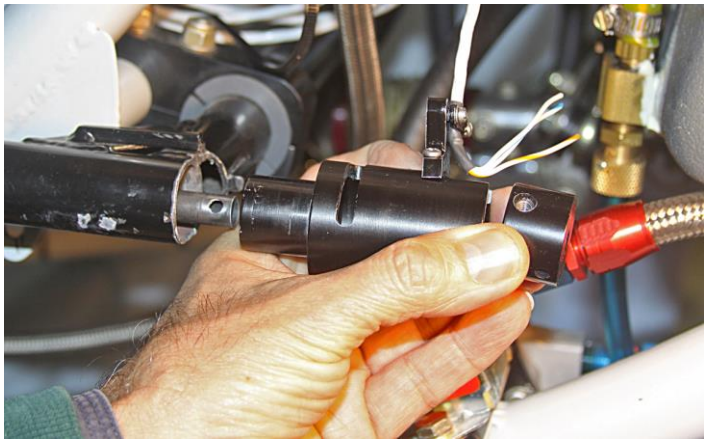
Here's the grip partially slid into position on the collective shaft. You can see how the fingers will grip the shaft when the knurled piece is tightened since the inside is cone-shaped. I had to sand the paint off the shaft to keep the friction down to a manageable amount. When the grip is in position the fingers are rubbing on paint.



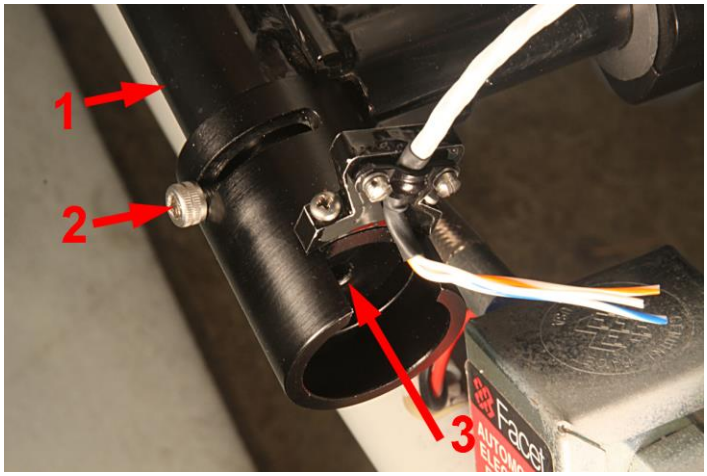
Here's the business end of the throttle tube with the tube sticking out of the collective. The largest piece I'm holding has a clearance hole for that tube so it slides through and into the back which is hollow. That piece pushes into the collective tube all the way until it bottoms out. If you lined the hole up correctly it will line up exactly with the slot above my thumb.

Ok… Now the little piece goes into the big piece until it bottoms out against the inside. It also has a clearance hole for the tube and if all is well that hole above my thumb nail will line up with the slot and the hole I drilled in the tube. A 3/16" bolt then goes through the slot, threads into the piece on the right, through that and into the hole I drilled. Whew! Now when you twist the throttle the little piece inside the big piece will rotate until the bolt hits the end of the slot. One end of the slot is idle and the other is full power.

Now we're ready for the last part of this sandwich of bits and pieces – the potentiometer, or "pot" for short. The shaft of the pot slides into a clearance hole on the backside of the small piece which is now nested inside the bigger piece. The shaft is secured with an Allen screw and the pot is epoxied into the back end of the big piece once it's properly adjusted by the factory guru/test pilot.

One last task… Once everything is in position I'll drill a small hole through the collective tube and into the larger of the two black pieces. Then I'll enlarge the hole in the black piece and tap it, and enlarge the collective hole for a clearance fit. Then a screw secures the assembly into position with service removable Loctite. Once all that's done I'll finally get around to soldering the cable to the pot.

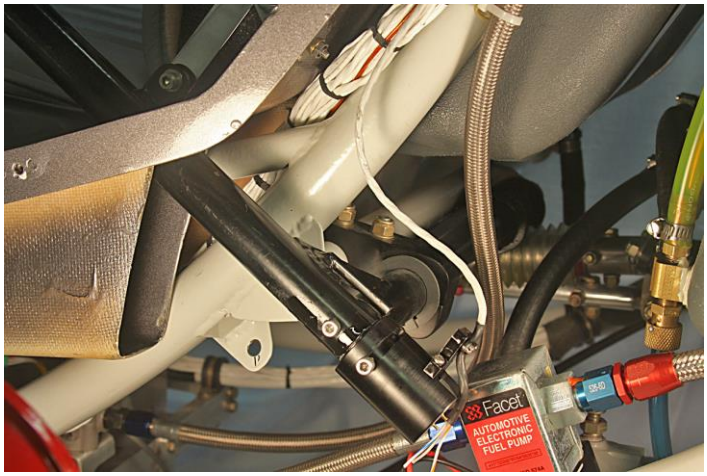
It would probably help to explain what a pot is… Inside there is a film of material in the form of an arc and it is a poor conductor of electricity – it has resistance. There is a contact at each end and the pot's shaft has a wiper attached to it that moves across the surface as the shaft turns. If you grounded one end and applied a voltage to the other fixed end you'd have a variable voltage on the center terminal as you twisted it. This is the input to the engine controller to set the RPM.



The throttle pot assembly is installed. To secure it I'll drill and tap a mounting hole through the collective shaft and into the large anodized piece at #1. It has to be a short screw so it doesn't interfere with the rotation of the internal tube.

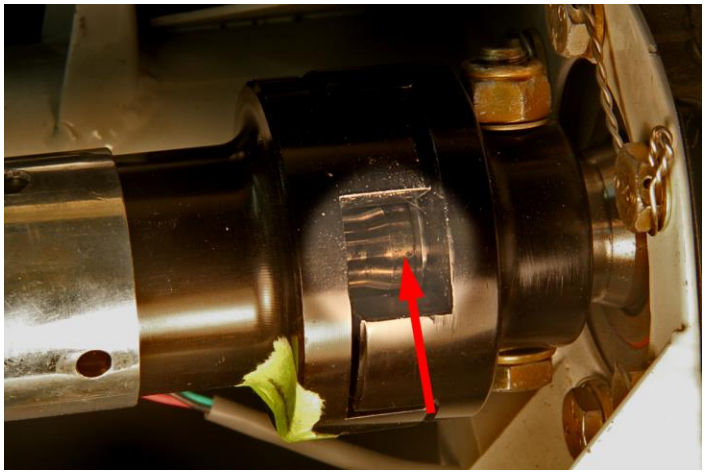
The Allen screw (#2) limits the rotation of the pot. The pot's shaft will extend into the hole marked by #3 where it will be secured by a set screw. Once adjusted by the test pilot, the pot is epoxied into place.

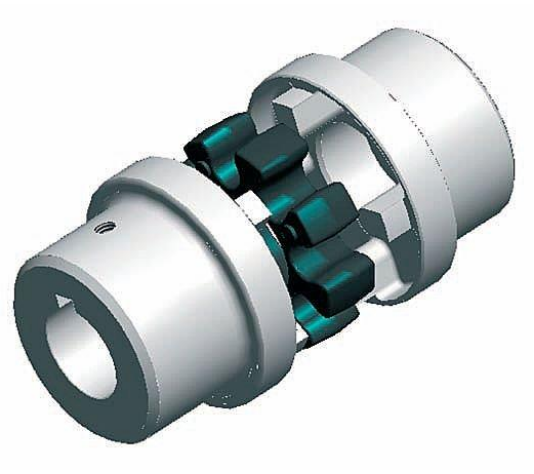
Here's the completed installation with the collective all the way down…



And here it is with the collective all the way up. I want to make sure that there is a nice service loop on the pot wire so it doesn't get snagged or abraded on anything, or stressed during operation. With the strain relief in place all the flexing takes place along the length of the wire and it's not concentrated at the weakest point – the solder connections.

I'll wait until checkout to actually connect the pot and Loctite the three screws.





Here's one last item that I need to repair. This is the jaw coupling at the rear of the tail rotor drive shaft. The cutaway at the right shows how these couplings work. The two jaws intermesh and are separated by a rubber spider that cushions shocks. In the picture at the left I've left the spider out and rotated the two halves so I can see inside. Since this is a precision coupling there is a brass piece inside that engages the gear box shaft and keeps the two sides lined up. The problem with this coupling is that that flat I'm pointing to is supposed to be INSIDE the gear box shaft! And in operation there is a gap between the two jaws which I have eliminated for this picture, so the flat is actually farther out than the picture shows.

Before proceeding, a bit of background… I had this all together but I was not completely satisfied (you'll see why in a minute) but I felt that it was probably "good enough". That's a very bad attitude to have when your life might depend on the thing working properly and not flying apart while you're cruising along. So, in the back of my mind I kept worrying about it. Last spring I trailered my Helicycle up to Hap's Central Sierra Helicopter Meet and had a chance to check out all the other machines. I noticed that my tail rotor seemed to have a lot more slop in it than the others and I made a mental note to dig into this when I returned home…

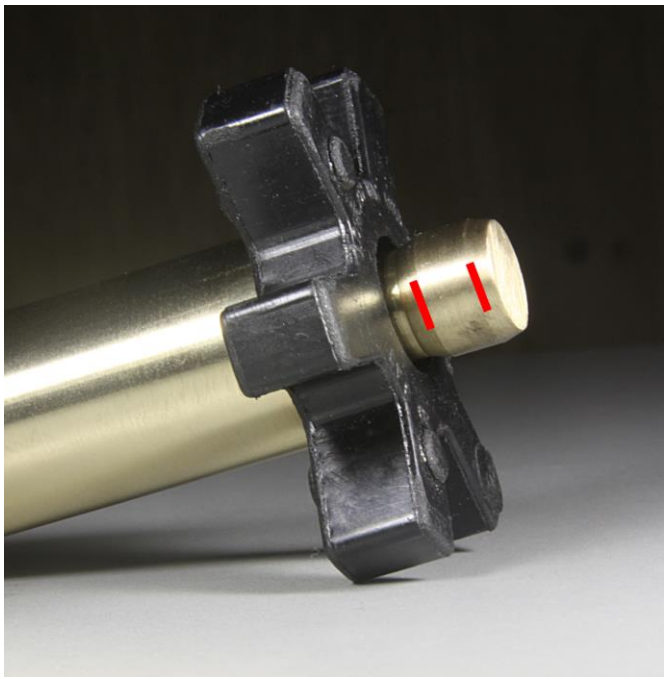
With the spider in place you can see that the flat portion of that brass center piece is mostly buried inside the spider. In fact the only part of the brass piece that was engaging the gear box shaft was the chamfered portion, and the inside of the gearbox shaft is also chamfered so it was engaging chamfer-to-chamfer, which is to say, really not at all.

The result of this poor engagement was that there was excessive lateral runout. You could grab the drive shaft and wiggle it around – not a lot, but enough to really cause serious vibrations. After seeing what I've documented so far it became clear that this brass piece was not extending into the gearbox shaft far enough. How could this be? I followed instructions.

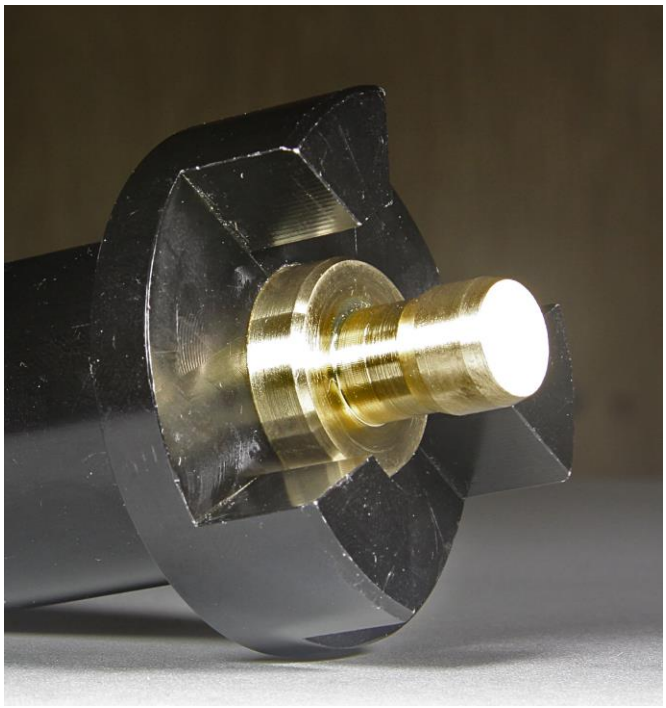
Here's the insert I inherited with the used kit at the left, and the new one I'm about to install at the right. The instructions say to mount the brass insert with the rear surface flush with the back of the coupling as you see them here, and that's what I did. I've drawn a red line across the front face of the coupling which is flush with the front flat on the old insert. I have no idea how this came to be – did the factory make it this way? Or did a previous builder decide to cut it shorter? I'll never know, and this is a good reason to be very careful when thinking about purchasing a used kit, and if you do, to tear it completely down to the smallest piece and rebuild it from scratch yourself. It's your life. (I'll get to all those holes in a minute…)

Here's the new brass insert pressed into the spider from the correct side. This will allow that entire area between the red lines to engage the interior of the gearbox input shaft and maintain the alignment of the drive shaft at the rear end.

The brass piece is supposed to be inserted from this end and the fat part should extend all the way to that internal shoulder. That will allow the business end to extend far enough to properly engage the interior of the gearbox shaft.

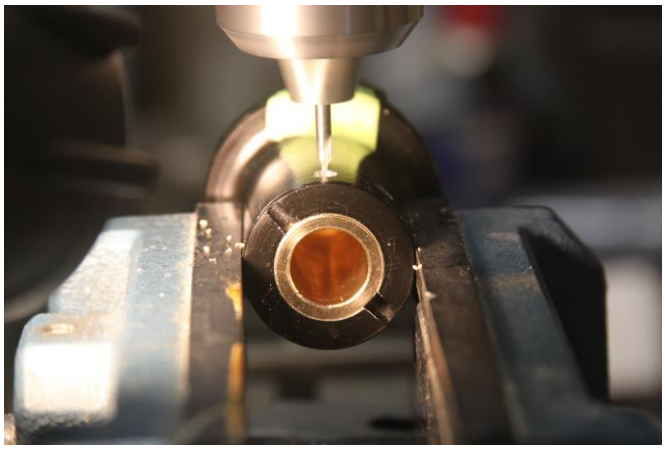


Now to explain all those holes… When I purchased the used kit I found that almost all of the holes that had been drilled were poorly done - either not aligned properly, or oversized or ovaled. I ended up tossing out many parts including all of the tail rotor drive shaft tubing for that reason (see pages 8 and 10.) I found that I could salvage the machined aluminum components by rotating them to expose areas that had not been drilled (page 32 and 94.) This explains two sets of holes in the brass piece at the top of page 304. The third and final set of holes was drilled when I discovered that the brass piece needed to move forward to expose more of the front for proper engagement with the gearbox shaft. That finally resulted in proper positioning of the brass insert, but about six holes too many. So now it's time to add that piece to my ever-growing scrap pile and start over. It's very difficult to match the existing holes in the coupling. They're reamed and create a very snug fit for the AN-3 bolts. I'll have to proceed with great care to do this properly…

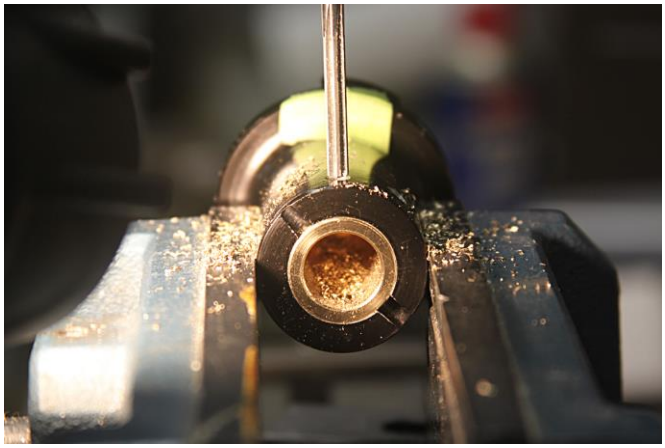


With the rear of the brass insert flush with the back surface of the coupling, the spider fits on perfectly. Now comes the hard part – match-drilling the two holes so the bolts will pass through the drive shaft tube, the coupling, and the insert, and still be a press-fit all the way through.

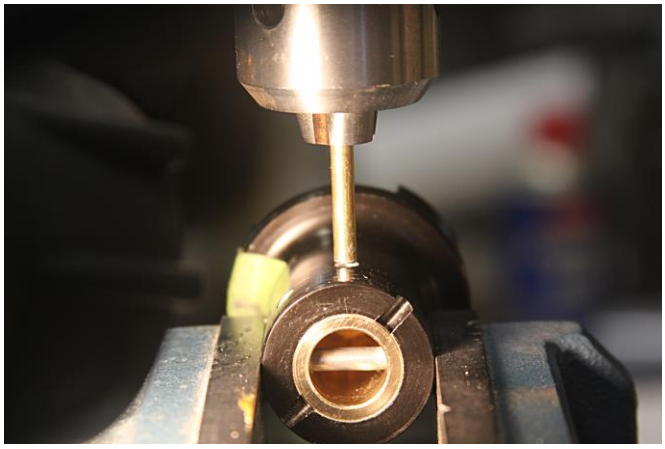
The first step is to align the first set of holes in the coupling using an AN bolt with the head removed. I ran it through the holes and then carefully lined up the coupling in my machinist vice on my mill. This is an example of why a mill is so much better than a drill press, and light years ahead of a hand drill. I can control the position of the bed within 0.001 inches. I adjusted the rotation of the coupling and the tilt by eye. Once I had the coupling secured in the vice I removed the modified bolt, tapped in the brass insert, and chucked up a center drill.



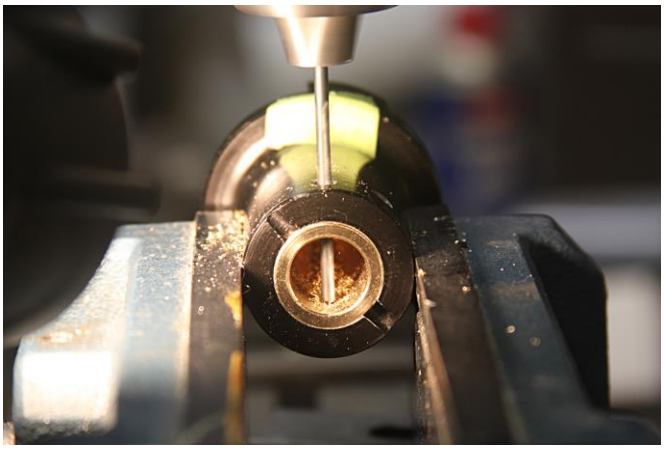
I used a series of three progressively larger drills and then finished off each hole with a precision reamer. Here's the first drill about to start on the far side of hole number one.



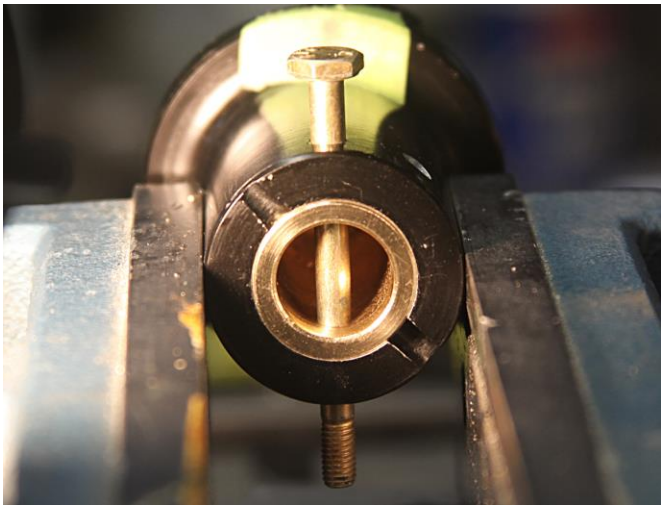
Now that the first hole is finished I checked it by tapping an AN bolt into position. Next I sawed off the head, cut the shank to the length I wanted, and deburred the ends.



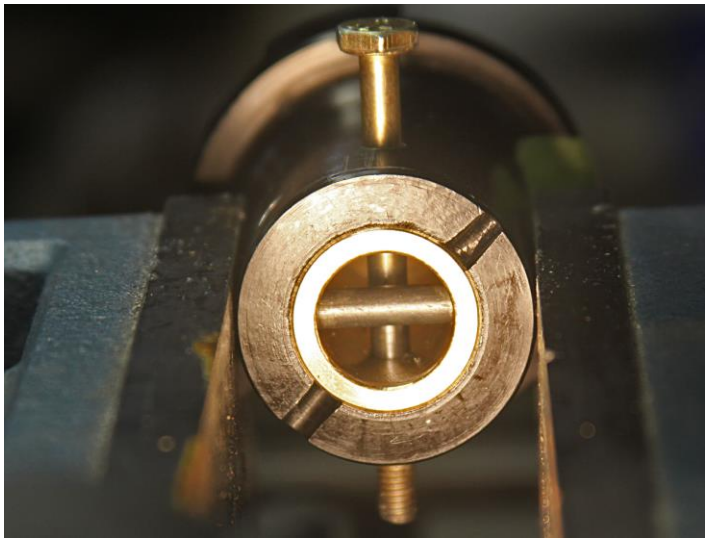
Now the brass insert is in position and I can center drill the starting point of the first hole so it lines up exactly with the existing hole in the coupling. I want to remove material from the brass insert but not the coupling – easier said than done!



I've slowly enlarged the hole using the three drills and now the reamer is about to finish off the first hole.

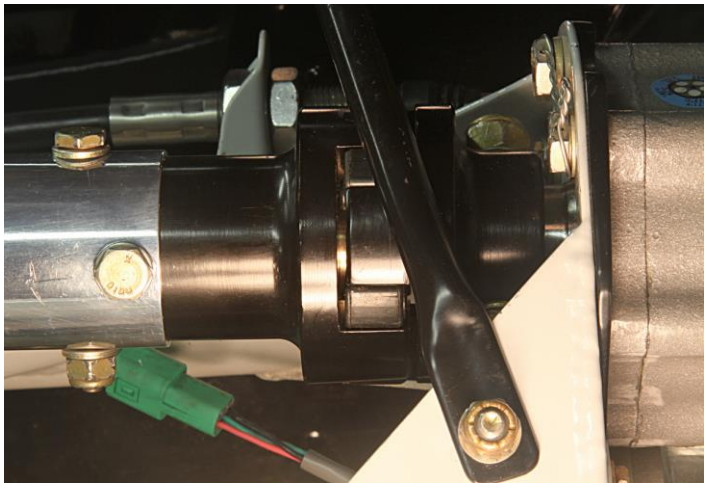


I used the pin I made from the bolt to hold the two pieces in alignment while I repeated the process with the second hole. I started again by lining up the chuck on the next hole to drill using another of my modified bolts as a guide.



After repeating the process on the second hole I checked the alignment and fit by tapping another bolt into position.

The next step is to remove the bolt and my custom pin and install the coupling and spider back on the driveshaft.

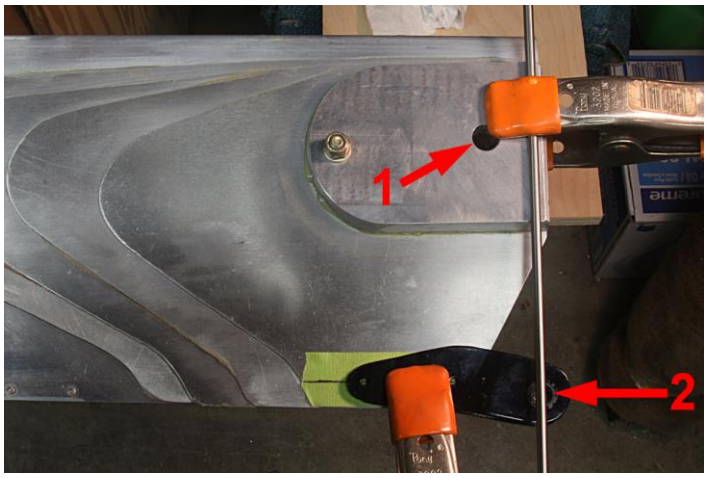


After lubricating the interface with grease I reinstalled the coupling onto the tail rotor drive shaft. That's the end of that project until the factory mechanic/test pilot comes out and aligns the driveshaft using a dial micrometer jig.

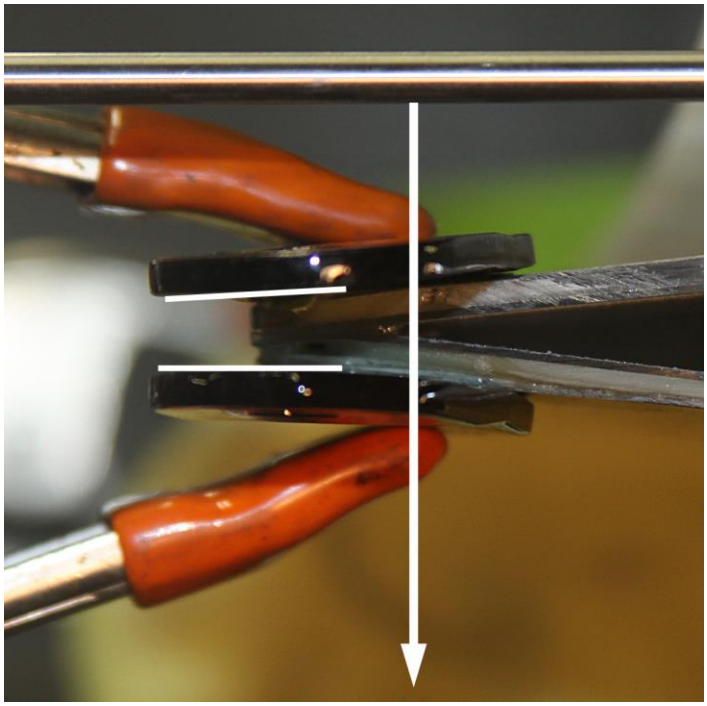
I have a number of small tasks to complete but the only large one left is to finish off the main rotor blades. Some people opt to paint their blades but that hasn't worked out very well because dust and grit abrade the paint off of the leading edge of the tips. At 620 RPM those tips are moving at 38631 feet per minute, or 439 miles per hour in a hover with no wind. In cruise flight the advancing blade tip is moving at about 550 miles per hour, or seven tenths the speed of sound. It's no wonder the paint doesn't last. Anyway, like most builders I'm going to polish my blades and leave them bare.

Wednesday 22 December – I'm finally getting back to the main rotor blades. Last night I got out the hack saw and took this piece off the root end of one of the blades and filed it smooth. Everything about the blades is critical and they are very expensive so I don't want to mess anything up!

I have quite a bit of very labor intensive work to do in addition to polishing the blades. I'll probably be working on these blades for at least one month.



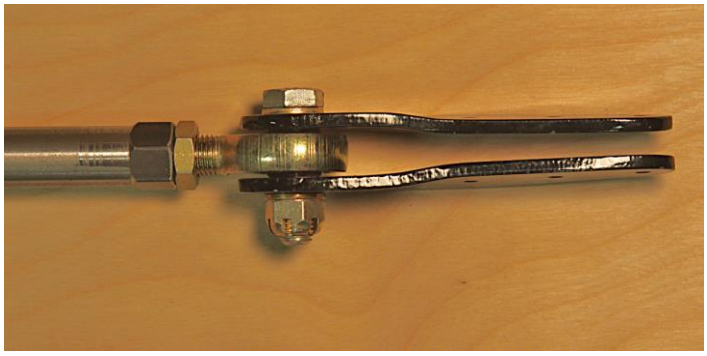
Thursday 23 December – I sawed the piece off of the other blade and now I'm ready for a very tricky part of the project – the attachment of the drag link brackets. Arrow-2 points to the top bracket which I've set into position for a fit check. The brackets are attached using three aircraft bolts. The blades are free to pivot on their attachment bolts (arrow-1) and the exact angle is determined by the adjustable drag link that attaches to the end of the brackets at the head of arrow-2. Lengthen the link and the blade tip moves forward, shorten it and it moves backwards.



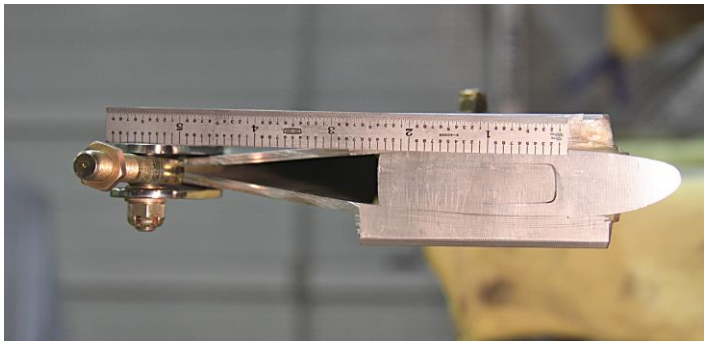
We're talking thousandths of an inch here. This means that if there is any slop in those three drag links mounting holes it will be impossible to precisely set the blade lead/lag adjustment, and that's critical for flight.

To make this interesting, I'll be attempting to drill precision holes at an angle. I've clamped that rod across the top of the blade root which is parallel to the chord of the blade. My holes have to be at right angles to that rod.

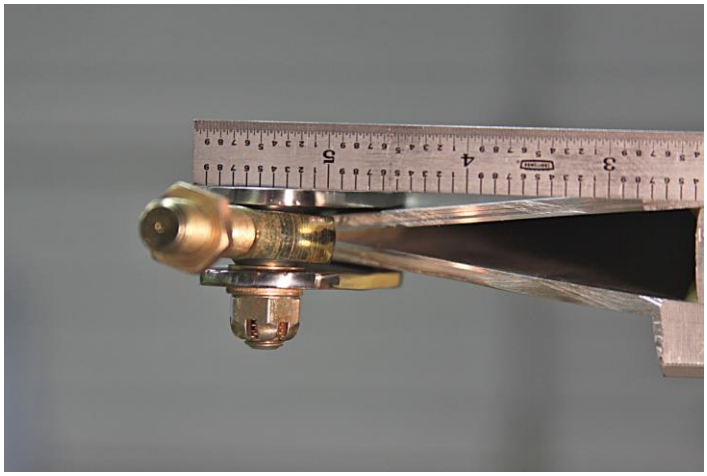
The drag link brackets have compound bends as they come from the factory, but they have to be tweaked by the builder. The inside surfaces have to be made parallel (the two white lines) and the space between them has to match the width of the drag link's rod end bearings of 0.435".



Here's a look at a bracket pair mounted to the drag link end bearing. You can see that the surfaces that will mount to the blade are not parallel. I need to spread this pair apart but also get the twist just right as well. This is going to be tricky, but it's the first step before even thinking about drilling those holes. I also want to strip off the paint and get down to bare metal.

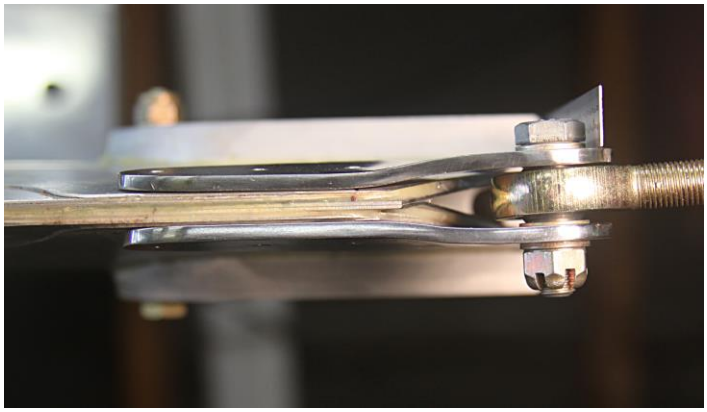


I stripped the paint off the brackets and gave them a going over with my deburring wheel. Then, after about three hours of careful bending and twisting, I was able to get one set ready to go. My straight edge is sagging a bit, but you can see that the top bracket end bearing side is now parallel to the blade axis. The width is also very close to perfect.



(In the picture above, you can see the solid extrusion that makes up the leading edge of the rotor blade.)

In this picture you can see that I've added a thin washer to get a perfect fit for the end bearing. That's perfectly acceptable.



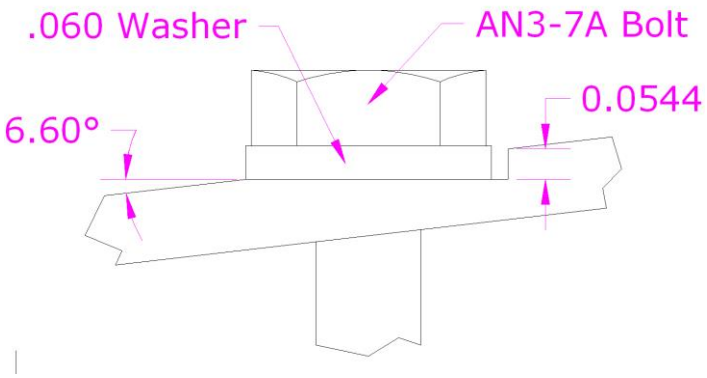
Here's a side view showing the twists and bends in these brackets as well as all of the layers of doublers and skin that make up the main rotor blades.
I'll repeat this process for the other set of brackets and then go over them again with the deburring wheel to smooth out any tool marks that might cause stress concentrations and lead to a fatigue fracture. I've also decided not to paint these brackets so I can keep an eye on them.

Once I get the other set of brackets bent and twisted into alignment it will be time to drill those precision holes through my expensive main rotor blades. While I'm working on these inexpensive parts I'm thinking about how to approach the drilling project on my very expensive rotor blades...

I just have enough room in my garage to fit a main rotor blade on my mill and still have room to move slightly.

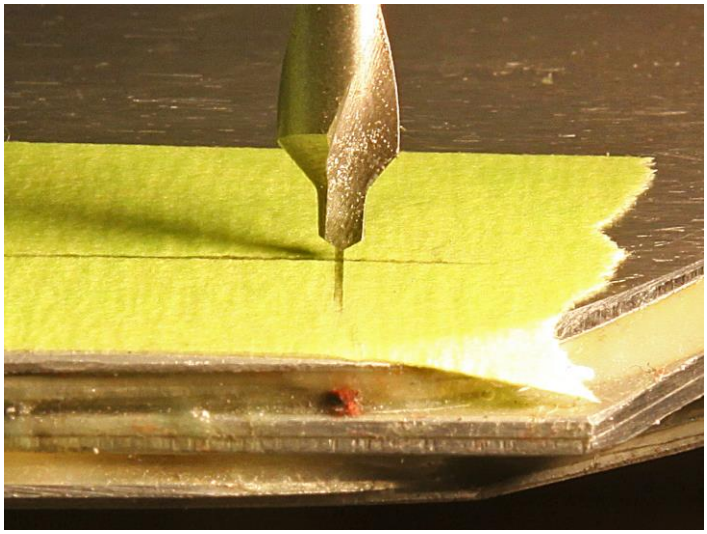
By judicious placement of a piece of plywood at this end, and a bin box at the other, I was able to secure the root end of the blade on the mill table so its plumb. Now I'll have total control over my holes which will be perpendicular to the blade root and exactly where I want them.

I still don't have a plan for exactly how I'm going to deal with the brackets which want to slide around on the blade. I'm thinking of a combination of double-back tape and clamps to hold the top bracket in place while I drill the first hole.

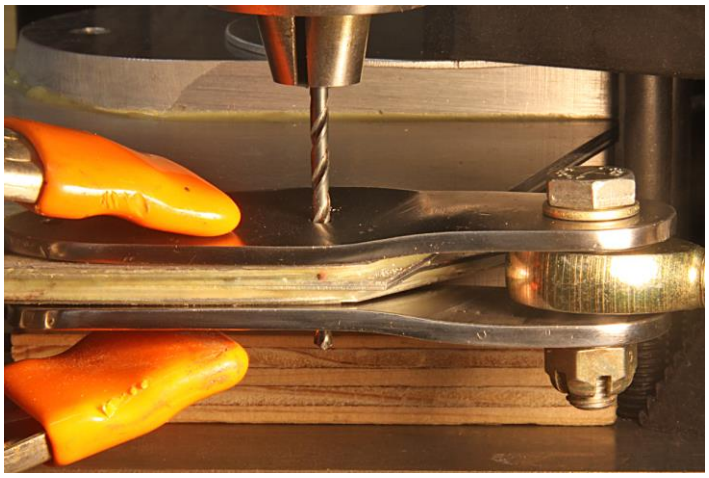


Friday 24 December – I've determined that I can countersink the three drag link bracket bolts and get around a messy situation with a sloped surface. The washers under the nuts and bolts need a flat surface and a shallow countersink isn't going to weaken the part. As you can see, it won't even be as deep as the washer is thick.

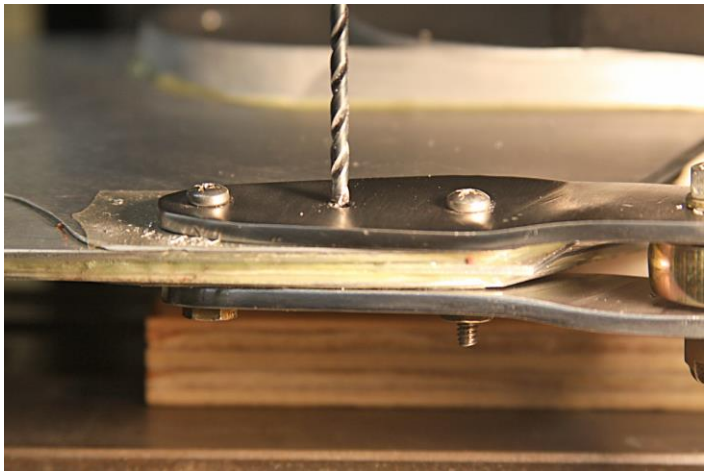
The three pilot holes in the brackets are not evenly spaced so these must have been made by hand. When I'm done these brackets will be a matched set and not interchangeable.



It's finally time to drill into my rotor blade. I think I have a workable plan. First I marked out the location of the first mounting hole from the dimensions on the plans. Then I center drilled the hole.

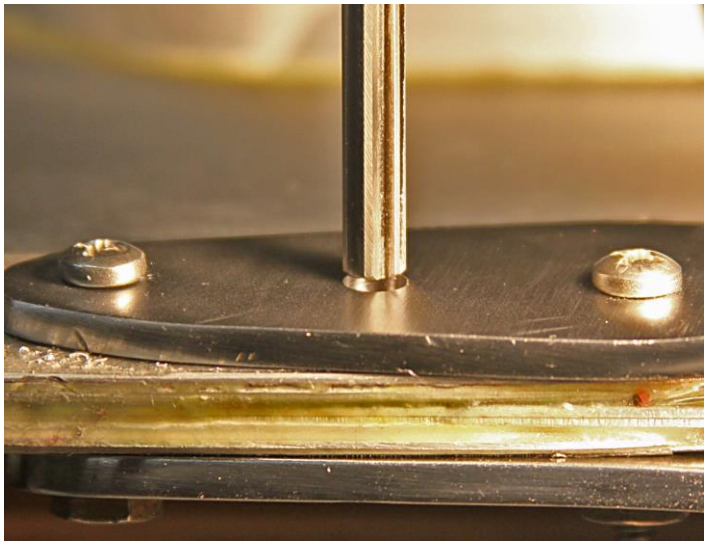


Without moving the bed I switched to a clearance sized drill and lined up the two brackets. They're bolted together using the end bearing to get the alignment top-to-bottom, and the spacing. I stuck them down using thin double-backed tape and held them in position with a clamp. Once I'd drilled through the rotor blade, and knew the hole on the bottom bracket was lined up correctly, I enlarged the hole to take a 6-32 screw.



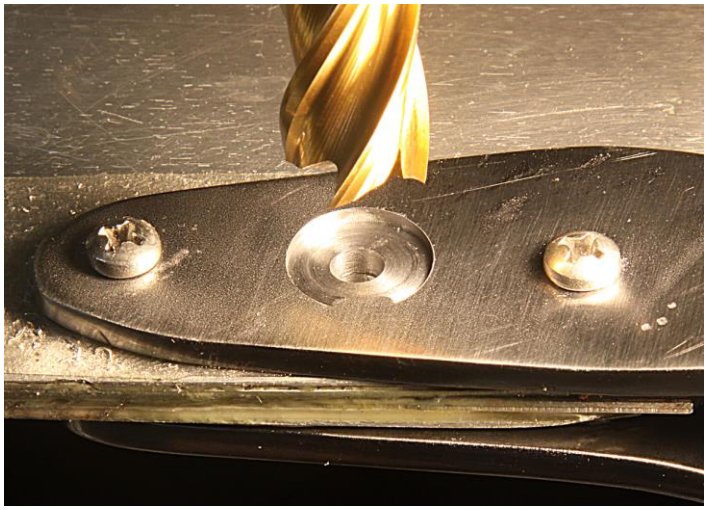
I secured that spot with a 6-32 screw and nut and moved to the other end of the bracket and repeated the process. I've got the long axis of the blade lined up with the mill base so all I had to do was move in one axis to get from hole to hole.

Once I had screws into both ends to secure everything I could go to the center hole and complete the machining for the AN3-7A bolt. As before I started with a small drill and progressively increased the size until it was just undersized for the hole.



Then I finished off the hole with a precision reamer. I know everything is perfectly lined up and the hole is plumb because of the previous steps I've taken. I haven't shown it because my lubricant is a foam and covers everything up, but I used a lubricant when cutting.

So now I have a nice hole but the surface the nut and bolt must sit on is sloped. The plans and construction video don't address this so presumably there are a lot of helicopters flying around with one side of the hardware stack flapping in the breeze.

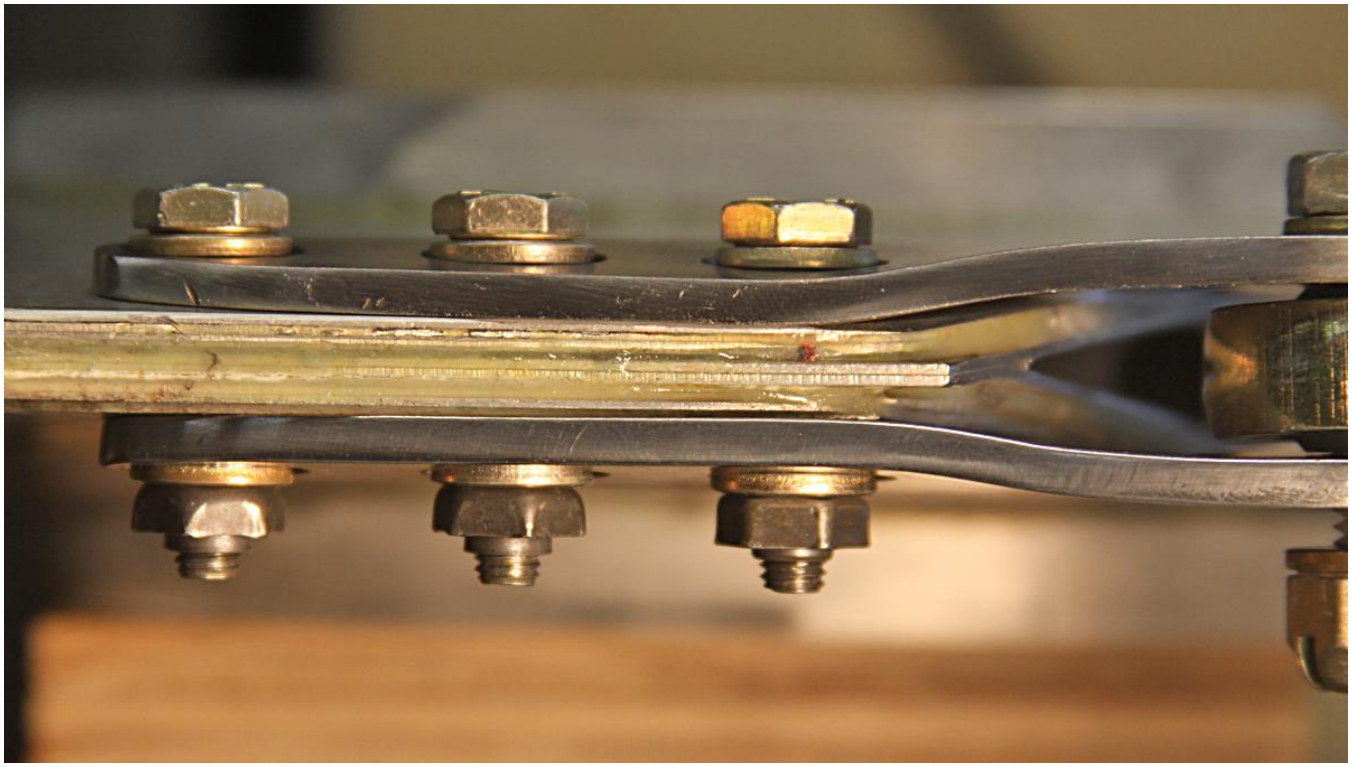


After using AutoCAD to confirm that I could safely countersink these spots I used a 0.500 end mill and ran it down exactly 0.054 inches as my drawing called for. Here's the result.

All of this would be very difficult to do accurately with a drill press and impossible with a hand drill. If you're thinking of building a Helicycle my advice is to spend the money and get good tools. It will cost you several thousand dollars but you'll end up with a much better helicopter, you'll have learned a new skill or two, and you can always sell the tools when you're done.

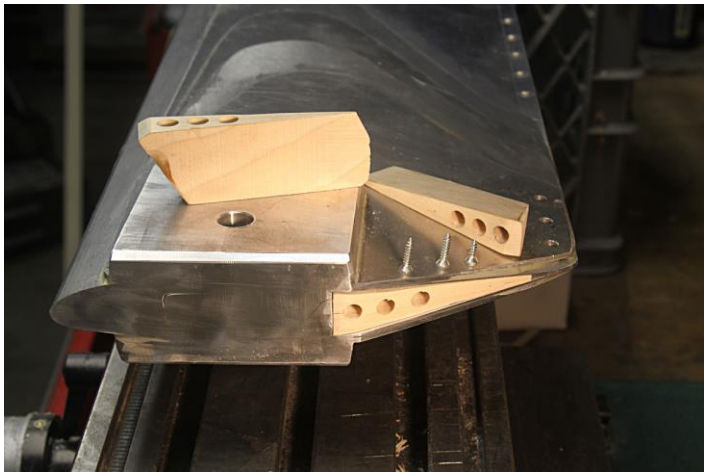
Here's the first hardware stack sitting flat on the countersunk surface. Of course I'll have to flip the blade over and countersink the other bracket.

Now that I've gotten this far it will be easy to remove a 6-32 screw one at a time and complete the machining for the AN hardware stack. My longitudinal alignment is perfect since I haven't touched it so all I have to do is line up one axis when I go from hole to hole. Once I'm in position I do all the operations without moving the bed – again, easy with a mill and difficult to impossible with a drill press.



Here's the finished assembly after flipping the blade over and countersink the bottom bracket. The end bearing bolt doesn't need to be countersunk because of the twists in the brackets.

Now that the brackets are all finished I'll go over them again to remove all the nicks and dings and then polish them up. Then I'll repeat the whole process again on the other blade.



While I have a blade staged near my mill I might as well take care of all the machining. The next job at the root end of the blade is to fabricate an end plug from wood. I used my mill to make this too. Since it has a number of angles it was a tad tricky and it took me three tries to get it right. The final one is temporarily in position. The plug gets secured to the blade with epoxy and six wood screws – four long and two short ones. You have to line up the screws so they don't crack the wood, poke into one of the three quarter-inch holes, or each other. (Three screws will come in from the bottom side.) All six need to be countersunk so the heads are flush. I might move the screws in by one hole but I have to make sure I can get my countersink over that inner hole without running out of room.

It's purely cosmetic at the root end since no lift is produced near the hub, but I'll be doing more or less the same thing at the tip end and ninety percent of the lift is produced in that outer foot or two of blade. The slightest imperfection out there will disturb the airflow and create a huge problem.

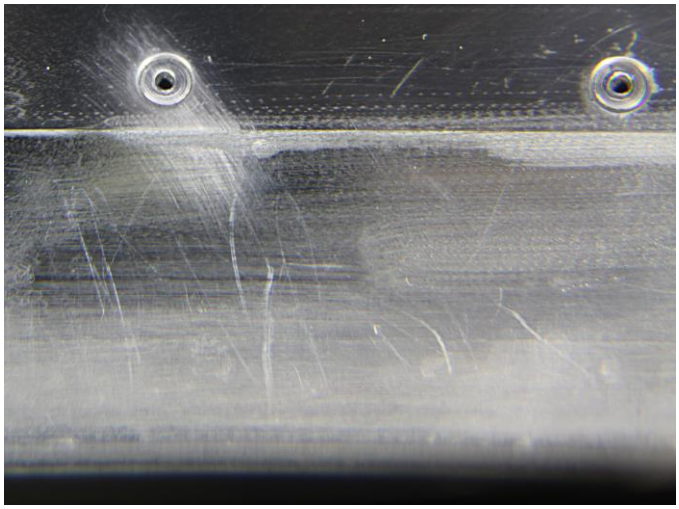
I broke off my ¼-20 tap in my tip weight just as I was about to finish it off. There's no easy way to get a busted tap out of a tapped hole without tearing up the threads so I'll start over with a fresh piece.

I decided to change projects and start polishing the tip end of this blade. This picture shows an area about 2-inches by 3-inches with some nasty scratches or pits that you can easily feel with your finger nail. Since it's near the tip the surface is critical and I want to smooth these out. I started with 600-grit wet and dry sandpaper and then switched to 1000-grit. After a few minutes of light sanding in this immediate area I switched to Nuvine G6 course grade polish.

I went over the outer two feet for about half an hour with an automobile buffer and a wool bonnet running at 1500 RPM. You can see the results at the right side of the picture. Nuvite describes G6 as a "smart abrasive" that provides a quick initial cut and then breaks down to a fine cut. They suggest it as the first step when working with pitted, chipped, or scratched surfaces. Judging by the picture above, I think this is a good polish to start with.

After polishing with the G6 the surface felt smooth to the touch and my hand slid over it with little resistance. As soon as I reached the unpolished area the friction increased greatly and the surface felt dirty, even though I cleaned it thoroughly. The G6 leaves a mirror surface covered with very small swirl marks. Nuvine calls this step "Compounding." It's designed to remove corrosion and surface defects. Once I've removed all of the surface defects and compounded the entire blade, I'll switch to a clean bonnet and start using progressively finer grades of polish. Once I get to the grade-S finish polish the blade should look like a mirror. Incidentally, the G6 polish feels very gritty with small pieces of abrasive material. By the time you get to the grade-S finish polish it feels like your wife's face cream.

Nuvine has made a science out of polishing aluminum. They have extensive material on their web site, including a section on polishing aircraft. The polish isn't terribly expensive, but they want you to use a right-angle car buffer for the earlier stages and then switch to a dual-head random-orbit polisher for the final stage, and the supplies will consist of multiple wool compounding bonnets for the car buffer, fleece wraps for the orbital polisher, and micro-fiber buffing towels. The cost adds up…

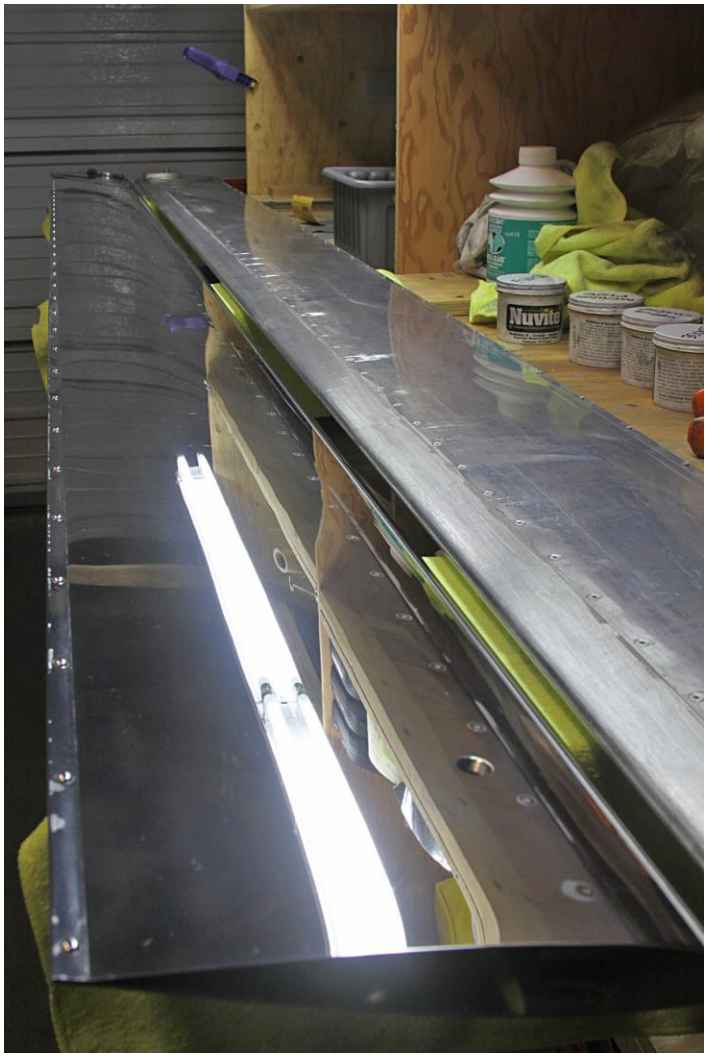


Given the sorry state my blades are in after about seven years of storage, I'm anticipating at least 40 hours of polishing to finish them off.

Here's a "before" picture of the blade showing the solid leading edge extrusion at the bottom of the picture and the sheet metal portion at the top. My plan is to hand sand the leading edge using 400, 600, and 1000 grit wet or dry sandpaper to remove those large scratches and then start in with the Nuvine polish and the rotary buffing wheel. Eventually I'll go over everything with the orbital polisher and fleece.

The picture on the left shows the surface after sanding with 400 grit and the picture on the right is the same general area after finishing with 1000 grit. The difference appears subtle but the final surface is satin smooth and ready for polishing. It took about 4 hours to finish the leading edge of one blade on one side. Its filthy work and disposable rubber gloves are handy.

30 December – I decided to stop and improve the lighting over my blade work area so I installed this 8-foot fixture. I also found that 1000 grit sandpaper was too rough so I picked up 1500 and 2000 grit.



1 January 2011 -- After about 20 hours of hard work I have one side of one blade polished fairly well. The picture above shows the leading edges of the polished blade next to the untouched blade. I ended up using 400, 1000, 1500 and 2000 grit wet and dry sandpaper. I found that it was almost impossible to polish out the metal that was sanded with 1000 grit. Going down to 2000 grit produces a surface that was much easier to polish. I spent quite a bit of time on the blade root end, sanding and polishing out all the scratches since that's a very high stress area and I don't want any stress risers to start.

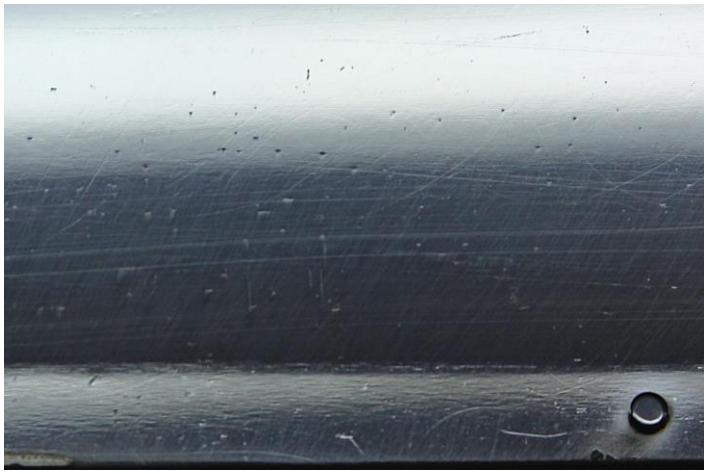
The instruction call for filling in the rivet heads and the seam between the extrusion and the sheet metal portion with Dynaglaze but it didn't seem to be available in my area so I used Evercoat Metal Glaze polyester finishing and blending putty. It's a two-part resin that has a working life of about 5 minutes and can be sanded in about twenty minutes. I picked it because it is formulated to adhere to fiberglass or bare metal and I can use it on the cabin too. I went over the tip end of the blade and filled in all of the rivets and the seam. The putty is so thin that it seeped into the rivets and slowly

subsided into the holes. After an initial sanding pass I went back and applied another dab of putty to each rivet head, and since they were plugged already this time there were no depressions and I was able to sand the heads flush.

Learning to deal with these blades has been a struggle. Going to the 2000 grit paper was my first breakthrough and learning how much polish and what grade to apply; depending on the surface characteristics was the second. I've found that I have more success using the random orbit polisher with fleece than I do with the car buffer and wool bonnets. It's an extremely dirty process and disposable rubber gloves make life much easier.

Here are the two types of buffers I'm using. I have separate compounding pads for each grade of polish for the circular buffer. The random orbit polisher uses that fleece on the left. You have to find a clean area and then hold the fleece by wrapping the excess around the handles. You can keep moving around to about six different spots before the fleece is ready for the washer.

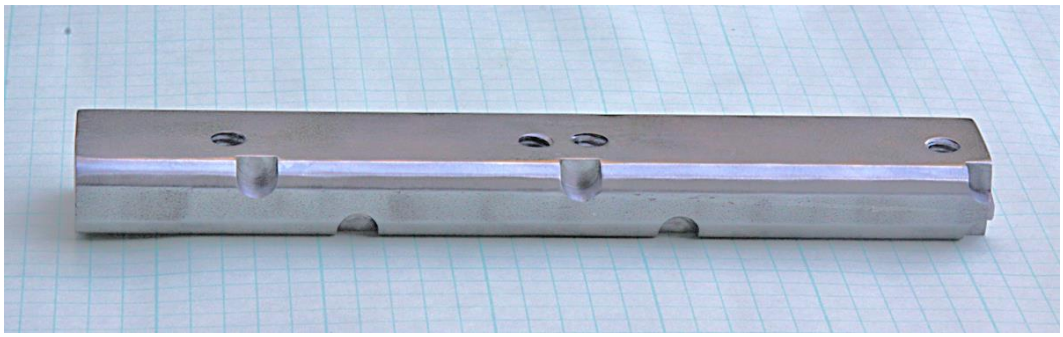
When the bonnets get caked up they can be cleaned using TSP and a bucket of warm water. The hard part is drying them without melting the rubber portion.



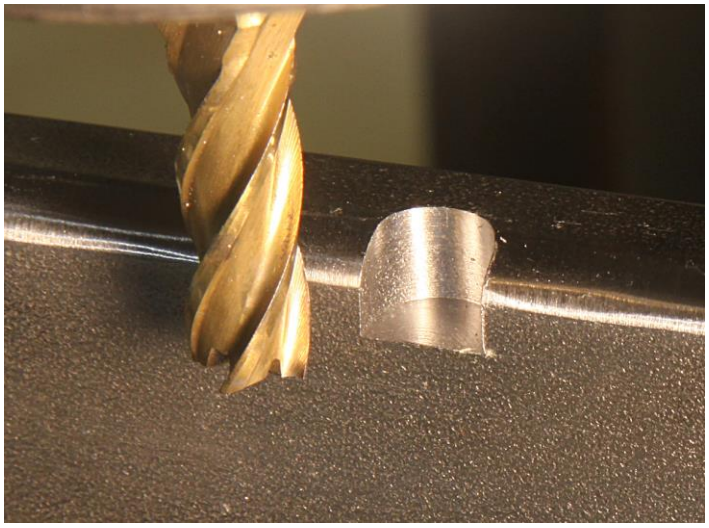
16 January – Two more weeks have passed and I'm still polishing the same side of the same main rotor blade. I've spent an entire weekend working on the outer two feet on one side. My blades are in terrible shape. In this picture you can see many very small pits. They're proving to be extremely difficult to polish out because they're quite deep. These pits are unsightly and can serve as the starting point for corrosion.

My kit was #15 of the first build so these blades have sat around for many years before I came along. I'm sure they were beautiful when they left the factory but somewhere along the way they deteriorated. There is an area of extreme pitting on the other blade. I don't even want to look at it. This blade is difficult enough.

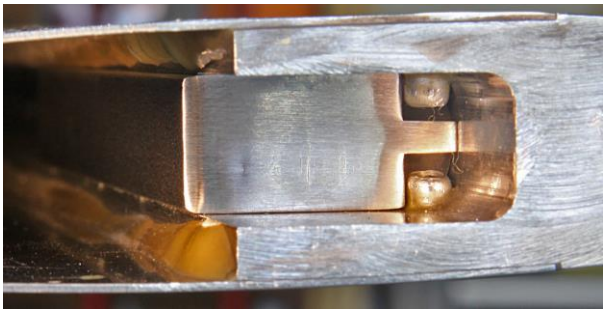
I've had to resort to extreme measures just to get the pits looking this good. I had to move to a ½" cotton spiral-wound buffing wheel and green rouge. I couldn't bear down on the sheet metal because I'll cause too much heat and I could warp the blade's critical shape. I thought I polished the pits and most of the scratches out so I switched to wool compounding buffers and worked my way through three grades of polish and then switched to the random orbiter and went through two more grades of polish using microfiber cloths and fleece for the final pass. I ended up with a milky haze over most of the area showing that I had to back up and start over with a course polish and get more of the minute scratches out before going back to the finer grades. It's tiring and dirty work and I'll be glad when I'm through with this.



22 January – I machined my tip weights yesterday. I started by chamfering the forward side to match the shape of the leading edge extrusion. This allowed the weight to mount all the way forward. Although the DVD instructions say to file down the rivets to make room for the weight I decided to mill small slots to accommodate each rivet. I didn't want to risk weakening a rivet and having it fail in flight. After milling, drilling, and tapping I deburred the part to remove sharp edges. The four ¼-20 tapped holes in the top are where the mounting screws secure the weight to the blade – three from the bottom and one from the top.

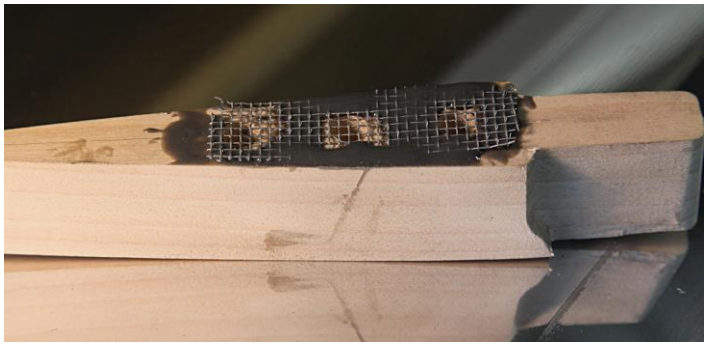


The end mill does a beautiful job, doesn't it?



Here's the blade tip with the outer two rivets nicely nestled in their milled slots, and the weight flush against the forward edge of the extrusion.

I have a triple-beam scale so I was able to weigh each tip weight and make them the same. After a few passes on the deburring wheel both weighs came in at 345.7 grams or 12.1942 ounces. I'm sure that small differences in the two blades will swamp out any minute differences in the weights, but this will keep me close. Final blade balancing comes later. I did take great care to insure that both weights are the same length, very close to the same distance from the blade tip, and that the mounting screw locations are matched as closely as possible.



While I'm focused on the blade tips I decided to epoxy a small piece of screen over the holes in the end plugs to keep wasps from making a nest inside my blades. Centrifugal force will keep the tip end plug screen from pulling loose since it will be pressed up against the wood in flight.

The plug at the root will be exposed to much less centrifugal force since it's close to the rotor hub.

My harness is now installed. It's a TSO'd product from Amsafe. This configuration for the Helicycle has its own part number now so anyone wanting one like this can order by that number and not have to go through the process of determining all the critical lengths like I did.

It has a rotary buckle and adjusters on all the straps – pull up on the small black straps to loosen and down on the large gray straps to tighten.

The buckle is fixed to the right seat belt so it doesn't get tangled up in the collective.

With all harnesses you have to be careful not to ding up your paint when the belts are disconnected and you're getting in or out. I'm not sure how to avoid that yet.

30 January 2011 – In the space of one year all the black button head cap screws I installed on my instrument panel have rusted, simply sitting in my garage. I don't live is an especially damp climate and nothing else in the garage is rusting like these screws.

There's a company near my work called The Olander Company and all they sell are fasteners. I'll swing by there tomorrow at lunch time and pick up some stainless steel replacements for most of my steel screws – for the cabin, the windshield, the tip weights, etc.

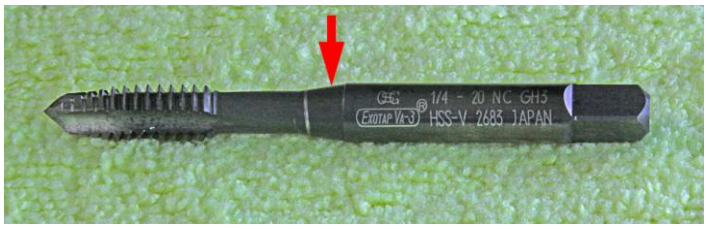
If you're interested, the Olander part numbers for the **black stainless steel** screws I'm using are:

- 6-32 X 3/8 BUTTON SOC SST BLK 6C37BHCSB
- 6-32 X 5/8 BUTTON SOC SST BLK 6C62BHCSB
- 6-32 X 7/8 BUTTON SOC SST BLK 6C87BHCSB

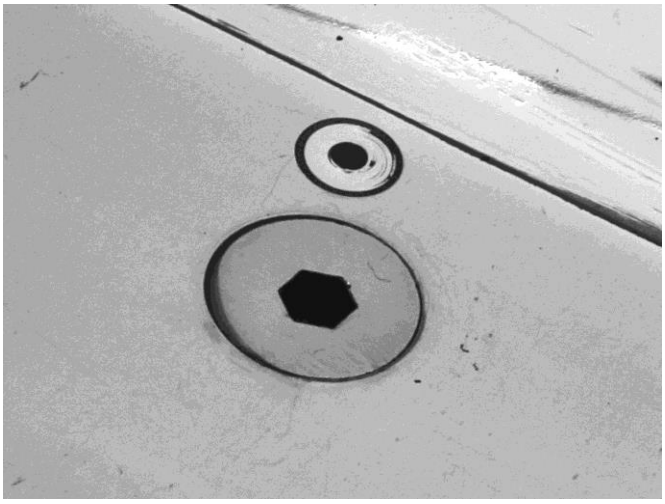
Contact Info: The Olander Company Inc.
144 Commercial St. Sunnyvale, CA 94086-5298
(800) 538-1500
www.Olander.com

04 February – I've replaced all of the rusted hardware in my instrument panel with black stainless steel and I'm now in the process of reinstalling the cabin so I can finish off the prep work before I get it painted.

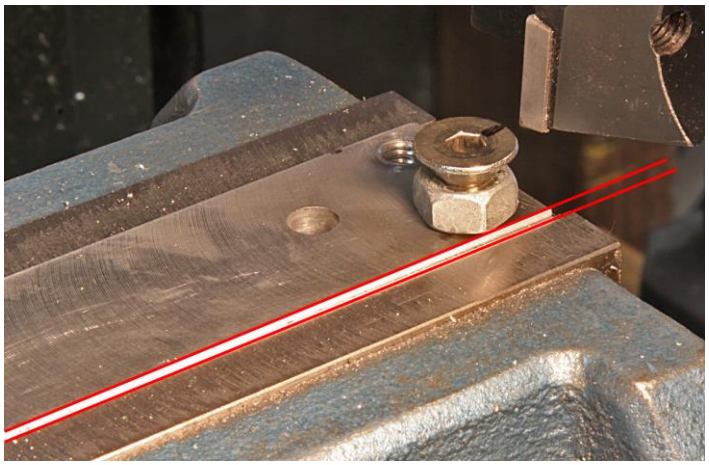
Meanwhile, I'm continuing to work on my main rotor blades. This afternoon I drilled all of the mounting holes for the wooden end plugs in one of my two blades. You can see the ten holes in the tip – five on top and five on the bottom. Hap Miller has a method of doing the fine balancing of the blades by adding a bit of lead shot to the tip of the light blade. He drilled and tapped a ¼-20 hole in the center of the leading edge extrusion. After you add the necessary weight in the light blade you secure it with a ¼-20 set screw. It sounded like a great idea but I didn't want to drill at an angle and come out the side of the blade. That would be hard to explain! I ended up with this lash-up. I'm resting the drill on my Genie Lift which is cranked up to the exact height that I need to keep the drill bit parallel. I determined that by sighting across the ruler that I have clamped to the leading edge of the blade. I kept the drill alighted in the horizontal axis by eye. The #7 hole extend as far as I could go. The next step is to tap the hole.



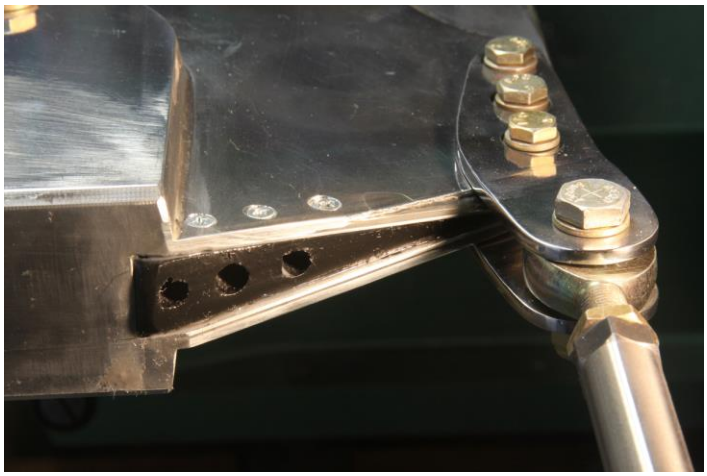
After busting off a ¼-20 hardware store tap and ruining a tip weight I purchased a Japanese coated tap from a machine shop supplier for about $17. It cuts through aluminum and steel like butter. The cost was about five times more than the cheap tap but it's been worth the money. It also allows me to tap further into a blind hole until I run into the shoulder of the tap (the red arrow.) The #7 hole is 2.6 inches deep and the outer 1.0 inches is tapped. That's as deep as my tools would allow me to go. I think I can do the fine balance using only ¼-20 Allen head set screws and not need any lead weight. I'm not sure how I'd get the lead back out, but I can stack set screws in that hole for the full length of the tapped portion and easily get them all back out if necessary.



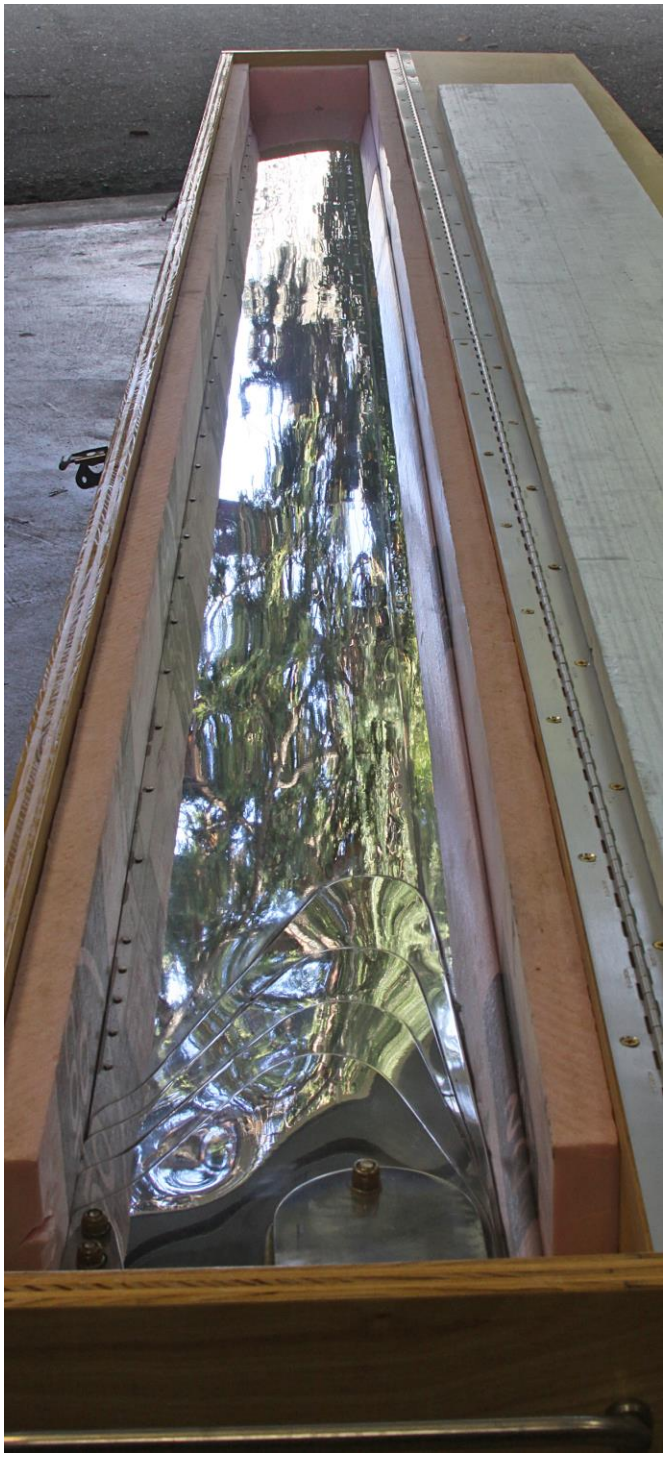
I've also been machining my replacement stainless steel tip weight screws to get them flush with the skin. On the left is a stock screw, and the right is the screw after machining and polishing. Once the balance is complete my plan is to fill in the gaps and the Allen head with finishing and blending putty, but if I use my gloss black 3M tape to make stripes on the tip, or clear 3M tape for the leading edge, I may not need to bother since the screws would be covered over with the tape.



I used my fly cutter to get the head close and then marked the high side of the screw head with a black marker. The screw then went into a simple jig made from a rectangular piece of scrap with a ¼-20 hole tapped in the end. I locked the screw down with a nut so the mark was pointing to the right and then tilted the jig very slightly in the vice and locked it down. I can shave off slices less than 0.001 inches thick with my mill and adjust the slope by tilting the jig in the vice (red lines.) When I get the head where I want it I hit it with the buffing wheel to shine it up and I'm done.



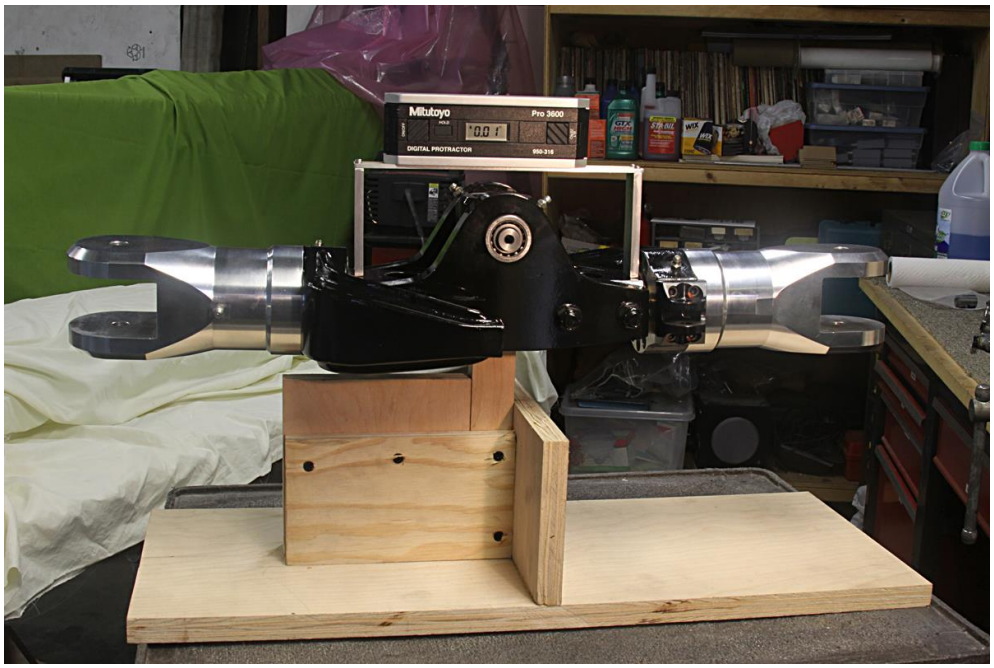
11 February, 2011 – I finally had time from work to get back to my project this afternoon and I was able to final install the root end plug in this blade. One more going over with the polish and this blade will be ready for static balancing. Then I'll have to start the process from the beginning with the second blade.



13 February 2011 – I gave the blade a final polish with the orbital machine and tucked it into its box. The reflection you see is of a large tree outside my garage. The polish job isn't perfect my any means but it's time to move on to the other blade. I also picked up a selection of ¼-20 stainless steel set screws that I'll use for the fine static balance of the blades once the second blade is completed. I've got six different lengths that add up to a weight of just over seven grams. I think these will work well. I can always tweak the total weight I screw into the tapped holes I made earlier by grinding material from these screws. I'll secure them with service removable Loctite.

It took me a long time to get this one blade to this point and now I'll be repeating the process with the second blade. I won't have much to say for a while until that second blade is completed and I can do the static balance. I already have the tip weight installed and the ¼-20 holes drilled so it will go a bit faster than this blade, but not much…

13 March – My progress has slowed to a pitiful crawl. It's been exactly one month since I last posted an entry in my log. The second blade is finally polished and ready for the installation of the end plugs. My problem is that I've learned too much about polishing so now I know what a show quality polish job looks like. My blades are nowhere near that stage but I simply got tired of polishing week after week. I think my blades were in much worse shape than a new kit and that added a lot of work. I've dealt with all the major scratches that could have caused stress cracks to form and the blades look very shiny if you don't look too close. Once in flight they will get dinged up anyway so I think I've put enough effort into blade polishing. It's time to move on.



I painted the end plugs last night and while I wait for the paint to dry I made this stand to hold my rotor hub for static balancing. I added a saddle that spans the center of the hub so I can sit my protractor on it and measure the angle of the hub. I machined the two legs at the same time so they're the same exact length. In this picture the left side is down by 0.01 degrees.

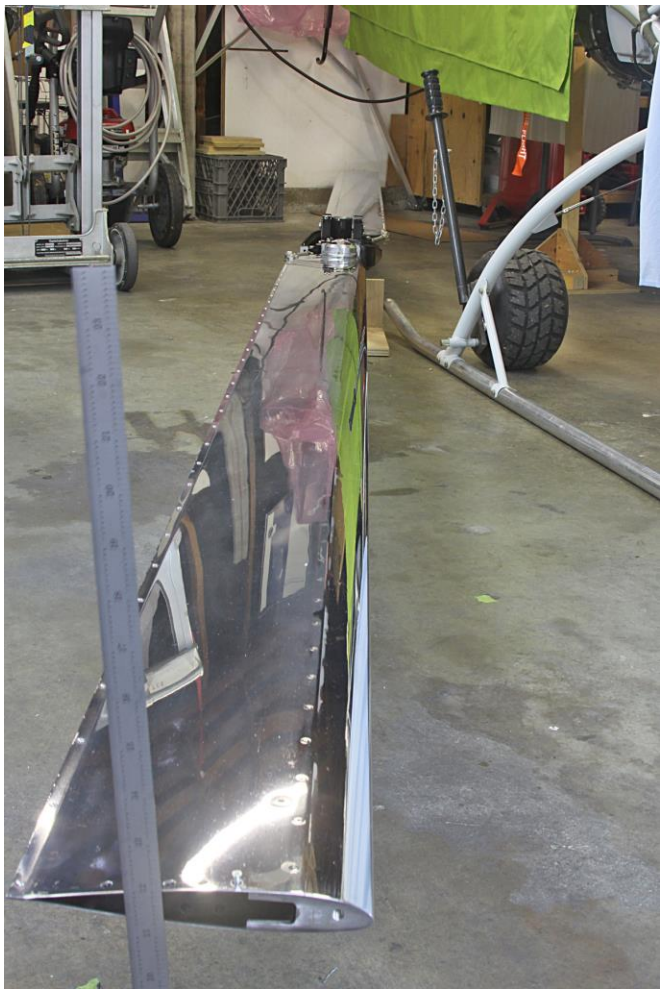
The reason I made this stand is that I can't balance on the helicopter because the garage is too small and the forward blade would stick out into the breeze. With this stand I think I can manage it in my garage, but I'll have to stick one blade under the Helicycle. We shall see…

The paint is now dry on my end plugs and I've epoxied small screens over the holes to keep bugs out of my blades. The epoxy should be cured by tomorrow evening when I get back from work. Then I can give this a try.

My eventual plan is to make two 4-inch gloss black stripes – one at the tip of each blade, and one four inches inboard. That should make the rotor disk look like there are two concentric black circles at the outer edge of the disk. I'll do the same thing using smaller widths of tape on the tail rotor. I want to do it using 4-inch 3M 8672GB Polyurethane abrasion-resistant tape and 3M 86A Adhesion Promoter. The plan is to use two fourteen-inch strips of tape wrapped from the trailing edge, around the leading edge, and back to the trailing edge on the other side.

I have several concerns; one is that the tape will cover the mounting screws for the tip weights so I won't be able to get them out in case the balance is grossly off and I need to grind material from one of the weights, another is that the tape might interfere with the micrometer jig that the factory mechanic uses to adjust the blade tracking, and lastly, it would be extremely bad if the tape flew off in flight due to the very high centrifugal force. The imbalance would probably shake my teeth out of my head. 3M has a technical bulletin that addresses helicopter rotor blades and supersonic jet fighters so I'm not breaking new ground here, but this is one of many things that have to be done correctly to prevent a very bad outcome.

I'll probably leave the decision regarding the tape until checkout time because of all those factors.



18 March 2022 -- I've now got the main rotor blades mounted to the hub and sitting on my wooden stand in the garage. One blade almost touches the rear wall and the other is inches from the garage door, but at least I didn't have to take them in my house.

I found that the stock hub bolts won't fit into the mounting holes. I spent several hours very slowly removing material from one bolt using a hand file, 400 grit wet and dry sandpaper and my deburring and buffing wheels. I took off about 0.003" in diameter along the whole length of the bolt. One of the ways I did this was to wrap tape around the threads to protect them and then gently chuck the bolt into my mill. Then I ran it at fairly slow speed while using the 400 grit wet and dry sandpaper on it. I found that there were slight bulges on the shank just above where the threads ended and also just under the head. Now I have one bolt that I can tap into position with a mallet, but the threads are slightly bunged up from the mill chuck. Next stop is to the local machine shop supply house to get a die and chase the threads. If they don't look perfect I'll start over with new bolts and be more careful.

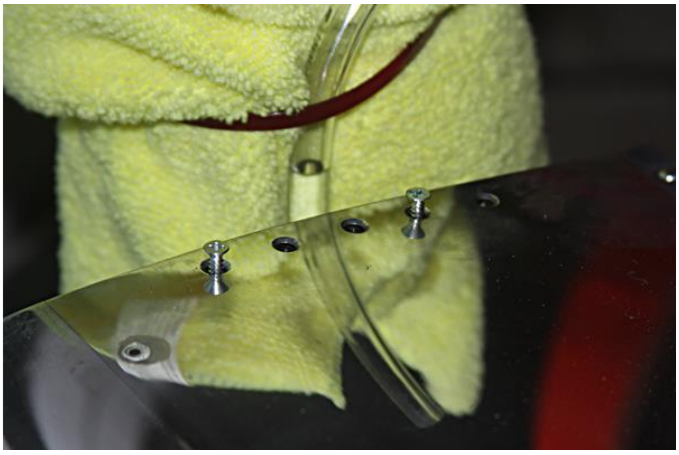
There's a lot to static balancing the blades. The first step is to get the lead/lag adjusted so the blades seek a horizontal position and don't tip up or down when the hub is jiggled. Then you need to take all the slack out of the hub bearings so the blades are as far out as they can go, and then you can look at the static balance. I think the best way might be to use a water level. The floor of my garage is not level and the digital protractor is OK but probably unnecessary. All I need is a plastic tube with some water in it that will reach from tip to tip. I think I'll pick up some tubing while I'm getting the die and give that a try…

I should also mention that just getting the blades into the hub is a challenge. I made a taper pin from a ½" bolt and carefully smoothed and polished the taper. Once the blade is in the grip and lined up fairly close you tap the taper pin in through the grip and the blade to precisely line up the bolt holes. This prevents dinging up the blade's mounting hole which would be a disaster and cause the grip to be scored when you tried to get the blade back out. The blade and the grip are a precision fit and you need to use anti-seize on the surfaces. Once one blade is in the hub the other one needs to be inserted at exactly the right angle to prevent stressing the grip. The blade has a huge mechanical advantage and moving the rotor blade tip up or down slightly while pushing it into the grip could apply tremendous spreading forces to the grip which might cause hidden damage (the first blade is not a problem because the hub is still free to tilt.) You don't want to be flying around with a blade grip that has a stress fracture in it! I spent a lot of time using my digital protractor to insure that that second blade went in at the same angle as the grip.

In this picture you can see the second blade grip bolt at the top and the pin I made at the bottom. I'll explain the round piece in a minute… After messing up the treads on the first bolt I decided to find a way to grip the second bolt by the threaded end without damaging the threads. I picked up a ½-20 bolt and a small bag of nuts at the hardware store along with a die to chase the damaged threads on the first bolt. I sawed the head off of the hardware store bolt so I could chuck up the shank in my small Sherline lathe. Then I screwed two nuts onto the threaded end and locked them together. I turned this one down until it was a good fit in an 11/16" collet. Then I could draw the collet into the R8 taper on my mill and get a good grip on my modified nut. The bolt could then be screwed into my new custom adapter finger tight. The rotation of the mill tends to tighten it so there is no need to tighten. This way I could easily unscrew the bolt for fit checks in the hub.

I knew from the last bolt that the two areas pointed to by the arrows bulge out a bit so I hit those with a file. I also very lightly kissed the threads to get their outer diameter down about 0.002 inches. I reduced the shank about the same amount using 400-grit wet and dry sandpaper. I learned to position the sandpaper so it couldn't catch and get drawn into the bolt, taking my glove and a few fingers with it.

The trick for me was to go very slowly and fit check often. I'd note where the bolt started to jam and go back and hit that area for a few seconds and then recheck. I hit the shank with my polishing wheel and used anti-seize for each fit check. This bolt is now a firm fit requiring a few taps with a hard rubber mallet to install it. The two bolts are prick-punched so I can keep them matched to their side of the hub.



19 March 2011 – I decided on a much simpler balancing method using a water level. It's nothing more than 25 feet of tubing from the hardware store. I forced water in one end until it squirted out the other end. Then I lowered one side and let a bit of the water run out. Holding the two ends together you can see that the water seeks its own equilibrium. I tie-wrapped each end to a handy support and stuck a yellow towel behind it to make the water easier to see. The picture above shows the two blade tips.

Initially it took three of my longer set screws sitting on the end of blade-2 to balance the blades. Using my triple-beam scale I measured the weight of the screws at seven grams. Then I weighed the tip weight from blade-1, the heavy blade. It weighed 341.0 grams. I set the scale for a weight of 334.0 grams and then started milling material off of blade-1's weight, a little at a time and measuring often. When the scale balanced I reinstalled the weight and the balance is now perfect. Once the tip plugs are epoxied and the black tip tape is applied I'll redo the balance, but this should insure that I'm close enough to correct any new imbalance using a few set screws screwed into one of the ¼-20 tapped holes I made back on page 320. After cleaning up the blades and putting them back in their box I'll be done with this project until final checkout.

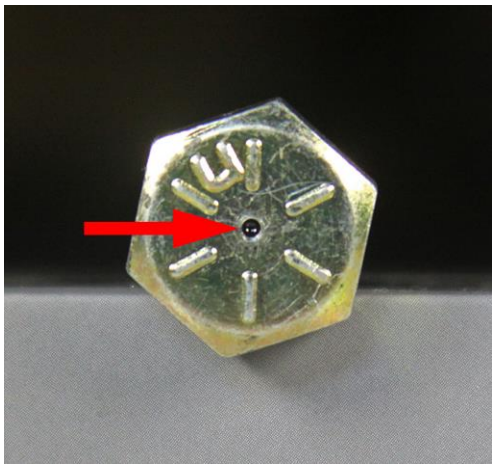
20 March – Now that the main rotor blades are static balanced the only thing left to do is finish off the cabin. Before I can have the cabin painted I need to patch a few dings, pits, voids and cracks. The most visible are here in the very front between the chin window and the windshield.

Here's a closer view showing some of the areas that need to be repaired.

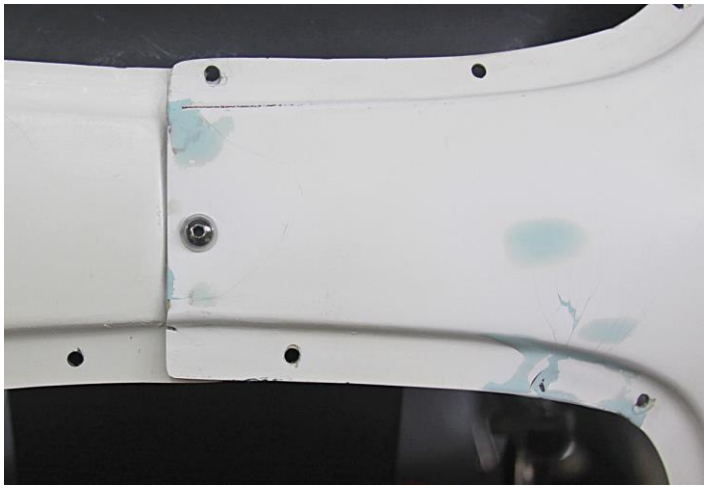
I need to smooth out and match the two sides along the edge where the windshield is attached (top of the picture.) There's a limit to how far I can go before I get too close to the screw holes. A previous owner had already drilled these so I'm stuck with what I've got unless I want to try and fill them in and start over.

The left hand cabin half (right side of the picture) rides up over the indented area where it mates to the opposite side, and there are several areas where the fiberglass had voids and the gelcoat has cracked and fallen off. Lastly, there are several cracks that I'll need to repair.

Fortunately, this is the only area that is really banged up. Unfortunately, it's in a very visible area – right at the front of the helicopter.



27 March 2011 -- While I was waiting for the finishing and blending putty to dry I checked in with my Guru, Hap Miller. He suggested drilling a very small center hole on the bolt that goes on top of the rotor head. During checkout the lead/lag adjustment process involves running a line from the tip of the master blade to the tip of the slave blade and adjusting the lead/lag of the slave blade to place the line directly over the center of this bolt. Initially I chucked up the bolt head in my small lathe and started to drill the centering hole using the smallest center drill I have. I noticed that the bolt threads were wobbling around inside the chuck. It turned out that the bolt head was not precisely centered on the threads. Plan-B – chuck the bolt by the threads instead of the head (only hand-tight so as not to damage them) and drill the hole that way. Sure enough, the bolt head was slightly off. I finished up this mini project by putting a very small dab of gloss black POR paint in the hole to increase visibility. If you look closely you can see that the six lines on the bolt head do not point exactly to the hole. The head was only off by a few thousandth of an inch, but it was off.



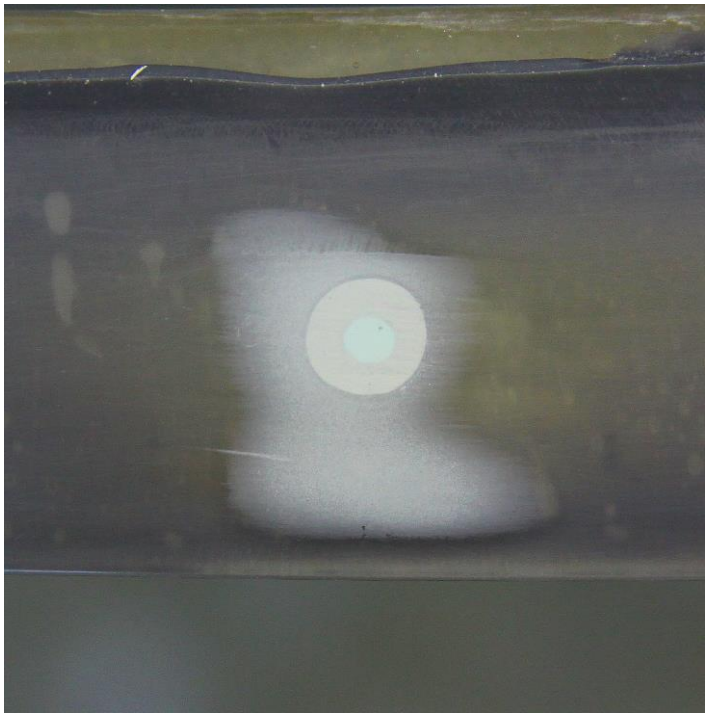
Before working on the bolt head I made another pass around the left cabin half with finishing and blending putty. The crack at the lower right of this picture went all the way through so I added two layers of fiberglass tape on the back side, let that set overnight and then filled in the damage on the front with the putty. I squared off the mating edge at the left of the picture, rounded off the top edge to try to meet the edge of the other side, and filled in the nicks and dings with putty. The windshield holes and rough trimming was done by a previous owner so I was limited in how much material I could remove to match those two sides. I need to leave enough material around that last screw hole so it doesn't fail. I'd much prefer that the two sides matched perfectly but the windshield was also already drilled to match the cabin mounting holes so I'm stuck unless I want to discard my windshield and start over. After over two years of work my patience is starting to wear thin and so is my bank account. This will have to do.

Major expenses remaining:

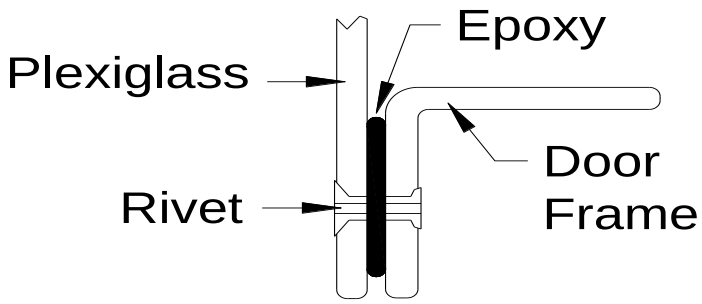
- Ferrari red paint for cabin (Naturally red is the most expensive pigment of all!)
- Painting labor
- DAR visit to acquire airworthiness certificate
- California use tax equal to state sales tax
- $2000 to Eagle R&D for checkout
- Travel expenses and room and board for mechanic/test pilot
- Approximately 20 hours of Robinson R22 dual instruction to get back into shape after 20 year gap in flying

That still leaves me wondering where I'm going to hanger the ship and where I'm going to fly. When I started this project I had assumed that I would be comfortably retired and living somewhere in the country by now, but that was before the latest economic meltdown. Now I'm still working every day and living in a highly urbanized environment under the approaches to three international airports, right in the middle of class B and C airspace, MOA's, the ADIZ, sea otter game refuges, multiple restricted areas, and a NASA flight test range. Flying around here will be like learning to drive by heading out to the Los Angeles freeways during evening rush hour in a rain storm.

29 March 2011 – I left one item off the list because I didn't want to jinx myself. It didn't work. The tax man got me for 9.25% of the sale price. Getting my FAA registration triggered it.



01 April 2011 – I've got a date with the paint shop next week so I'm doing last minute finishing of the cabin halves and the two doors. Here's a picture of one of the rivet heads on the door that bonds the Plexiglass to the fiberglass frame. Looking through from the outside, the material at the very top is the fiberglass door frame. The dark gray material is the epoxy showing through the Plexiglass. Using 600-grit wet or dry sandpaper I roughed up the Plexiglass perimeter of the door where it will be painted to cover the epoxy bond with the frame and then smoothed a layer of Evercoat Metal Glaze polyester finishing and blending putty over all the rivet heads and scratches. I sanded the area down until I couldn't feel the rivets when running my finger across the head. I masked the area to keep from scratching the Plexiglass window portion.



I want to paint the door frame with Zolatone and I'm not sure how the paint shop will deal with this. The epoxy bond is uneven. Sometimes it's down inside as I show here, and sometimes it squished up and over the top of the door frame slightly. On the outside the exterior paint needs to come up even or slightly above the door frame to hide the epoxy and the rivet heads. I should mention that I also smoothed out the back side of the rivets so they don't tear up the cabin paint when the door is shut. The right door is secured with bolts so it's less of an issue, but the left door is hinged and the cabin paint will be visible under the door's lip when the door is open. The same goes for the bottom side of the door frame. I don't want it to scrape up the cabin paint.

I haven't decided exactly where the transition from Zolatone interior paint to exterior paint should be. Do I paint the cabin door frame with Zolatone? Since it will be tougher and easier to touch up I probably will.

I've finally perfected my windscreen installation procedure. I line the edges of the cabin halves with about ten microfiber towels, leaving a gap between each towel. Then I Cleco the windscreen between the gaps in the towels. Once I have a Cleco on either side of a towel I can pull that towel out. The reason for this is that the cabin halves and the windscreen are both very floppy until they're mated together. The windscreen ends up sliding around against the fiberglass while you struggle to get the first few Clecos in place. The result is scratches on the windscreen. Not good. A helper would make this much easier.

Don't be alarmed by the black round smudges on my towels. These were used with my orbital buffer to polish the rotor blades. After a few trips through the washing machine they're nice and fluffy but always end up looking slightly used. (If the towels are ever exposed to metallic shavings I throw them away. You'll never get the shavings out and you'll end up scratching something by accident.)

One other note – I cover the magnetic compass with a towel while I install the windscreen just to be safe.

Lastly, when installing the cabin halves to the seat pan I install the right half first since it goes inside the left side where they mate together. I cover the instrument pod with towels when installing the cabin halves, and I cover the most forward section between the windscreen and the chin window in the same way. Those pieces scrape together when installing the left side. That's probably how that area got so messed up (pages 327 and 328.)

Installing the cabin halves really is a two-person job but I usually do it by myself. My technique is to have a few screws in my mouth and the screwdriver in my pocket where I can reach it with my left hand if it's the right half, and in my right hand for the left half. I have an awl on the ground near the front screw location. Once in position I hold the cabin half with my leg while lining up the top/rear screw. Once I get that one partially threaded into the seat pan nut plate I work my way to the front and use the awl to line up the hole in the cabin half with the nut plate in the seat pan. Once I get that second screw installed the cabin half will stay in position and I can take my time installing the rest of the screws. I'm using stainless steel button head cap screws with white nylon washers for the cabin and the windscreen. The Allen tip is much less likely to come out of the head and scratch the expensive paint job than a Phillips head, and they polish up nicely on the buffing wheel.

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In this picture I've applied a thin layer of the Evercoat blending putty to an area that had several small scratches. I could have smoothed out that area on the right a bit so I would have less work to do later, but this is fine.

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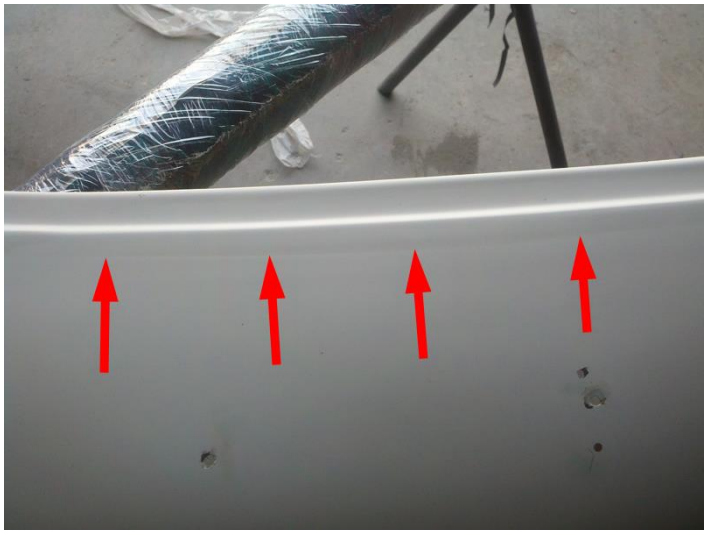

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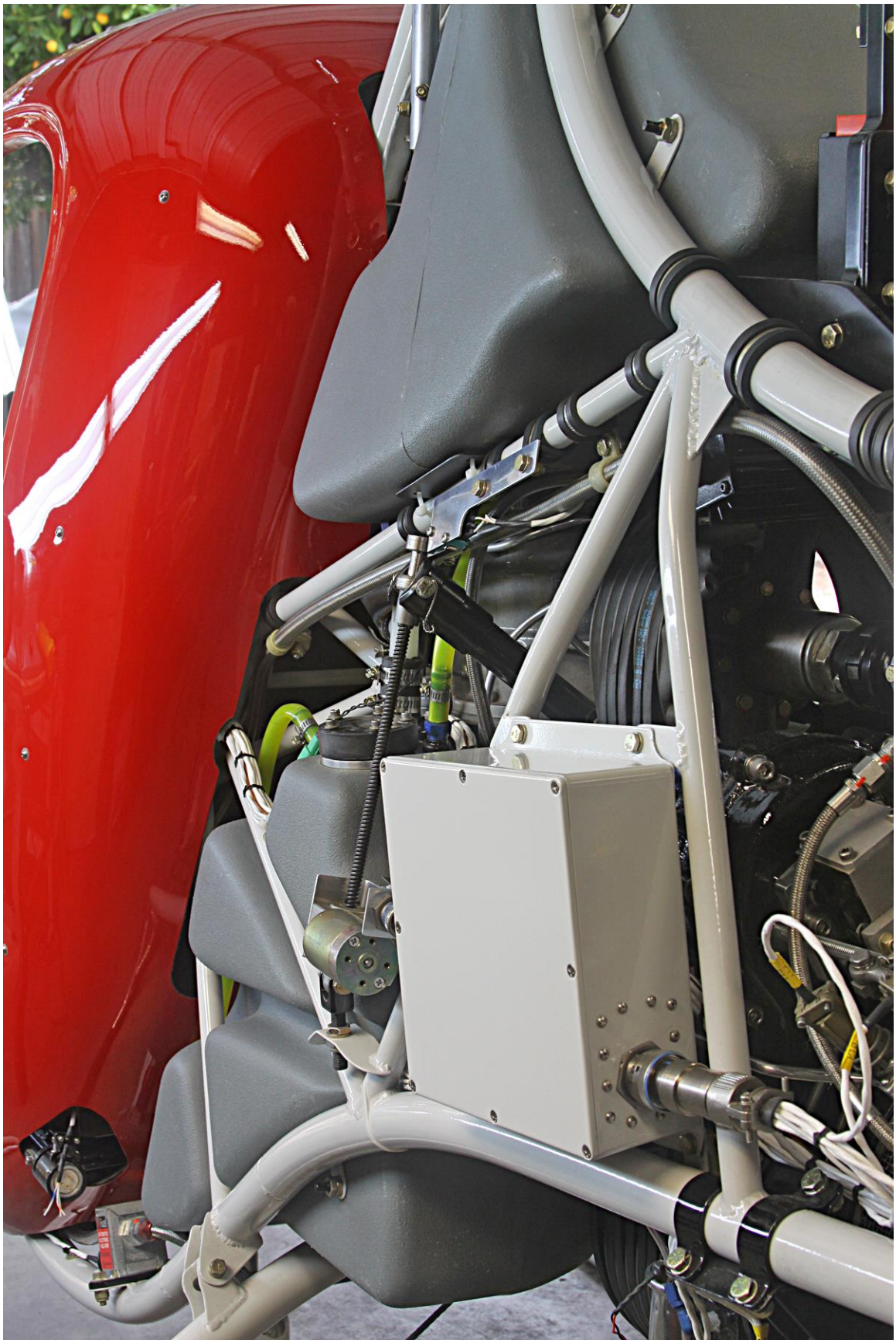


AIRSPEED
VERTICAL SPEED
ROTOR RPM X 100
ALT
122.50
123.50
1200
LOW FUEL
ENGAGED
IN TRANSIT
STACK
GOV
FUEL
MFS
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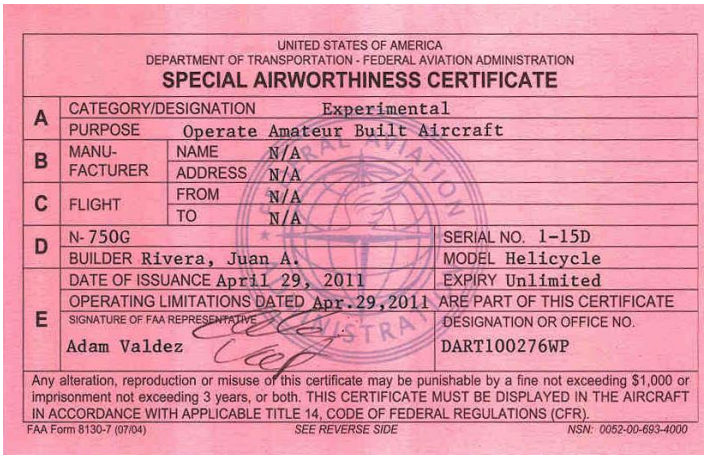

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D	N- 750G		SERIAL NO. 1-15D
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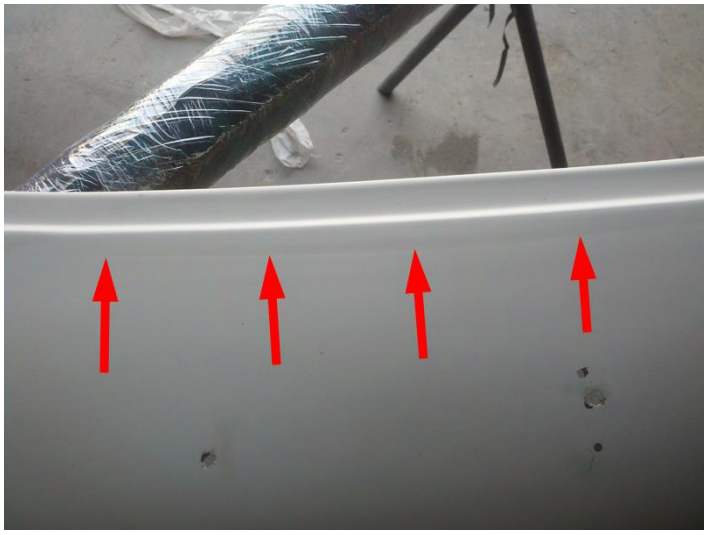

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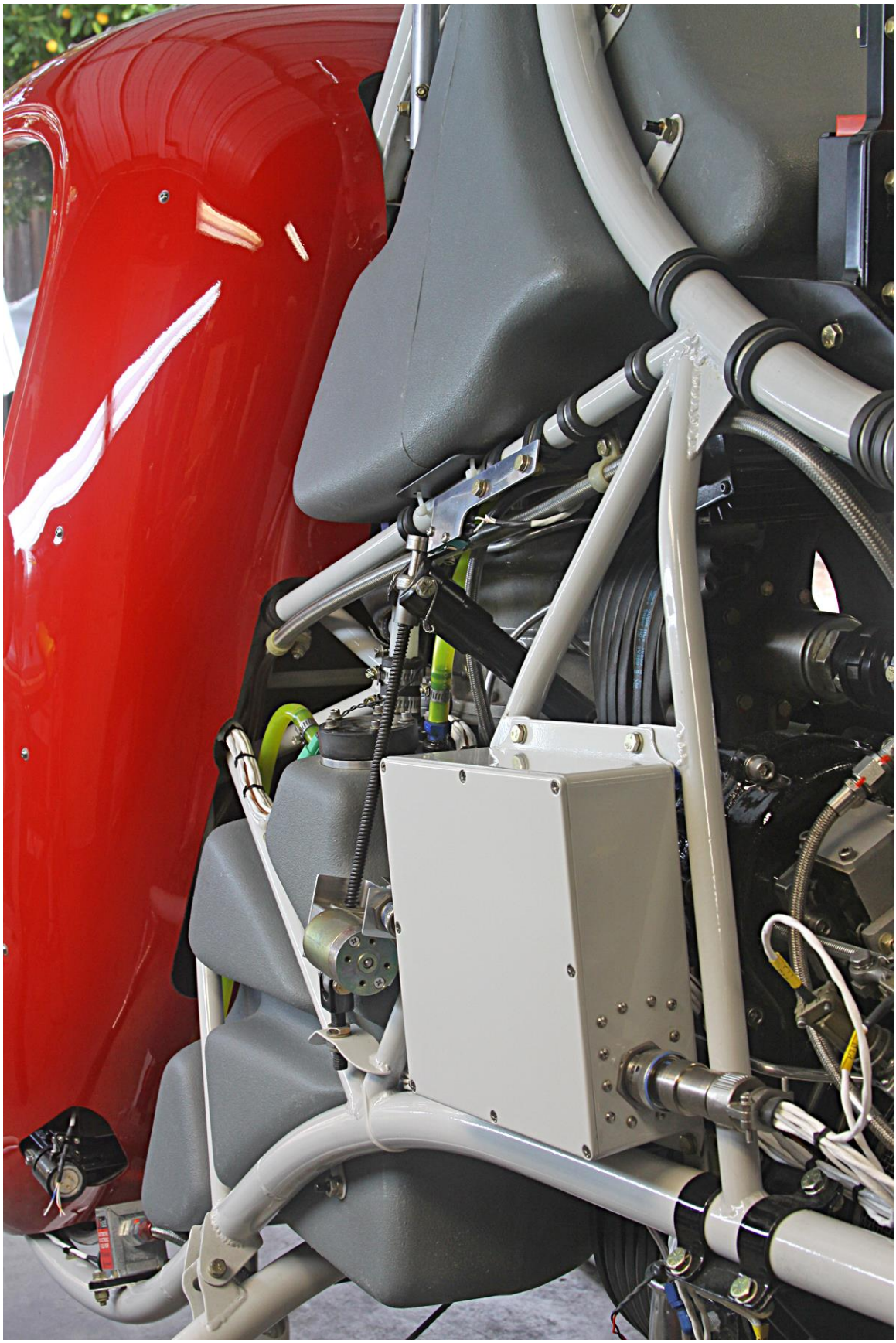


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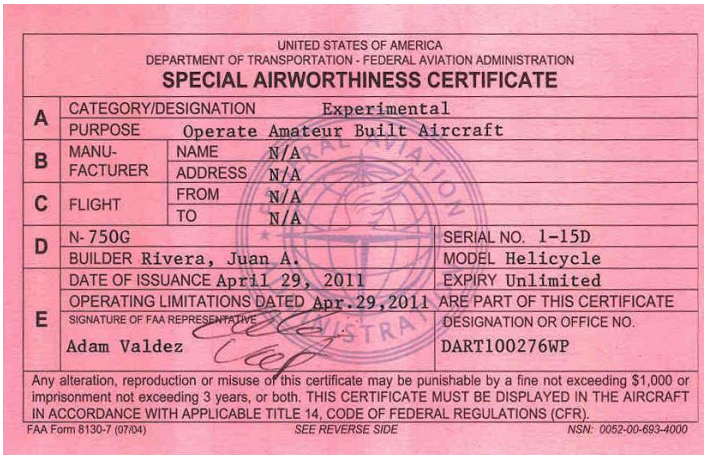

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