical Bendix system utilizes fuel pressurized to 24-49 PSI, as does the API unit Tom uses, as API specifies using the same pumps.

When looking over Tom's engine we noticed primer lines, but were confused over that due to the engine being fuel injected. Since this engine did not start out life as an IO, it was set up for a primer system and the heads were drilled and tapped for primer nozzles at the factory. Since there needed to be a port on the head in which an injector nozzle could be installed, it made perfect sense to Tom to employ the otherwise unused primer port to locate the injector nozzles.

"I sold my first airplane, #31 'Long Gone Mong'", Tom told us, "and the gal who got it ended up racing it for several years, and she won with it in the early to mid 90's. She managed to get an additional 6-8 mph out of the airplane by doing two things: First, taking the engine to Ly-Con and having them build it. And second, they took the Bendix throttle body and sent it to API. Don Rivera bored it out and made it into an "Airflow Performance" injector that looked like a Bendix".

COOLING AND EXHAUST

Updraft cooling was chosen as the lowest drag method of moving the necessary air through the cowling. The flow only has to make two 90º turns (compared to the usual 4 turns made by standard down-draft cooling), which results in less restriction and lower drag. Cooling drag is a very significant factor for all airplanes, oftentimes summing to 30% of the machines total induced drag. Tom states that the cylinder head temps are still rather low, so more MPH may be obtained as the cooling system is further refined. There are five cooling relief vents in the upper engine cover, one for each cylinder and the last positioned as the oil cooler outlet. See photo below.

The exhaust system is notably unremarkable. Tom started out with set of long, equal length, stainless steel headers feeding a four into one tailpipe that collected under the engine and exited between the landing gear (under the pilot's seat). This more elaborate exhaust system was never actually installed because it was deter-

This Reno 2003 photo, shot by Chris Luvara, clearly shows the straight stack exhaust system Tom once used.

mined that the firewall size advantage gained with the dry sump would be negated if these pipes were used. Dyno testing at Ly-Con revealed that the four into one netted 8 HP at wide open throttle. Instead, Phantom flew in 2003 with 4 straight stacks penetrating the cowl cheeks approximately 10 inches. For Reno '04, Tom cleaned things up a bit, shortening the stacks and making them curve ninety degrees aft into the slip stream.

THE WINGS

The one of a kind, high aspect ratio wings were commissioned to Grove Aircraft. www.groveaircraft.com Besides being very well known in the experimental aircraft community as a provider of formed aluminum landing gear and brake systems, Robbie Grove also operates a first class composites shop. Much of his work there is contracted to governmental sources. Robbie Grove is an EAA guy from way back, and loves interesting challenges. Tom tells us that Robbie has been building formula one components and aircraft wings for quite some time. He agreed to take on the fabrication of the radical looking wing sections.

The wings are constructed using custom made carbon fiber box spars (main spar and drag spar), formed around 4.5 lb. Clark foam, using a composite polymer thermosetting resin. This particular foam product is no longer available from the original manufacturer. Only builders "in the know" and with a vision toward the future had the good sense to order a sizable amount of the 4.5 lb per cubic foot polyurethane material for new projects yet ahead. Grove Aircraft was one of the shops with the wisdom to cache a volume for in-house use. The less forward thinking must now use a heavier, but still available product for similar applications.

The modified NACA 65 series airfoils were shaped using hot wired foam blanks of Dow extruded polystyrene, as found on most all Rutan airframes and many other plans-built and kit experimental aircraft. (Extruded polystyrene is not to be confused with white expanded bead polystyrene.) The shaped airfoil pieces were bonded to the previously assembled and cured spars and this new assembly was then encapsulated with carbon fiber; two plies laid up at +/- 45º from the spar for strength, plus a third layer encompassing only the forward third of the wing. The different composite resins and epoxies in use are post cure compatible. All the fuel is contained within welded aluminum cells, so fuel resistance was not a specific concern. When using expanded polystyrene, caution is used to keep it far from any chemicals (including gasoline) that can dissolved the foam.

The completed wing sections were delivered to Aberle Custom Aircraft and mated to the modified Mong Sport fuselage, now re-christened "Phantom". The total wing is

just above the 75 square foot minimum area requirement for the class, and features some unique aerodynamic qualities, which understandably, given the competitive nature of the owners, cannot be revealed at this time. One specific feature which can be shared is that this plane has a pretty high stall speed. Tom says that it just quits at 80 mph, which he finds very unusual, as all the other planes he's flown with similar wing loadings usually stall in the high 50's to low 60's. Given the high aspect ratio wings, this seems fast for a plane which only weighs in at 738 lbs empty. This high stall speed makes landing at the home field, with its 2165' x 60' runway, extra fun.

When we first saw the plane, complete with the Elippse prop, we couldn't help but notice how the planform of the wing and propeller complemented one another. When we mentioned that to Tom, he replied, "As a matter of fact, when the two bladed prop arrived, I even said in a strange way it compliments the airplane, and as I told a whole bunch of people last week, the airplane sits here in front of my desk, in the hanger, and it's taken me almost a year to be able to look at it and see that it may be pretty. The airplane is so striking in unconventionality that it's difficult for me to see beauty". Of course Tom can agree that it's beautiful when it brings home shiny trophies and a few bucks.

Photo courtesy Aberle Custom Aircraft

Tom test drives the Mong Sport fuselage truss before hacking off the aft section for the carbon fiber monocoque tail cone and empennage.

THE AIRFRAME

The stock donor Mong Sport frame was steel tubing from firewall to rudder. The fuselage was modified by the crew at Aberle Custom Aircraft by first installing the landing gear. Now the aft section is a totally carbon fiber composite monocoque shell, attached at the seat back of the steel tube cage structure which makes up the cockpit forward to the firewall. By removing the tail cone and propeller, the completed plane can be transported "side saddle" on a standard width, highway legal trailer.

FUEL SYSTEM AND LANDING GEAR

Phantom is a pure racer, but carries enough fuel to fly to races if the owners choose to do so. There are two welded aluminum cells bussed together totaling 14.7 gallons, in the space between the instrument panel and the firewall. This configuration was required in order to facilitate installation of the cells into the extremely compact space available. Race rules require a minimum capacity of 14 gallons but the aircraft need not be full when racing. There are also two auxiliary fuel tanks of 2.5 gallons each, also bussed together, located in the lower wing root leading edges, inboard of the wheels and the lower wing panels.

Photo courtesy Aberle Custom Aircraft

The landing gear is comprised of a welded steel square tube truss which is actually the root section of the lower wings, and the small aluminum reserve tanks are hidden there within the aerodynamic shell of the non structural composite wing root fairing. They are designed to feed the engine directly through valves. With a grand total of nearly 20 gallons of avgas available, Phantom could be flown to events, but this is not a comfortable cross country machine, being a very snug fit and with minimal instrumentation and no avionics at present.

THE PAYOFF

When a race plane makes a quantum leap in performance, everybody takes notice. All of the Aberle shop crew's work finally paid off.

Tom made many special arrangements with folks during the early weeks of the race plane development to insure that the hurried production schedule could be met. One of these advance deals was to have a race prop built for this high power, low drag application. Something went terribly wrong with the prop maker's production schedule, and the prop blank that Tom put on order in the beginning was not available when the time came to carve the prop from Tom's specifications. When the Phantom group was ready to go racing they had no prop, other than the test prop used for the first flights and to gain data from which the custom prop would be designed. Tom was able to borrow a spare propeller from the "Class Action" #21 team. This was a 2-3 year old unit, but was showing no signs of fatigue so it was installed,

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Gary Walsh's Prop Problems

By Gary Wolf
President, RAA Canada
Photos by Gary Walsh

In late June of 2004, RAA (Canada's Recreational Aircraft Association) member Gary Walsh experienced a thrown prop blade and the near departure of his engine from the mount of his 912S-powered Kitfox amphibian. The prop was a 3 blade NSI CAP 140. CAP stands for "Cockpit Adjustable Propeller". The prop had only 200 hours on it since new, and one of the blades chose this time to leave the hub. Gary remembers flicking off the ignition, but the vibration was so intense that both carbs came out of their spigots and may have been the real reason the engine shut down so quickly. Fortunately all of the hoses and wires and a few engine mount tubes retained the engine within the cowling, so the C of G was not affected when the engine mount failed.

Gary had previously owned a Cessna Aerobat and had frequently practiced dead stick landings, so he managed to get the Kitfox safely on the ground. After landing he got out to survey the damage, and found that the departed blade was embedded in the top of his float, taking out the nose gear retract linkage in the process. The blade was intact except for the lower part of its retaining cuff, which was still secured to the hub.

This photo shows the machined undercut groove in the corner of the sleeve. (Refer to the arrow). The fracture appears to have originated in this groove.

We inspected the broken blade and saw that there was a beach mark, typical of a fracture that had been waiting to let go. Gary contacted Lance Wheeler, owner of NSI, to find out if this sort of event had happened before. Lance said than this was the first failure where there was no previous damage history, such as a prop strike. Even though Lance felt the cause was torsional vibration caused by the higher compression of the 912S engine, Lance promised that he would take care of Gary's expenses in terms of the prop; Lance has never promised to address any other damage.

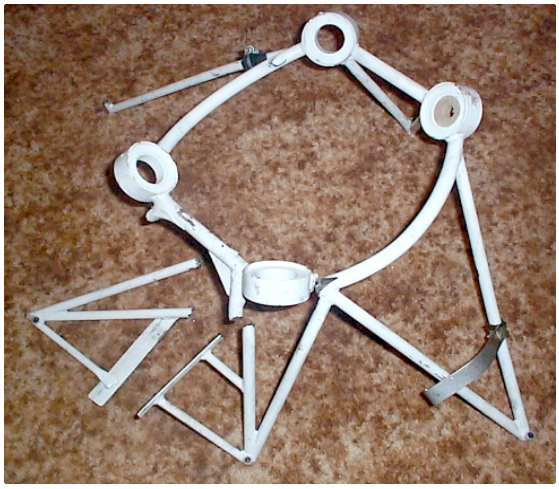
Looking closely at this photo, you'll see one of the three blades missing from the NSI hub and firmly planted into the top of the Kitfox's port float.

A bit of history - Gary had bought his Kitfox with this CAP 140 propeller two years ago and it had not come with a prop manual so he ordered one. A few months before this prop threw a blade, Gary had noticed some play at the tips of the prop blade and called NSI for advice. The prop hub was also throwing grease. Lance said that he should not idle the engine below 2500 rpm and that the play was normal. Centrifugal force would eliminate this if the prop were not idled below 2500 engine rpm.

Back to July - Gary removed the engine and took it to Tri-City Aero for an inspection of the gearbox. He also made photographs of the hub and blades and then took the damaged parts to Cambridge Materials Testing, a local test lab that spends its days determining why bridges fall down and auto engine blocks crack. This lab inspected the parts and found that the crack had been growing for quite awhile. They issued a report that pointed at the sharp inside corner radius of the cuff as the culprit. At Lance's request Gary shipped the entire propeller with hub to NSI in Arlington, WA, USA. Gary also met Lance at Oshkosh, and delivered a copy of the lab report. Gary then began the wait.

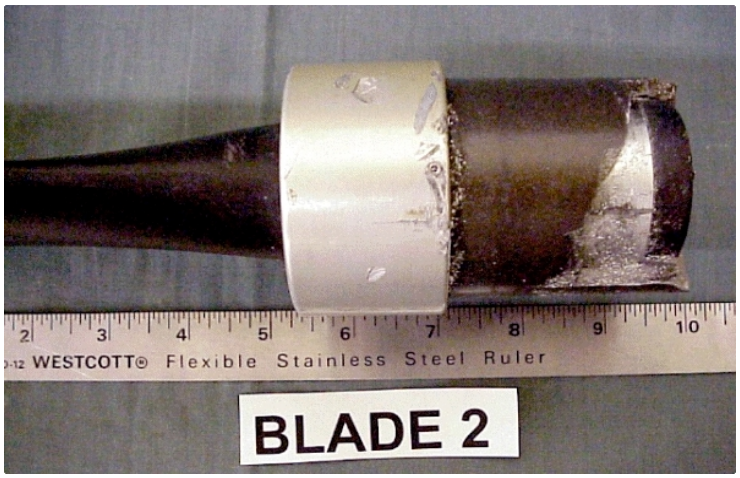
At first it was Oshkosh that prevented Lance from responding. Next, Lance had a medical condition that had to be taken care of. Gary meanwhile retrieved his 912S and bought a new motor mount. He found someone to talk to about the eventual repair of the damaged fiberglass float. There were many calls to NSI but none were

returned. Gary eventually got through to Lance after persistent phone calls, emails, and the odd fax, and was told that there were reported failures with the CAP 140 but they all involved prop strikes or problems with the way the unit was being operated. He was told that the cause of this particular failure was probably due to letting the engine idle at too low of an rpm and to torsional vibration inherent to the 912S. Lance suggested that he should fit the slipper clutch that Rotax has as an option, to lessen the G-loads on the blades during start up and shut down. He was still offering to take care of Gary's prop damage, but he had so many business opportunities due to the new sport pilot ruling that he would not get to it for another two months.



Within a matter of seconds the engine shook hard enough to break the upper supports of the engine mount, leaving the engine dangling from a few hoses, cables and wires. This makes a great argument for the use of a safety cable from the firewall directly to the engine block.

By this time, Gary had heard that there had been an NSI failure on an Europa in the UK in 2002, and that the Popular Flying Association (PFA) had issued a notice to their membership. (The PFA is the representative body in the United Kingdom for amateur aircraft construction, recreational and sport flying). Gary found out that the owner had sent his prop back to NSI and that upgraded blade cuffs were installed. Once again Gary contacted Lance Wheeler, but was told that the PFA report was inaccurate, that there was the history of a ground loop and prop strike, and this could have been the source of the failure. He did not adequately explain why they had upgraded the cuffs nor why they had not issued a service bulletin to their customers, informing them of the upgrade.



In September, 2004, I sent an e-mail to Mr. Wheeler and got no reply, so I phoned him. After a long wait on hold, Lance and I had a very informative conversation. According to Lance, each Europa that had a complaint, also had a prop strike. There had been a few direct drive applications which had a thrown a blade, but these applications were not approved. Lance also said that there had never been a failure on the 80hp 912 engine, only with the 100hp 912S. The 912S does have higher compression and has a harsher vibration below 2000 rpm. Lance forbids operation of his prop below 2500 rpm and recommends that the slipper clutch be installed on all Rotax applications with his prop. Lance told me that the 912S was not approved for use with the CAP 140, whether or not the clutch was installed and that owners who were using this combination were doing so at their own risk.

I asked Lance about the lab report and the beach mark crack that emanated from the sharp inside corner of the cuff on Gary's blade. He told me that this was because Gary had been operating the engine in an incorrect manner and that there could be reversals of 8 G's in the range below 2500 rpm. He also said that he was preparing to release a new series of prop cuff that would be made from 7075 aluminum instead of 2024, and that these new parts would be some 50% thicker. As soon as the current inventory was all sold, Lance intended to supply only the new model of blade cuff. He also said that he had been considering putting out an AD or a service letter on the failures but did not want to put all owners to a needless expense if only a few had suffered the loss of a blade. I suggested that his proposed $500 AD cost would be a lot less than the estimated $10,000 in damage that Gary Walsh is facing. I also offered to post his AD or letter on the RAA website to let Canadians know of these problems. Lance also promised me that he would soon be giving Gary three new blades plus his new in-cockpit blade angle indicator, and that he would be sending these parts as soon as they were produced.

Finally, having given up on waiting for NSI to inform anyone, Gary Walsh posted details of his prop breakage on the Yahoo Kitfox owners forum. In a subsequent phone conversation Lance explained to me that this action had cost him $100,000 in lost sales but that he still intended to do right by Gary Walsh.

Meanwhile, Gary had done a bit of investigating with the PFA and with the Europa owners in the UK that Lance had been adamant that the incidents they had involved a prop strike. Correspondence with the owner and with the PFA brought forth the information that there had not been a strike, and that two years ago Lance said that he would be sending out an AD or a service bulletin.

The PFA meanwhile issued a caution to owners of the CAP 140 while they waited for NSI to do this. The caution limits the life of blade cuffs to 25 hours when operated on a 912S engine. It also cautioned that any looseness of the blades in the hub could be a precursor to breakage. None of this was told to Gary Walsh when he had first called NSI to find out about play in his own blades, long before the actual breakage.

On October 27th, 2004, I called Lance to get an update and was told that there would shortly be a third version of the blade cuff and that it would be made thicker, and from stronger 7075 material, instead of the previous 2024. In this conversation, Lance agreed to issue an AD on the CAP 140 and dictated the details that are printed at the end of this article. When asked, he admitted that the sharp inside corner would not be changed in this third version of cuff, but expected that the thicker 7075 would prevent any future breakage. He also admitted that there would be no actual testing done on the new part before sale to the public and that he was relying on finite element analysis. I next called an engineer for an opinion on this "upgrade" and received a warning that 7075 can be more prone to stress cracking than 2024.

RAA Canada immediately distributed the details of Wheeler's AD to Transport Canada, PFA, EAA, COPA, UPAC, MD-RA and to other national organizations around the world, with the request that they publish the warnings. An RAA member sent out the warning to various newsgroups, and this brought e-mails from customers who had experienced related problems. Most of these involved waiting for return of deposits or refunds for defective parts, plus finding that there is little or no means of contacting the company's principals or safety officer for information. There appear to have been blade cuff problems in other countries, and the correspondence is on file at the RAA office.

The NSI website is www.nsiaero.com. At this printing, there is still no information on that website about the AD that Lance dictated late in October. There is a form to collect customer satisfaction information, but it errors out when submitted. Lance had earlier told me that the 912S was not approved for use with the CAP 140 prop, but on the website the 912S is one of the supported engines. I also noted that there is no caution about low rpm operation for any of the Rotax engines.

If you own or are considering the purchase of a plane that has one of these NSI CAP 140 propellers installed, you should consider making your own investigation about its condition and its suitability for the engine. There are not many manufacturers of in-flight adjustable propellers, but perhaps a ground-adjustable unit might do what you need. At this writing, Gary Walsh's hub and blades are still in Arlington, WA, and he has given up on receiving any satisfaction from NSI.

Gary Wolf
President, RAA Canada wolfpack@sentex.net

After fueling up in Brampton, near Toronto, Gary Walsh and his 12 year old daughter departed, only to

The NSI CAP 140 prop is in-flight adjustable and has three Warp Drive blades that are modified by the addition of an aluminum cuff that fits into the NSI hub. There have so far been two versions of this cuff, with a third version about to be released. Some applications will have their effective lives limited by this AD, and others are grounded immediately. New version 3 parts are not yet ready, so some planes will be grounded until parts are available near the end of 2004.

This AD affects only the blade and cuff when installed on Rotax 912/912S/914 engines.

Effective immediately, all CAP 140 props on 912S Rotax engines with either the version 1 or version 2 cuff are grounded. These parts may not be used any longer. Ship your blades to NSI for installation of the version 3 cuff. Lance Wheeler stated that the cost will be under $500 US.

Effective immediately, all CAP 140 props on 912 engines with the version 1 cuff are limited to 500 hours. On 912 engines with the version 2 cuff they are limited to 1000 hours. Blades must then be shipped to NSI for installation of the version 3 cuff.

Effective immediately, all CAP 140 props on 914 engines with the version 1 cuff are limited to 700 hours. On 914 engines with the version 2 cuff they are limited to 1000 hours. Blades must then be shipped to NSI for installation of the version 3 cuff.

In Lance Wheeler's estimation, blades fitted with the version 3 cuff will have an effective life of 2000 hours. This estimate has been calculated by Finite Element Analysis. This AD does not affect any other models of NSI propeller, or any NSI engine package.

Planning Your Charitable Giving

Just in time for tax season, CONTACT! Magazine supporter Percy Lorie offers a little food for thought.

CONTACT! MAGAZINE and its parent 501(c)(3) Charity, Aeronautics Aviation Enterprises like all Educational Charities needs and welcomes your support and contributions.

Knowing you have other organizations including Religious, Educational, Social Service, Hospitals, Service Organizations and a multitude of worthy recipients, a series of articles will be added along with links to informative sites, in the future, to help donors interested Experimental Aviation control and maximize for personal benefit and Charitable benefit their giving.

Let us first look into the problems and various personal goals of the average USA giver. Sorry, for those of you not subject to "Uncle Sam's" rules you may gain ideas however the tax advantages will not apply.

Where did you first learn charitable giving? For most of us it was thru religious training where as small children we took our 10 cents per week or more and placed it in a box or plate to help those less fortunate then ourselves. Perhaps you learned it at school with UNICEF or donations to other causes. Some learned by watching their parents or others in the community help out when called upon. Don't forget the influence of television Ministries, Jerry's kids or seeing the "Bell Ringers" in front of stores during the Holiday Season. For some that are a little older the contribution to support of the war effort by the purchase of Savings Bonds or in school Savings Stamps to support the World War II effort in behalf of the Allied Forces. Most remember their history of sales to the German people of a coupon/stamp book promising them a free VW Beetle from Hitler's Nazi Government.

NO of course we do not agree with the goals or operation of every Charity, Government or Organization but there among the crowded list seeking your help worthy recipients that each of us wishes to help. In addition most within society wish to be absolutely sure the funds donated are in fact used for the stated or intended purpose and not diverted as we are reading about to subversive organizations or unreasonable operating overhead expenses.

Almost all give some or a lot to various Charitable or others needing our help and wish to promote and assist with their cause or efforts. Most of us wish to help and teach our children the responsibility and pleasures derived by generosity. Social Engineering is a part of most government laws and tax codes.

Ideas presented are not in detail nor suitable for every readers needs or desires but with careful reading you may find in this series of articles something that is of use to you.

Let's start with a few basic tax rules that make donations attractive. In order to take a tax deduction you must file a "long form" tax return and have "Adjusted Gross Income" on which you owe tax. If you donate Cash or un- appreciated assets then the maximum that may be applied within the IRS form is up to 50% of your AGI or if you donate appreciated assets then the maximum that may be applied in one taxable year is 30%. There is a provision that permits you in both cases to "carry forward" the un-used portion of the donation to future years for a period of (5) five years.

Assets could be cash, stock, bonds, deeds on Real or Personal Property or anything of value. "Fair Market Value" must be established. Cash of course presents no problem but other forms of gifts need a little caution when giving.

Stock or Bonds should not be sold by you when donating but transferred directly to the Charity for them to sell if you have a gain over "Adjusted Cost Basis". In a loss just sell but if you have a profit transfer direct to the Charity as a "IN KIND" transfer. The instruction to your broker should read "DO NOT SELL BUT TRANSFER IN KIND". Were you to sell at a profit and then donate then you would own tax on your gain at ordinary or long term capitol gains rates depending on length of time you held the securities. The value of "Common Stock" donated is its value as of "close of business" on the day donated. If you wish to donate securities and the Charity does not have an account, as is often the case, simply arrange for your broker to open one for them. This makes transfer "IN KIND" very simple. It could take a little time so don't put off until the very end of the year.

Gifts of Real or Personal Property should be substantiated by a qualified appraiser if the gift is "substantial" or is Real Property be sure you take this extra precaution.. If total Personal Property donated exceeds $500. for one year be sure a receipt is obtained and it should be itemized again at the "Fair Market Value".

Donations for things of value are not deductible. A good example of this would be a fund raising dinner. If however the amount charged for this dinner exceeds it value than that portion that exceeds the "Fair Market Value" of the dinner is deductible and the Charity will advise you of the amount of the deduction.

Hopefully this information will help as you file your 2004 taxes and in planning your giving and tax planning for this New Year. In the next issue tax ideas how giving affects your estate plan will be continued with a series of in depth information and details.

Future donors who give Aeronautics Education Enterprises will be acknowledged with their permission in this column of your publication.

CONTACT! MAGAZINE AND AEE OFFERS THIS REFERENCE MATERIAL ONLY AS A SUGGESTION THAT IDEAS PRESENTED BE DISCUSED WITH YOUR ATTORNEY, CPA, ACCOUNTANT AND/OR FINANCIAL ADVISOR.

Second Annual Alternative Engine Round-Up

By John P Moyle

For the last half decade, even before we took over the publishing of CONTACT! Magazine, it has been our pleasure to participate in the forum activities at the Mountain States Tandem Wing Fly-In. This annual event in Laughlin, Nevada, heralds the spring season for us west of the Rockies.

Dragonfly enthusiast Don Stewart, along with his gracious and accommodating wife Debbie, have been the principle organizers of this gathering for as many years as we've been involved, unselfishly making the arrangements for a place to get out of the sun and the wind, where all who've flown or driven across the High Desert can congregate. Those still building, or not yet decided, have the opportunity to hook up with pilots of Quickie or Dragonfly. Many folks get their first chance to "try one on for size", and frequently rides are given (weather permitting). This is a very casual, non commercial venue. The low pressure feel of the group makes for a comfortable situation in which one may ask questions.

Last year CONTACT! Magazine officially took over the scheduling of the forum activities, allowing our host to relax a bit more than was previously possible. Since one of the primary topics written about in our articles is automobile, or other alternative power plants which may be converted into flight engines, we had christened the 2004 Laughlin event forum the "Alternate Engine Round-Up" We had a fine list of presenters and an appreciative crowd.

We are proud to announce the Second Annual Alternative Engine Round-Up which will be held once again at the Laughlin/Bullhead International Airport, (just across the Colorado River from Laughlin, Nevada) on Friday, April 29 through Sunday, May 1. Friday arrivals may join up for dinner, this year at Harrah's Casino Buffet, 7:00pm

Forums will be Saturday, April 30th, all day in the FBO hangar on the lower level of the field. The management generously offers free tie downs with a fuel purchase, and a 10¢ per gallon discount if you use your Chevron credit card. On the field is a mini market adjacent to the forums hangar and clean restrooms available.

The current list of forums scheduled includes a return visit from Jess Myers of Belted Air Power, manufacturer of PSRUs for Chevy V engines and other auto

Klaus Savier speaking on Lightspeed Ignition

power conversion solutions; Joe Horvath of Revmaster Aviation, presenting his 110hp R-3000 engine; Klaus Savier returns to talk about Electronic Ignition and EFI; Paul Lipps will discuss the Elippse Propeller; Pat Panzera and I will once again share our knowledge on the Corvair Engine for aircraft; Scott Casler visits us for the first time and will tell us about the "Half VW" Hummel Engine; Jim McCormack of Jabiru Pacific will join in for the first time with Jabiru Engines; and Jim Patillo will again cover prop balancing.

You owe it to yourself to attend this low key, educational and entertaining gathering. There's plenty of fun things to occupy your spouse if he or she's not especially excited about aviation topics. The Colorado River offers many pleasant tours and recreational activities. There's an outlet mall for shopping, and of course the Nevada side of the river has an abundance of inexpensive hotels, and dining facilities, as well as casinos. Lodging is also available on the Arizona side, close to the airport, which can be a bit more expensive, but way less hassle.

If driving, bring chairs, and if possible some extras for those who do arrive by air and are generally unable to provide their own. We do not charge admission, since we do not incur any expenses such as rental furniture, etc. If you can assist by bringing folding chairs, we'll be able to continue this wonderful, "no fee" format. For more info, visit: www.contactmagazine.com/Roundup.html or just call your editor Patrick Panzera at 559-584-3306.

***SWITCH ON!* Continued from page 2**

we can reward you with a wrist band good all week long. All we ask is that you man the booth and help us tell people about CONTACT! Magazine. If you are interested in helping, please contact me as soon as possible.

A NEW SERIES

We've started a new multi-part article in this issue, one which is not really related to the main thrust of this magazine, but which is close to the philanthropic nature of our parent company, AEE. I don't like the idea of taking pages away from experimental aviation, so I've added pages to this issue to make up for it. The series is well written and very informative, and I hope you find it educational and beneficial.

LETTERS

Pat,

While reading those back issues I asked for, I noticed what seems to be a common theme amongst your correspondents: that they're sick of agendas. They didn't like the issue with the "Sonex agenda," or the one with the "Corvair agenda," etc.

I thought you might like to know that I think you're doing a great job, especially considering that it's nearly a one-man show. Even when the articles revolve around a single type, they're interesting and cover technical details you wouldn't normally read in *Sport Aviation.* In fact, at least a couple of times recently, you've covered newsworthy airplanes months before *Sport Aviation* did. E.g., the Chevy-powered Junkyard Dog, which article was reprinted verbatim in *SA.* E.g., the Peregrin XS; while *SA's* reporter didn't bother to find out why Chris had a booth at CS, you did.

(Name withheld by request)

This is only one of several letters we received concerning my last editorial. We certainly get more positive letters than we get complaints, but this one pretty much sums them all up. I certainly appreciate all the support from those who have taken the time to write encouraging notes.

THE COVER STORY

Along the lines of bringing to the pages of CONTACT! Magazine, stuff which is overlooked by the big boys, it's truly disheartening that Tom Aberle's accomplishment has gone almost completely unnoticed in the pages of magazines devoted to experimental aviation. How much more experimental can you get than with what Tom and crew accomplished? To build a plane from scratch, by hand, with no plans, in seven months, and to be totally competitive in a class in which 1st and 3rd places are separated by 10ths of a second, and then to improve its performance by 20+ mph the following season, walking away from ALL competition is totally remarkable. Yet each major magazine has now published their Reno issue, and Phantom has received not much more than a blurb. We'll be keeping an eye on Tom, and you can trust that we'll bring you news on any new developments.

FLETCHER BURNS CHECKS IN

Pat,

It's been a while since I had a chance to update you on our progress. I think the attached photo says it all. The UltraVair engine is running strong on our ultralight we call the "Spread Eagle". It's really a Legal Eagle that we put longer wings on. The wings are off an old ultralight called a Delta Honcho. They increased our wingspan to 32 feet while reducing our empty weight to the legal limit. So we finally have a legal ultralight!! It's a blast to fly!!

I want to thank you again for running the article about our engine in your magazine. I hope to see you at Oshkosh. We don't have the resources for a booth, so we will just be parked in the ultralight area. We do plan on flying it while we are there.

Fletcher Burns
fletcher@ultravair.com

SUBSCRIPTIONS

Many of you reading this note might have an expired subscription. We are sending this issue out to everyone who expired with the previous issue, hopefully to motivate them to renew. Please check your mailing label. At the bottom of the label there is a statement as follows "Your subscription ends with issue # ". If the number is 79 or lower, this is your last issue. If it's 80 or higher, you are fine for the time being.

We certainly could use more subscribers. As I've said in the past, the more magazines I have printed per issue, the lower the cost per magazine. If we reduce the cost per magazine, I can afford to increase the page count.

Continued on page 21

TURBINES

Is it turbine time for homebuilts?

By Vance Jaqua

In the upper power regimes of commercial and military aircraft, the gas turbine variants have taken over. Does this mean that turbine power is ready to dominate the amateur builder field as well?

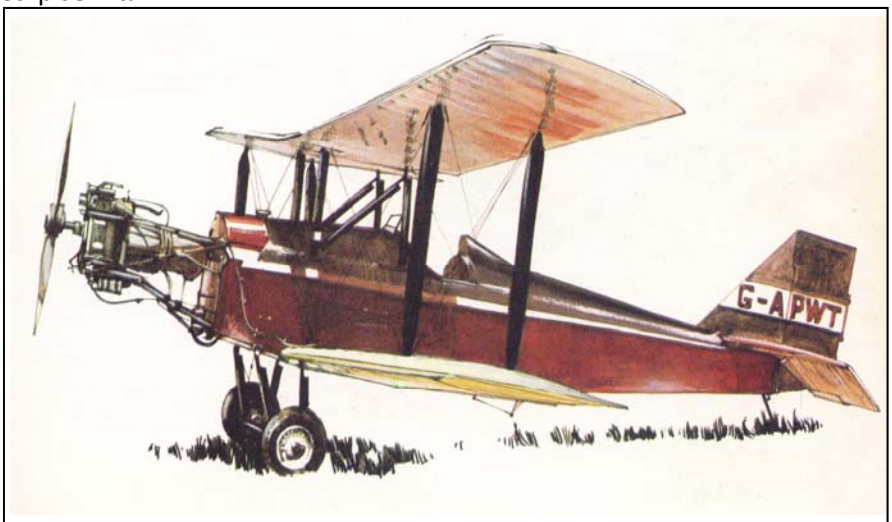
If you are building a 600 horsepower high performance, high speed ship, the resounding answer is yes. The wide availability of the Walter turboprop engines surplused from the fleets in the ex-communist block countries, have made this option a bargain you cannot refuse. Although thirstier than the piston equivalents, the lower initial cost and light weight are major selling points. However, in the 200 to 300 horsepower region, where most of the builders live, the picture is not nearly so rosy; the road appears littered with snake-oil salesmen.

You have no doubt seen in the various magazines, glowing claims for conversions of the Solar Titan based auxiliary power units and jet starters. Again, the surplus market seems well supplied with numerous versions of these units at attractive prices. The most numerous applications are showing up from small helicopter installations. There is high potential in this market, where a high power-to-weight ratio is a premium feature. The rather greedy fuel consumption of these units is relatively acceptable as a rational trade for the reduced weight and the promise of reliability and low maintenance issues under continuous high power settings. The fuel limited flight duration is generally not a major goal for this type of aircraft. The pioneer in homebuilt helicopters, B.J.Schram, was in the process of acquiring a supply of these units for conversion to helicopter use but his tragic death will leave a void in this effort.

For the typical, RV6, Long EZ, and similar craft builder, the turbine picture is really quite bleak. In spite of some vendor claims, the maximum power capability of most of the Solar Titan based units is about 130 horsepower, with a few examples as high as 160. A turbine does not lend itself to usual hot rod tactics. The two limiting characteristics are flow rate and turbine inlet temperature. The margin between efficient power generation and overdriven turbine temp is very narrow and abrupt. The difference between thousands of hours and a few minutes or even seconds of turbine life can be as little as 100 degrees. The official manufacturers stated specific fuel consumption for these units is typically 1.3 pounds per horsepower hour, or almost three times worse than a well tuned piston engine.

HISTORY

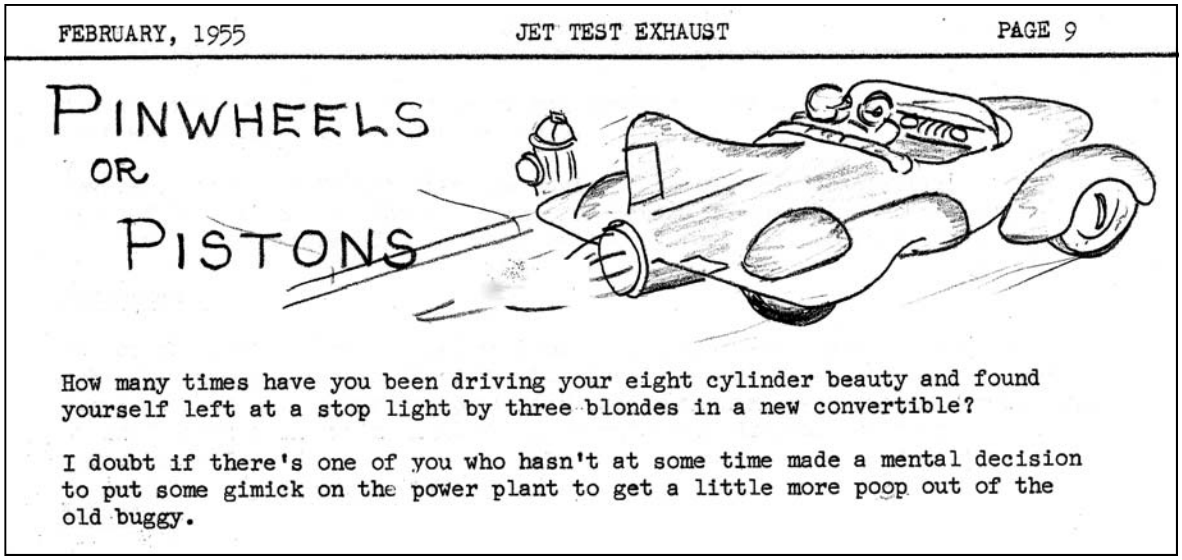
The concept of gas turbines has been around for quite a long time. Actually one might argue that the windmills used for ages for pumping and milling, are really a form of gas turbine. Heat energy from the sun creates the high and low pressure regions across the landscape, providing the wind from which power may be extracted. However, the modern history of gas turbines is primarily based on the development of jet engines in the WWII time period. Though attributed to Whittle in England, gas turbine work was proceeding in many places, with the Germans being the first combat ready aircraft in the air. These early jets have led to a major powerplant source in current times. There is hardly a power requirement that is not being served in someplace with a gas turbine.



Rover powered “Hot Wot”, a popular homebuilt aircraft in England.

Probably the first home built craft to be powered by turbine was the Rover powered “Hot Wot”. A popular home constructed aircraft in England was a scaled down replica of the DeHaviland “Moth”. One of these wooden biplanes was fitted with a small Rover gas turbine engine. While Rolls Royce had been charged with the development of the large jets and turbines, Rover was given the task of developing smaller units for various uses. One of these engines was also fitted to a series of automobiles, producing probably the first gas turbine powered cars. The Hot Wot was no “barn burner” with flashing speed, and the primary motivation for the installation was “because they could”. Modest power and speed were provided but at the cost of excessive fuel consumption.

The argument between turbines and piston engines has been going on for a long time. My own personal experience dates back to 1955 when I was a green, young engineer at General Electric's Aircraft Gas Turbine Division. We had a newsletter by and for the young "test" engineers, as we were referred to in those days. One of my coworkers wrote an article predicting the imminent replacement of the piston auto engine with a gas turbine, with this lead in. One of the projected breakthroughs was expected to be a ceramic turbine in about 5 years.



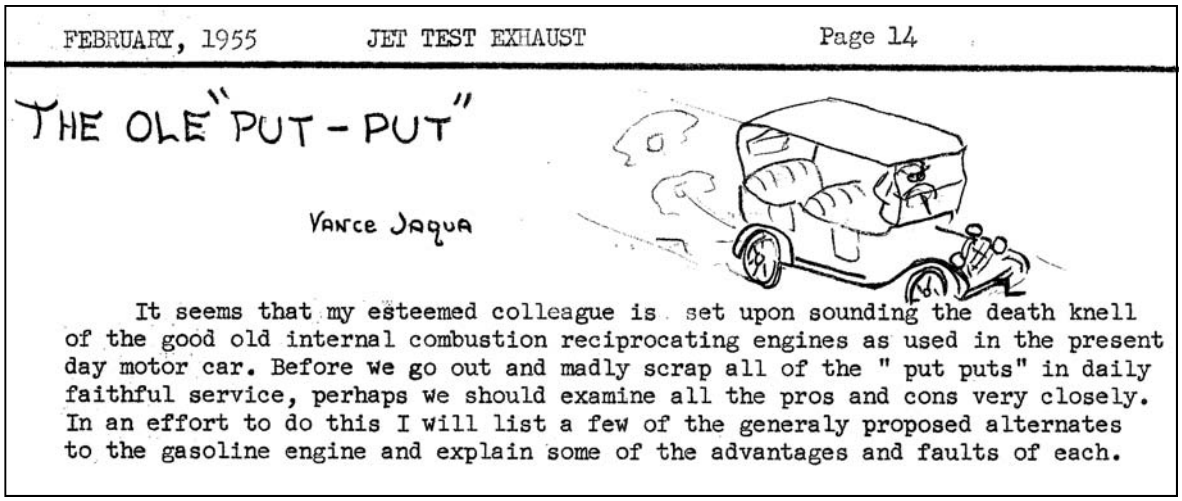
FEBRUARY, 1955 JET TEST EXHAUST PAGE 9

PINWHEELS OR PISTONS

How many times have you been driving your eight cylinder beauty and found yourself left at a stop light by three blondes in a new convertible?

I doubt if there's one of you who hasn't at some time made a mental decision to put some gimick on the power plant to get a little more poop out of the old buggy.

Although, I was also in the turbine design business, I felt compelled to come to the defense of the classic piston engine. So I penned the response that followed this heading.



FEBRUARY, 1955 JET TEST EXHAUST Page 14

THE OLE "PUT-PUT"

VANCE JAQUA

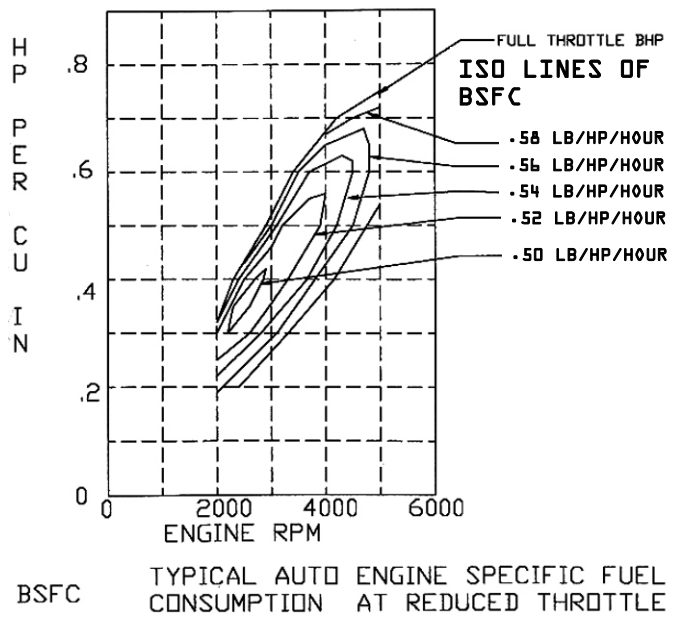
It seems that my esteemed colleague is set upon sounding the death knell of the good old internal combustion reciprocating engines as used in the present day motor car. Before we go out and madly scrap all of the " put puts" in daily faithful service, perhaps we should examine all the pros and cons very closely. In an effort to do this I will list a few of the generaly proposed alternates to the gasoline engine and explain some of the advantages and faults of each.

I even went way out on a limb, and predicted that the piston engine would remain supreme for auto use for at least 10 years – wow! To keep things in perspective, this was the year the Chevy "small block" was introduced, and ceramic turbines are still at least 5 years away.

EFFICIENCY – SPECIFC FUEL CONSUMPTION

Piston engines generally have a "sweet spot", a combination of manifold pressure (throttle setting) and rpm. The chart on the next page is from an earlier auto engine, where full throttle richening of the mixture is used to permit high compression ratios. As you can see, backing off the throttle slightly at about 2500 rpm moves operation into the best specific fuel consumption area. This characteristic is exploited with overdrive in automobile applications for improved gas mileage, and is also the principle applied during high manifold pressure, low rpm cruise for piston powered airplanes. Gas turbines have no "sweet spot". When you reduce power with a turbine, the fuel consumption is not reduced an equal amount, the specific fuel consumption being greater at low power settings.

The actual thermal cycle of the gas turbine (the Brayton cycle) is more efficient than the Otto (gasoline engine) or the Diesel cycle, for the same pressure ratio but limitations of the pressure ratio and maximum practical turbine inlet temperature have resulted in rather low efficiency for actual devices in most applications. However, in large installations for stationary, marine and large commercial aircraft, the use of complex active cooling systems for the turbine blades, coupled with multiple compression stages and exotic alloys has led to specific fuel consumption competitive with Diesel power. With smaller and simpler (read "affordable") units, the economy numbers are pretty dismal. Efficiency for any gas turbine is at it's maximum at maximum rated power. Reduced power operation (equivalent to throttling) is provided by reducing fuel flow, so power generation is reduced by dropping turbine inlet temperature, reducing thermal efficiency. Compressor efficiency is also lower at reduced rpm and the parasitic losses remain at high levels. It's not unusual to require half of maximum power fuel consumption to maintain idle (no useful power output) conditions. Operators of smaller turbine powered aircraft will frequently completely shut down engines during runway "holds".



Earlier auto engine chart, showing full throttle richening of the mixture used to permit high compression ratios.

Scale, and development level are both major drivers in the fuel economy picture. In general, smaller and older designs will have poorer efficiency. Some relative examples are:

ENGINE	SHAFT HP	RATED CRUISE
ALLISON 250	317/ 500	0.68/0.59 0.73/0.66
WALTER 601	700	0.65
AVCO LPT101	650	0.55
PRATT PT6	500/1020	0.65/0.56 0.67/0.58
ALLISON T58	4000/5000	0.53/0.50 0.54/0.52
SOLAR 65	60-130	1.3 (Pessimistic?)

NEWER AND BIGGER IS BETTER

Note that for some models, we have old/new ratings. For example; the Allison 250, (now being produced by Rolls Royce) which is an old design which has gone through numerous "dash number upgrades", has gone from 317 to 500 horsepower, while specific consumption has dropped to 0.59 pounds per horsepower hour (which is a very livable number). Note also that cruise specifics are in all cases poorer than rated operation. The Allison has been applied to numerous successful applications. The primary down side of this unit is the high price, something over $200,000 the last time I checked. The "low cost" Williams units, turbofan and turboshaft engines, were tightly coupled to the Eclipse business jet airplane program which has dropped them from consideration. The stated numbers for the Solar family of auxiliary power units are all given as 1.3 to 1.25, which, I believe, are pessimistic ratings but even at more optimistic levels these are fuel hungry, underpowered devices.

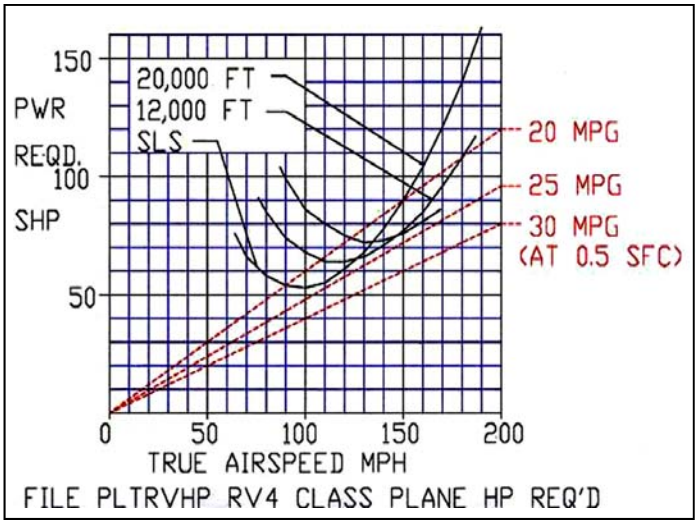
As mentioned earlier, the relatively low price of the Solar Titan family of gas turbine auxiliary power units on the surplus market has led to numerous efforts to convert them for small aircraft applications. Helicopter usage has been fairly successful; good power-to-weight ratio and perceive reliability have out weighed the heavy fuel consumption. Fixed-wing applications have flown with generally meager results. A few vendors are actively trying to market such a product. Demonstrated performance has been disappointing in spite of the usual optimistic claims. The maximum speed and performance results are limited by the modest power available from these units and fuel consumption has been predictably high.

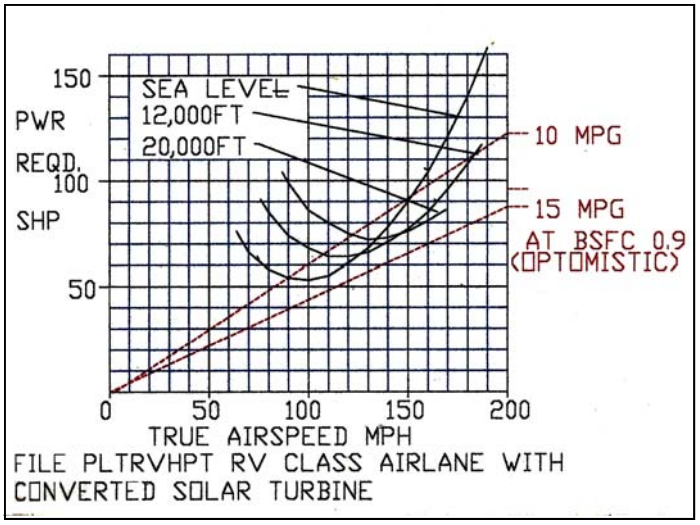
One vendor has published some static thrust data points with fuel consumption figures. Static thrust is generally regarded as unusable for determining engine power but with prop diameter known, one can make a pretty good estimate of engine shaft horsepower based on the "air horsepower" of the resultant air flow mass and velocity and estimates of typical prop pumping efficiency.

THE DATA SUPPLIED:		COMPUTED PERFORMANCE:	
THRUST LBF	GAL/HR	ESTIMATED ACTUAL BHP	SPECIFIC FUEL LB/HP/HR
300	10.7	52	1.37
375	11.6	72	1.08
450	13.4	93	.0.96
525	14.9	115	0.90
600	16.6	143	.078

These computed numbers support my feeling that the stated 1.3 pound per horsepower hour from the Solar data is pessimistic, but still much poorer than the vendor claims. I am not sure which dash number Solar T62 was used and I suspect that the higher power value was obtained with the turbine inlet temperature at or above the limit. The improved specific fuel consumption at higher power level is a typical turbine characteristic. The vendors frequently claim that with sophisticated injectors and atomization the performance or efficiency will be vastly improved, but the combustion process is not the limiting item in these units.

The flight performance of the vendor's prototype installation reflected these more modest power estimates. The reported performance was typical of an engine the size of the Lycoming O-235, with over twice the fuel consumption. This year at Oshkosh the same people were there, only with a new name and the claims were shakier than ever. They are actually claiming a 300 hp version now, and they still are not offering dynamometer data, and were promising an October 2004 delivery. Rumors of lost deposits and unfilled promises of delivery are starting to surface.



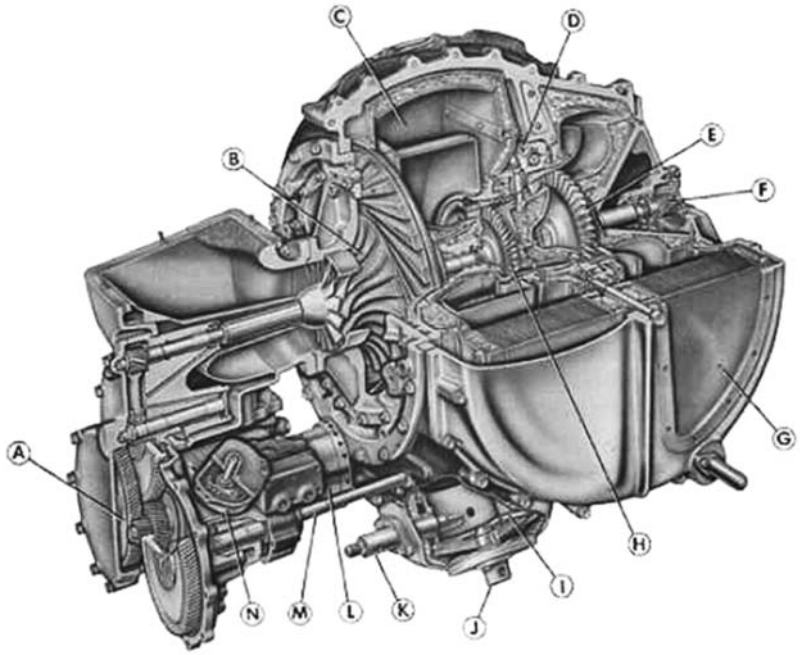


ALTITUDE

You often hear it said, "If you fly at altitude they get a lot more efficient". Well, that's not really true. The actual efficiency of the turbine engine is reduced at altitude, such that the specific fuel consumption per horsepower is actually poorer at higher altitudes. The fuel consumption versus true air speed is indeed improved, but just as with a piston engine, the power required to fly at that speed is reduced (by the reduced drag at true speed). The above charts show an estimated comparison between two identical airframes (RV-4 class performance level), one with a converted turbine, and one with a conventional aircraft engine of similar maximum power.

The predicted "miles per gallon" with the Lycoming engine at a conservative 0.5 lb/hp hour is better than most mid-sized automobiles, approaching 25 mpg. The most optimistic prediction with the converted turbine is roughly twice the consumption.

Notice that the best overall miles per gallon would be a line tangent to the sea level curve, but that would be slower than most impatient pilots would tolerate. In this case it would be about 110 miles per hour true speed and about 55 horsepower. With a piston engine and a controllable pitch propeller, this can put the engine in that "sweet spot" for outstanding economy. Indeed, this is the actual tactic that was part of the Voyager plan (high and slow). The turbine engine on the other hand, becomes very inefficient near half rated power and would deliver crummy mileage even there. As you go up in altitude that tangent point falls on a more effective true speed, with a very acceptable minor loss in miles per gallon. So, while the old belief that you always get better gas mileage at altitude is not really true, but it is still a very sensible way to operate your plane.

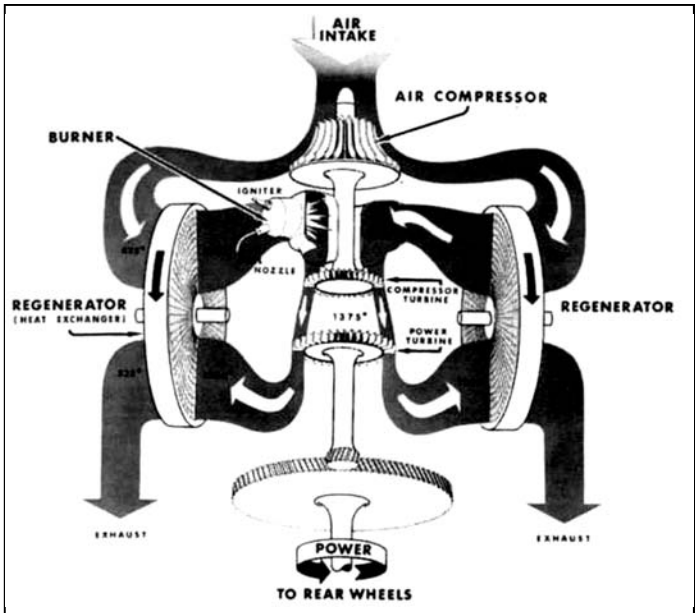


MAIN COMPONANTS OF THE TWIN_REGENERATOR GAS TURBINE
(A) accessory drive (B) compressor (C) right regenerator rotor
(D) variable nozzle unit (E) power turbine (F) reduction gear
(G) left regenerator rotor (H) gas generator turbine (I) burner
(J) fuel nozzle (K) igniter (L) starter-generator (M) regenerator drive shaft
(N) ignition unit

OPPORTUNITY LOST

The lure of the market for a gas turbine powered car (Hey! Look at me! I have JET car) led to development of regenerative systems to improve fuel economy. The most well known turbine car was produced by Chrysler, about 50 years ago and they utilized what is often called the "side wheeler" heat exchanger system. This system passed the exhaust through a mesh of metal tubes in the slowly rotating side wheels. These hot tubes were then rotated into the flow system between the compressor exit and the burner inlet, preheating the air to reduce the amount of fuel burn to heat the turbine inlet gasses.

This concept worked well enough that Chrysler fielded a small group of cars and loaned them to potential customers for real life road experience. Potential production costs sunk the program, and most of the fleet was scrapped to avoid tax penalties.



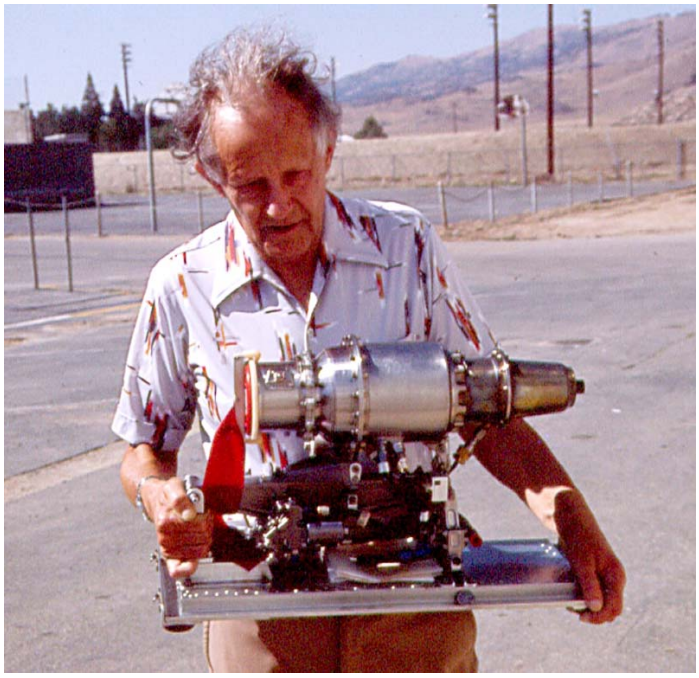
Another view of the Twin-Regenerator Gas Turbine.

About 20 years later, General Motors was on the brink of offering a similar but more refined turbine for a Camaro class sporty car. Design point specific fuel consumption was better than the current V8, but low speed operation was still rather poor. Emissions were outstandingly low, and the predicted driving cycle economy was in the range of roughly 18 mpg highway and 10 mpg city, rather poor, but saleable for the class except the specter of the Corporate Average Fuel Economy (CAFÉ) promised heavy fines and the program was dropped. Although rather bulky, this would have been a great powerplant for the smaller, general aviation and sport aircraft. The fuel consumption would have been competitive with existing aircraft piston engines and the smoother operation and longer potential life would have been a significant advantage.

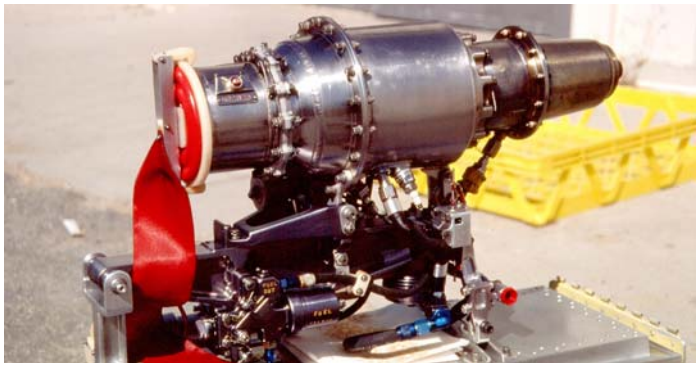
MODEL TURBINES AND JETS

French built "Cri-Cri" has been flown with twin jet engines used in the model airplane industry

If you have been following the radio control model activity, you have undoubtedly seen and marveled at the proliferation of model aircraft turbojets. Available thrust levels have grown, and at least one man carrying plane (a Cri-Cri) has flown using jet engines from the model aircraft field. Prices have remained fairly high but have been steadily becoming more reasonable in cost while becoming more sophisticated. Recent ads suggest that they are approaching the $100 per pound of thrust cost level. However the rules of scaling continue to limit specific fuel consumption to painfully high levels. If you thought the converted Solar APU units were thirsty, just convert the ratings of these models to the pounds per pound thrust hour units. With the higher thrust levels, novelty airplanes, and perhaps self launching of sailplanes become viable, emulating the famous Baby Mamba built by Max Dreyher, and shown in the picture below.



Max was a definite pioneer in the small jet engine field and produced this beautiful example of machinery/fine art, well before the radio controlled jet market existed.



The mission this unit was designed for was the self launching of a small sailplane. Specific fuel consumption was high and the thrust minimal for this task – but it worked. Power off drag of a small jet like this is very low as compared to even a feathered prop.

Again at Oshkosh last year, a maker of model and RPV jet engines showed a prototype of a high bypass turbofan of 650 pounds thrust and a thrust specific below 0.5 lb/lbf/hour. This would make for a very credible small jet airplane, but that is still a takeoff consumption of nearly 50 gallons per hour. Predicted selling price was estimated at $50,000 and although that may sound high, it's well below the $100 per pound thrust value mentioned earlier. The performance of a well designed small two place using an engine such as this would easily exceed that of the famous Bede Microjet. However, the fuel consumption would still be pretty outrageous, being in the same class as a high performing piston engine twin.

CONCLUSIONS

In the meantime, if you want to look like, sound like, and smell like a jet, is *IS* possible; you might end up spending money for fuel like a jet but being disappointingly short of flying like a jet. At 500+ horsepower, where you are already in the, "If you have to ask, you can't afford it" class, there is a lot of surplus hardware out there that can feed those urges. But for most of us, the best advice is to keep our hand clutched firmly over the wallet and keep the BS filter in the tight and fine mode.

Vance Jaqua

***SWITCH ON!* Continued from page 15**

This issue is 28 pages long. We normally produce 24 pages. I currently have enough material that I was very tempted to increase this issue to 32 pages, but the budget is just not there. So if you'd like to see CONTACT! Magazine grow to exceed the content in all the other magazines, or even go to a monthly publication, please help us increase our numbers. Show the magazine to everyone you know, buy a gift subscription for someone you think might enjoy it, or even send me the address of someone you think might enjoy a complimentary issue and become a subscriber. I'll send them a free copy of issue #72.

Please don't get the idea that I'm sitting on tons of articles and don't need contributions. I *DO* need contributions. Most of what I'm "sitting on" are articles that I still need to write! I really don't have the time to write the articles; it's much easier on me to simply edit and layout articles submitted to me. So please, (I'm definitely begging here) write that article you've been meaning to. Don't worry if you think you can't write, we can help. You could even dictate the article on tape and I'll get it transcribed for you. We'll certainly work with you in any way we can to get your story told.

THE FLY-IN SEASON

As mentioned previously, SnF is right around the corner but it's not the only venue we'll be attending this year. Virtually every fly-in we attend, we present or host an engine forum and this year is no different. Here's a short list of the events we plan to attend this year:

- ***Sun-n-Fun***, Lakeland, Fl. April 12-18 Exhibitor building C, space 63, and forum tent #10.
- ***Alternative Engine Round-Up***, Bullhead City, AZ.. April 29– May 1. FBO hangar.
- ***Golden West EAA Regional Fly-in***, Marysville CA. June 3-5. Forum tent and exhibitor booth to be announced.
- ***Rocky Mountain EAA Regional Fly-In***, Denver, CO. June 25-26. I'll be attending this event for the first time this year, hoping that we might be able to add it to our schedule next year.
- ***Northwest Experimental Aircraft Association Fly-in and Sport Aviation Convention***, Arlington, WA. July 3-5 - Probably just John Moyle this year, no booth or forum, but he'll be hosting the Sonex camp.
- ***2005 AIRVENTURE,*** Oshkosh, WI. July 25-31. Exhibitor building C, space 3109, and the Honda Pavilion, date and time to be announced.
- ***Tandem Wing Fly-in***, Livermore CA. August 19-20 Hangars 113 and 114.
- ***EAA Chapter 723 Camarillo Air Show***, Camarillo CA. Aug 27-28
- ***Copperstate Regional Fly-in***, Casa Grande, AZ. October 6-9 - Forum tent #5

We hope to see you at a fly-in soon!
Patrick Panzera

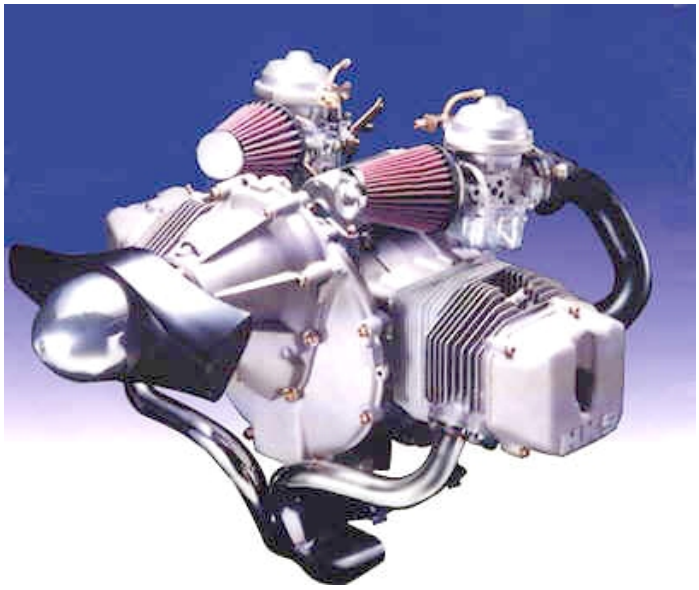
Light Plane power with Racing Car heritage

By Michael Friend

Michael Friend received his B.Sc.AAe from the University of Illinois in 1978. Some of his work experience includes Boeing Commercial Airplane Group, where he worked as a configurations engineer, wind tunnel design engineer, aerodynamics manager and Technical Research Center (Moscow) General Director, Deputy Chief Engineer, Advanced Design and Chief Engineer, New Airplane Product Development. His experience includes: aircraft designer since 1979, commercial pilot and instructor, instrument rated, land and seaplanes, and gliders. Extensive experience in the coordination of international design engineering projects, involving the Netherlands, Japan, Indonesia, Japan, Russia, and Ukraine. Michael is also the author of several published articles on light aircraft design. Presently, Michael is the Chief Engineer, Future Platforms, Preliminary Design for Boeing in Seattle, Washington, USA

Near Shizuoka, Japan, in the shadow of Mount Fuji, you will find a gleaming new factory that produces an assortment of car racing parts and an interesting little light plane engine. HKS has been in the business of building racing car engines and components for quite some time but recently they have turned their attention to the production of the HKS 700E, a well-engineered two cylinder, four cycle, 60 horsepower engine. Recently I was able to visit the new HKS factory to see the engines being produced and tested.

That HKS has impressive engineering and fabrication capabilities can be seen in a corner of the factory devoted to its racing history. Most interesting to me was a Formula 1-specification car with an HKS 3.5 liter V-12 from the early 1990's. Although it was not actively raced



in competition, it was apparently successfully tested. There are only a few engineering houses around the world capable of designing and fabricating such an engine, and the same engine design team later turned its attention to the 700E engine that I'll describe here.

The HKS 700E (pictured above) is a 60 horsepower air-cooled two cylinder four-cycle engine. It was originally intended to be a four-stroke alternative to the two stroke Rotax motors widely used in ultralights. It is a simple design and makes its horsepower at a higher engine speed than would normally be expected by those used to slow turning aircraft engines. As I observed in the factory assembly area, there are so few components in the engine that the complete assembly takes a technician only about two hours at best.

The low parts count makes for a quick assembly time.

The rough engine castings arrive at the factory to be precision NC machined in a variety of machining cells. They then travel upstairs to the assembly area, where I was able to closely inspect the various components. The quality of manufacture seems to be quite high and helps to explain why the engine costs more than some of its competitors.

A bore of 85 mm and stroke of 60 mm gives a total piston displacement of 680 cc. The compression ratio is 11.3:1 and the weight is only 103 lbs dry, with all electrical equipment, electric starter, carburetors, and gearbox. The weight increases to 116 lbs when you add an exhaust system, oil tank and oil cooler. The aluminum cylinder barrels are coated using the Nikasil process, providing good heat transfer away from the bore while eliminating the need for iron sleeves. The overhead valves (four per cylinder) are actuated by pushrods from a centrally located camshaft and are equipped with hydraulic lifters, eliminating the need for periodic valve adjustments. The cylinder heads are oil cooled, allowing the high compression ratio without detonation. The engine is a dry sump design, circulating the oil from a stainless steel oil sump through an oil cooler. The propeller speed reduction gearbox is pressure lubricated from the engine oil supply, with a small jet squirting fresh oil onto the reduction gear teeth.

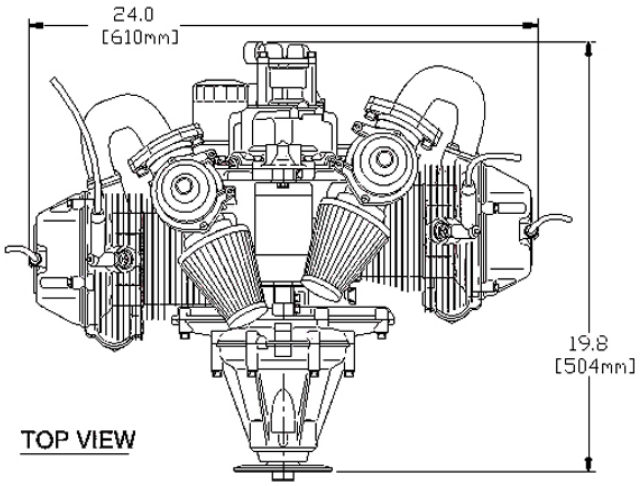
Murphy Maverick used as an HKS 700E engine test bed.

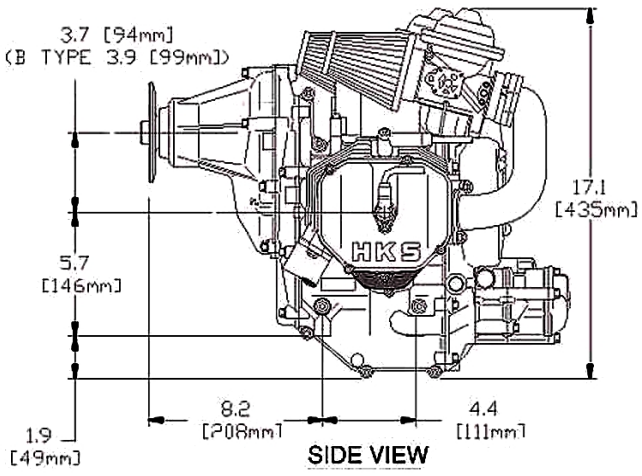
The HKS 700E is used on several different aircraft today, with more than 150 engines currently flying. The highest time engines (at the time of this writing) have over 800 hours on them. The 700E is a standard engine on a long list of ultralights and "LSA" type experimentals.

During my visit, I was able to witness the engine dynamometer testing located in a corner of the original factory several miles away. The well-instrumented test engine was wailing away at 6700 crankshaft RPM (equivalent to about 2600 propeller RPM with the standard 2.59:1 reduction box), 150 hours into a 500 hour cycle. At 500 hours the engine will be torn down to check for any areas of wear before going back on the test stand. The current TBO is a conservative 800 hours. The engine is designed and is being tested to go to a realistic 1000 hours before needing an overhaul.

Just as Rotax did with the first 912s, HKS wants to inspect field units prior to establishing a higher TBO. HKS recently replaced the original 700E engines in the field with new model engines as a part of honoring the warranty. The original engines could have been nursed along without this expensive solution, but HKS wanted all of the engines in the field to be the same specification. All of the original engines were kept in the air with free parts from HKS and some training by Hpower, the US HKS distributor. www.hpower-ltd.com This has all been very well received by the company's customers.

The engine costs $6435 USD. Depending on the aircraft, a complete installation may run $8500, which includes: engine, gearbox, stainless steel exhaust system (with muffler), oil tank, oil cooler, Aeroquip oil lines and racing fittings, HKS throttle and choke cables, filters, pneumatic fuel pump, electric fuel pump and a one-year warranty. The HKS engines are distributed in North and South America by HPower, Ltd. PO Box 760 Ellington, CT. 06029 (860)-875-8185. Email: fstar@mail2.nai.net





HPower Ltd. has been working with HKS for close to five years on the project, helping with the field of testing of new parts and engines as well as providing consultation on product development. HPower is the first authorized overhaul facility in the USA, and others are planned. Right now customers are sending their engines to Connecticut via truck for overhaul and repair work. HPower maintains an inventory of parts and has been factory trained in the assembly and overhaul of the engines. HKS has developed several new accessory parts for the engine, such as a 3.47:1 reduction unit, an exhaust system for noise reduction, a proprietary HKS tachometer and electric carb heater for the Bing-CV carbs.

The integral gearbox on the 700E uses straight-cut gears with a spring-washer type torsional coupling ahead of the large flywheel. The gearbox is attached to the flywheel case; the gears are lubricated by the main engine oil system, the same as a Rotax 912 four-stroke. The gearbox can be run up or down and is changed by rotating the flywheel case around. The large flywheel mass and attention to the internal balance of the engine are the keys to the smooth running and low vibration. At a lower RPM you can hear the gears singing, not clattering. The standard gear ratio is 2.58:1. Since the maximum permissible RPM is 6200, the RPM at the prop is 2400. With the optional 3.47:1 gearbox, the prop speed and noise are even lower.

In power-to-weight ratio, the 700E matches conventional two-strokes. The real difference, however, is in the high-peak torque of the engine (50.6 ft.-lbs@5000 RPM), and the very flat torque curve. This allows the 700E to pull better in a climb or hold a higher prop load (pitch) than the 60 horsepower rating would suggest.

The prop hub bolt pattern is 75 mm; the direction of rotation is the same as a Rotax two-stroke. HPower has conducted baseline tests of several popular propellers including the Ivoprop, Powerfin and APC Sport Props. In tests, the 700E can swing a 74" two-blade but a three blade 68" was typical. The engine was just as smooth with a two-blade prop as with three. This also allows the use of a light, wood two-blade for certain applications.

The induction system of the 700E has been optimized for a wide torque band. The runner lengths are tuned for this purpose. The carburetors are Bing constant velocity, which vary the mixture with horsepower and provide a modest amount of altitude compensation. These are the same carburetors used on the Rotax 912 four-stroke.

The crankshaft and connecting rods are forged and run in split-shell type bearings. During overhaul the crank and connecting rods won't have to be replaced, only the bearings. As mentioned before, the aluminum cylinder bores are Nickel-ceramic coated for wear resistance and thermal compatibility with the expansion of the piston.

The dual CDI (Capacitative Discharge Ignition) varies the timing for ease of starting, smooth idle and detonation resistance. The connectors to the electrical system are large and sealed and each can only attach to the correct component. The charging system is 15 amp-180 watt.

The exhaust systems that are provided in the complete packages are beautiful. Made from highly polished stainless steel, they come in four configurations (two manifold types, two mufflers) and can be modified with optional stock components. HKS is a big producer of performance exhaust systems for all types of automobiles and their expertise clearly is shown in the design and fabrication of the manifolds and the mufflers.

HPower has been testing the 700E on a Flightstar-IISL test bed since July'97 and the results have been impressive. The engine has been easy to start, very fuel efficient and reliable in operation. The range of the Flightstar-IISL was effectively doubled with the switch-out of the standard 503.

After taking a good look at the 700E, I asked Manabu Ohtsuki-san, sales manager for HKS Aviation, about the future plans for other aircraft engines from HKS. I didn't receive an answer, but I suspect that it would be relatively easy to use the experience gained from the 700E on a larger four or six-cylinder engine. I probably wasn't supposed to see them, but I noticed some drawings for a four cylinder version tacked to the wall.

The HKS 700E would make a good engine for the type of airplane I've been thinking of for a few years- a very light single seater with wings that could be folded, allowing home storage. At 75% power, the HKS motor burns less than 3 gallons per hour, so you can go a long way on a little bit of fuel. I also suspect that the HKS would make a nice alternative to the VW engine used in many designs over the last 30 years. As fuel prices continue to spiral upwards, I predict that the enthusiasm Europeans have for efficient low powered airplanes will spread back across the Atlantic again. The HKS engine provides a good starting point for this type of airplane.

Michael Friend

Continued from Page 9

personally torqued in place by Tom, and found to be satisfactory. In fact, with this loaned prop, the plane set the highest qualifying time at Reno in 2003, but Tom felt that something wasn't quite right, as the plane exhibited a "yaw-hunt" at speeds over 200 mph.

Unfortunately, after this qualifying run in the 2003 series they discovered that there were screw heads missing and sheared off of the spinner. Further inspection found that there was damage to the hub section of the prop. Two of the prop bolts had zero torque remaining. The prop exhibited signs of failing under compression, and the "squirming" of the prop on the hub is what Tom attributes to the unusual yaw anomaly. Another mad scramble ensued, looking to find a suitable replacement prop for the next day's heat race.

Biplane Class president, Frank Jerant had a prop on his airplane which wasn't doing as much for him as he thought it should, and had replaced it with another. He agreed to let Tom use the one which had been removed. This prop was flight tested on the Phantom before competition, as required by race association rules. All went well, or so they believed.

Tom ran the first heat of his class Friday and took the checkered flag. Upon returning to the pits, he killed the engine as he taxied up to where his son was standing. The first thing he noticed was Jerry's face going sheet white. The prop had lost about 2 inches of composite laminate off of the forward face, near the tips..

At this point Tom had destroyed two propellers, neither of which he owned, and he was very upset with the failure of the contracted prop maker to deliver the new prop which had been ordered so long before. In desperation, the crew looked in every hangar and shop area, and although many offers where made to loan props, none of them would have made the plane go as fast as the two units which had already been sacrificed.

Tom told the sponsor, Chris Piedmonte of Eagle Creek Systems, "We have a choice; we have a plane that was built in 7 months, and that's a win. We have the top qualifier, and that's a win. We finished first in our heat race, and that's a win too. Now, anything I do at this point in time will produce a no-win situation, and possibly cause damage to something or someone." Having just safely survived the in-flight failure of two props, they agreed that they would retire from the event prior to the Gold Race. "Well, we went and got a whole lot of beer, cried for awhile, stuck around until Sunday and enjoyed our little bit of laurels" Tom said.

About a month after Reno 2003 was over, Jack Cox's "Sportsman Pilot" Magazine arrived at Tom's desk. He was pleased to see what he considered a very good article on Phantom. A few days later he received a call from Paul Lipps who shared some interesting ideas about propellers and offered to design a special prop for Phantom.

Photo Courtesy Craig Catto

FAST FORWARD A BIT...

When Tom returned with the same aircraft to the same race venue in 2004 he had made only two modifications. He had shortened the exhaust stacks and he had a radical new Paul Lipps prop. Regular readers of this magazine will recognize the prop design as an "Elippse" model created from the fertile mind of Paul Lipps and carved by master craftsman Craig Catto www.cattoprops.com

This three blade, fixed pitch, wood and composite unit proved to be the significant contributing factor leading to even greater performance from an already amazing race plane. The 2004 Reno Air Races saw the #62 Phantom take on all competitors and leave them far behind. It posted the winning speed of 241.5 mph, a new race record. The twenty mile per hour jump in speed from the previous year certainly caught everyone's attention.

BACK TO 2003

When Tom was originally approached by Paul, they had only a passing acquaintance. Paul is associated with Light Speed Engineering, the company that produces the very popular electronic ignition magneto replacement. Phantom is equipped with one such module.

In the Fall, 2003 issue of "Sportsman Pilot" magazine, Paul read about the two prop failures that the high RPM race Lycoming had endured in 2003 at Reno. He had been experimenting with a very unusual propeller plan form, which he believed might be able to assist Tom in realizing his dream of a championship trophy. A phone call got the wheels in motion, with the loan of a two blade experimental model, flight proven for both airworthiness and proof of concept on Paul's own Lancair 235.

A BIT OF APPREHENSION

Tom Aberle and his crew had some misgivings about flying behind the unconventional looking design. Their first impression was "is this thing going to work? " To add some pucker factor to the already dubious nature of this "first flight" endeavor, Aberle Custom Aircraft is located at the Fallbrook Community Airpark (L18). This field's only runway is less than 2200 feet long by 60 feet wide,


Photo courtesy Jerry Aberle

This high-speed taxi text shows the "carrier-like" runway at the Fallbrook Community Airpark.

which is marginal to many pilots frames of mind, but to make matters worse, the strip is even more of an unforgiving place than the brevity of the airstrip suggests. It is carved from the top of a hill. There is no threshold and no overrun area. It resembles a Naval carrier, but without benefit of arresting cables or catapult! This might not seem like the wisest choice of a place to test a new prop design, but then again it probably wasn't the best place to test fly a new race plane either! Tom, however, swears the Elippse prop (even with its "slow start" feature) launches the Phantom before the mid-field marker.

The immediate area is surrounded by avocado orchards and expensive homes, not a swell place to be forced down. Southern California's Interstate 15 is close by, but that might be more dangerous than the groves. Well folks, racers are not faint hearted types, and the plane was flown from the hilltop location with the funny looking prop. Tom reports that the Elippse equipped airplane seemed a bit slow from the initial throttle up point; it took a long time to get the tail up, but, "immediately after lift off it was like getting a boot in the butt". When the wheels left the ground it pressed him firmly back into the seat, and he knew right away he had something special. It both out climbs the previous props and is significantly faster at the top end, too!

The data gathered from these early flights gave Paul the information he needed to design a prop especially for Tom's airframe/engine combination and its intended purposes. A hand carved, wood laminate, composite covered three blade fixed pitch Elippse design was specified and Mr. Catto was then engaged to carve the race prop.

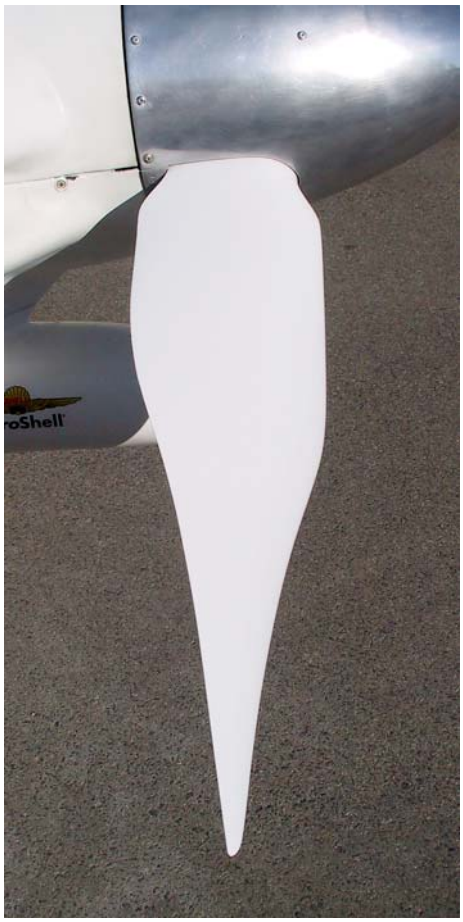
THE PROP

Using the data collected by Tom, flying Phantom with Paul's surplus 2 blade prop, Paul used his computer program to design the planform and twist for a custom 3 blade propeller, optimized for very high speed and very high RPM. In fact, Tom has not been flogging Phantom for all she's worth, there's still some reserve left in her.

As you may remember from the Paul Lipps article in issue #77, the Elippse propeller makes thrust from the tip to the spinner. Unlike conventional props that make no thrust or even negative thrust at the root, Tom's Elippse propeller makes enough thrust at the root to increase the ram air effect on manifold pressure from the previous 1.5" over ambient (with a conventional prop) to a phenomenal 3" over. That's 1.5" additional MP for free, which could easily translate to several extra horsepower. The propeller was drilled with an SAE-2 bolt circle, bored to accept 1/2" bolts (with drive lugs), which with the use


Photo courtesy Jerry Aberle

Propeller designer Paul Lipps (left) and builder/pilot Tom Aberle (right) confer at Reno '04, while enduring the mid September cold.



of an aluminum squash plate, affixes the propeller to an 8" prop extension.

As mentioned previously, the 2 blade Elippse propeller was slow to get Phantom rolling, and this new three blade version was no different. But once off the ground, both props seemed to really hook up. We asked Tom what he might attribute this to, and he told us, "My summation its pretty layman in concept, but basically I think what's getting the Cessna 150 off the ground is the propeller tips, and what's keeping it down to 100 mph is the roots. Paul is eliminating the area of distribution on the tips that would normally do a good job of getting you from here to 50, but also slows you down at higher speeds".

In reflecting upon his decision to take the risk and use this unconventional propeller, Tom said, "I have thought in the last couple of months, I wonder, I really do wonder if conventional technology had not pooped on me last year, would I have embraced such an unusual looking propeller as I did; I don't know. I would probably have been hesitant; I've seen enough broken props, I've seen enough broken airplanes from broken propellers, but I was emboldened a bit by conventional technology crapping on me".

Usually, a fixed pitch prop will perform well in one regime or the other and most folks not intending to race for a trophy will choose some blend of fair climb and good cruise. Not many props that we've heard of can boast a really super rate of climb and still deliver championship race lap speeds! Claims such as these are generally reserved for constant speed props, but the Biplane Class does not permit those, so the Elippse design is truly one of a kind. See issue #77 of CONTACT! Magazine for the complete article on this new propeller design authored by its creator Paul Lipps. Expect to see further information about development of Elippse props for the sport aircraft market in future issues of CONTACT! Magazine as well.

SPECIFICATIONS

Overall
- Span 19'+
- Length 18'+
- Height (level) 6.5'+

Fuselage
- Seats 1
- Cockpit Width 20"-
- Cockpit Height 36"+

Performance
- Vne 290 MPH IAS
- Vc-75% 200+ @ 2600 RPM
- Vs 80- mph
- ROC (est) 3000 FPM
- Ceiling 25 ft AGL
- Fuel Capacity 19.73 US gal

Weights
- Empty 738#

Top Wing
- Dihedral 0º
- Washout 0º
- Sweep 0º
- Incidence 1º+

Bottom Wing
- Dihedral 1.5º
- Washout 0º
- Sweep 0º
- Incidence 0º

Elevator (projected)
- Def-up 25º
- Def-down 21º

Rudder (projected)
- Deflection 30-30º

Powerplant
- Make Lycoming
- Cylinders 4
- Displacement 360 cuin
- Max HP. 250+ @ 3xxx RPM
- Fuel 100 LL

Propeller
- Make Elippse
- Type Fixed Pitch
- Material Wood/Composite

Continued on Page 28

Continued from Page 27

WHAT'S NEXT FOR PHANTOM?

What's next for the Phantom race team? They feel that they have enough "reserve" to hold off the other planes for the time being. Andrew Buehler, co-owner of Phantom, will get to race her this year (2005), and there is some sponsorship help from National Aircraft Salvage of Long Beach, CA and possibly Aircraft Spruce & Specialty Co., so you can expect to hear more from this team effort in the future. We'll be following the developments of Phantom closely, so count on CONTACT! magazine to follow up on this story. For more info on the world of the Reno racers, contact Tom Aberle:

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CONTACT! Magazine, 559-584-3306 panzera@sti.net

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