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# ENGINE COWL INSTALLATION



This chapter will cover the modifications required to mate your stock Vans RV7-IO cowling to the e-motor. There are a variety of creative ways builders have come up with for actually fastening the cowl to the airframe. Vans prefers to use long piano hinges which make for a very clean, tight-fitting cowling installation. Others have made good use of Camloc style fasteners such as the kits offered by Skybolt Aeromotive Corporation, or even a combination of the two methods. If you think you'll be opening up your cowling often to admire and show off your e-motor, then you might consider using the piano hinges for the lower cowling and Camlocs for the upper cowling. Either method works fine and I am not going to spend any more time advising you on either technique, it's your plane!

The stock oil access door will suffice for your engine. The oil dipstick is positioned just slightly forward of the oil door cutout, but you can still get at it to check your oil level. If you are performing routine maintenance, you will probably be removing the cowling anyway, so filling the crankcase is best done with the cowling removed. If your motor just needs a small drink, you can still access the filler port using a funnel with a short piece of hose on the end. Bear in mind that your e-motor is not an oil-thirsty motor like those air-cooled ancestors. Your motor will seldom need a drink of synthetic oil, MOBIL-1 5W30

*Being an old street-rodder myself, I have built motors without any oil filler cap at all, since they are notorious for leaking and getting your beautiful motor dirty. I fill these motors through the dipstick tube using a small hand-pump orchard sprayer with a nozzle made from a short piece of brake line tubing. With a hand vacuum pump attached to the sprayer tank you can extract the oil the same way. Works like a charm!*

You'll be putting your fiberglass talents to work in this chapter, so stock up on the basic supplies:

1. Dust masks
2. Latex gloves
3. **EPOXY RESIN** (just a small amount, but you'll need this for your windshield and canopy too). **DO NOT USE POLYESTER RESIN** like commonly used in the automotive world. It is incompatible with your materials. West Systems 105/205 Resin/Hardener is perfect. Don't forget to buy their plastic pump kit.
4. Micro-balloons such as West Systems 410, or fiberglass flox (powdery or itchy

stuff you add to the resin to form a paste)
5. As a cleaner and simpler alternative to items 3 and 4 above, you can use a good two-part aviation filler such as "Super PolyFill".
6. A couple of Bungee-cords
7. Some duct tape (similar to what was recommended for Homeland Security :^)
8. Sandpaper of a few various grits ranging from 60 to 400.
9. Some 80 or 100 grit sandpaper strips for linear body sanders, aka "board sanders", available at your auto body supply store, or you can cut open a sanding belt.
10. A Dremel or similar grinding tool
11. A Dremel Carbide Cutting & Shaping bit number 542 (works great on cowling and canopy)
12. A Dremel sanding drum bit and sandpaper sleeves
13. Some popsicle sticks, masking tape, brown paper, etc.
14. 1", 1.5" and 2.25" hole-saw drill bits (wood cutting types work fine, small teeth are best).
15. Some scrap particle board and 1/2" plywood about 24" square each to make a prop backing plate jig.
16. Misc drills, jig-saw, and common hand tools.

The tasks at hand include:

1. Making a prop disk jig
2. Fitting the lower and upper cowling
3. Fitting the cowling to the radiator shrouds
4. Fitting the oil cooler shroud
5. Making a cutout for the oil cooler inlet
6. Making a pair of cowl vents to release heat when parked.

Sounds simple! Let's do it.

## Making a Prop Disk Jig

Before you begin fitting the cowling, make a wooden prop disk to help you with cowling alignment.

Start by tracing two 13.5" circles on a piece of 1/2" particle board or 1/2" plywood. Cut them out with a jig-saw or band-saw. Don't bother smoothing the edges just yet. You need two of these disks, one MUST be made from 1/2" material, the other can be thicker if you like. I used 3/4" particle board for the forward one, and 1/2" plywood for the rearward one.

In the center of the thicker forward disk (if you made one thicker), use a 2.25" hole-saw to drill a hole for the prop flange boss. Slip the disk onto your prop flange to make sure it fits and adjust as necessary. In the other disk, trace and cut out a 6.25" circle. This disk must fit loosely over the entire prop flange.

While holding the disk with the smaller center hole in place, mark the location of at least two bolt holes from the back of the prop flange. Drill these holes to size and locate some bolts and nuts to secure the disk to the flange (but don't bolt it together just yet).

Now fasten the two disks together with some glue or a few screws.

Sand the edges of the disks smooth and round on your belt sander. No need to get carried away here...

Now bolt the disk onto your prop flange with the large center hole covering the prop flange. The back side of the disk should now be flush with the back side of the flange.

# Fitting the Lower Cowling

Read the entire chapter on this subject from Vans installation manual at least a few times, then set it aside.

Assuming your motor is fully and properly installed (Forgot to do that? Do so now and return here when ready).

Assuming your propeller is NOT installed (if it is, remove it and return here when ready).

You will find that the length of your mounted engine is such that only a tiny amount of cowl trimming will be required to mate with the firewall. Keep this in mind throughout the installation because while you can always remove more material, it is very hard to put it back if you sand or saw too much away. This is a slow, trial-and-error process which requires patience and perseverance. Some additional trimming will be required around the radiator shrouds before you can fully seat the cowling against the firewall. The oil cooler cutout comes later.

Some builders prefer to fit the upper cowling first, then the lower cowling. I personally chose the opposite approach, but it will work either way. In my opinion, the lower cowling has the most material to spare and also requires the most cuts, so it seems reasonable to start there.

If you are building a tricycle gear RV, you will need to make provisions for the nose gear leg to protrude through the lower cowling. Vans suggests cutting a long slot in the lower cowling. If you are careful, you can save the piece you remove and fashion a means of screwing it back into place to cover the rear portion of the slot after installing the cowling. If you are using a three-blade prop, this slot will need to be longer since the lower cowling must drop lower to clear the three-blade prop. All of this is described and shown on Vans plans. I suggest starting with a measurement or two using a long straightedge on the belly to determine where to drill that first hole through the cowling. Use a 1.5" hole saw to make the forward-most cut, then mark the parallel lines and saw out the slot using your Dremel cutting wheel or a hacksaw blade (the cutting wheel works best and you

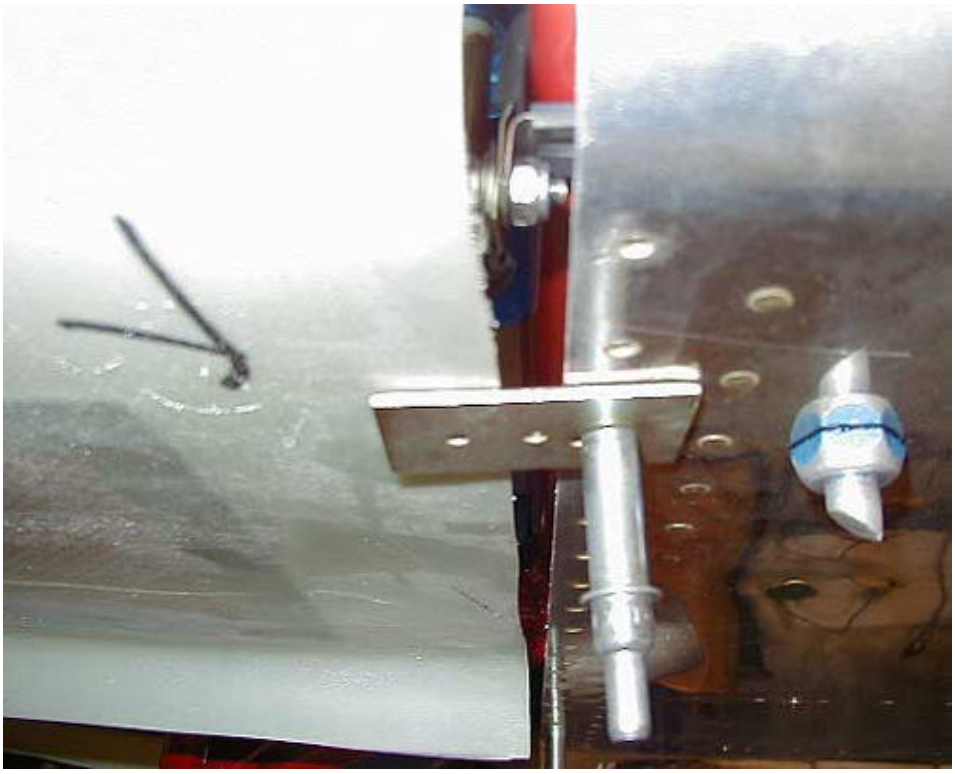
may as well get used to it now).

*As an alternative, some builders, myself included, have chosen to create a much larger cutout in the lower cowling and fashion a cowl flap mechanism. While not strictly necessary, the ability to open a larger exit area can help with ground cooling on hot days. You're deep in mod-country if you choose to go this route. I will include some photos of my cowl flap mod at the end of this chapter if you are interested in attempting something like this, but it is a lot more work and is not required.*

Keep in mind that the slot must clear the nosegear leg fairing too, so you should temporarily install the gear leg fairing when making the slot. Of course, even the nose leg fairing requires some cutting and shaping to fit, so you may as well do that now. Vans suggests that you make a fiberglass fairing around the seam between the nose leg fairing and the lower cowling. You can do this later if you choose. As always, there are many ways to do this.


As you test-fit your lower cowling, simply let the firewall end of the cowl overhang the airframe skin for now. Do not attempt to trim it just yet. What you want at this point, is just to get the clearance of the nose gear assembly correct. The forward cowl ring should fit up against the wooden prop disk. You can prop up the rear edge of the cowl with jack-stands, boxes, paint-cans, etc. and insert a few scraps of cardboard between the front edge and wooden disk as you work to help hold the cowl in position. Keep in mind that the wooden disk represents the rear edge of the spinner, so a thickness or two of cardboard is a reasonable gap to have. Vans recommends no more than 0.25" gap, but you can do better. Just don't make the gap too little.

I had not yet installed my piano hinge material to the firewall, so I found it handy to cleco a few scraps of aluminum to the hinge rivet line to help support the cowling as shown below.

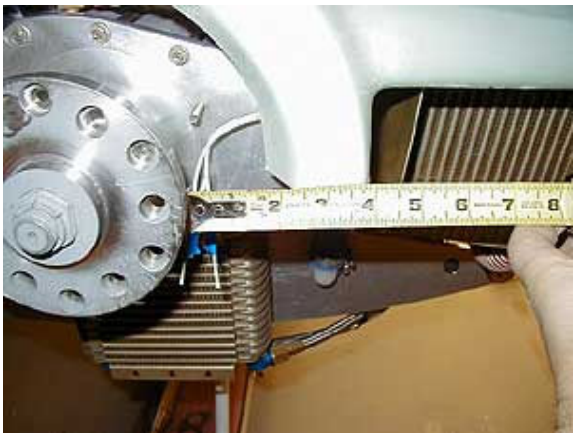


A Bungee cord hooked between the nosegear slot and somewhere on top of the motor helps to hold things up in front.

You have undoubtedly noticed by now that the front of the lower cowling does not clear the radiator shrouds. The trick here is to raise the lower cowling until it contacts the shrouds and mark where the cowling needs to be cut away to clear the metal shrouds. You have two choices here, you can cut the metal shrouds, or cut the cowling. I suggest that you cut the cowling. It is easier to work with and looks better in the end. Only cut the metal shrouds as a last resort, but you should not have to do this. Be patient and remove only as much material as you need to provide about 1/8" clearance from all radiator material. When you have a good fit, you can go back and smooth out the curves to a

pleasing shape. The cuts are best made with the Dremel cutting wheel and the corners with the Dremel sanding drum. It's a dusty, itchy, messy process, so wear protective masks and gloves and try to do your cutting and sanding in a remote corner of the shop, or even outdoors. I like to have my shop-Vac running with the hose right next to my tools as I work with fiberglass so the dust is sucked up before it can spread around and make life miserable (and believe me, it CAN make life miserable).

As you get closer to a good fit, use the wooden disk to make sure you have the cowling reasonably well centered. The following photos show that the inner fiberglass ring is 2.25" from the prop flange. Make sure you maintain this centered dimension, particularly as you start to trim the cowl to firewall seam.

When you've got it just about perfect, you will notice that one or both of the oil cooler hose fittings may contact the bottom of the cowl. Ideally, they should just clear the cowl by about 1/16". You can locally remove ("core") a section of the honeycomb if needed to clear these fittings. I found that this was not required on my own installation. If you do core the honeycomb, lay a single layer of fiberglass mat over the cored area to reinforce it.

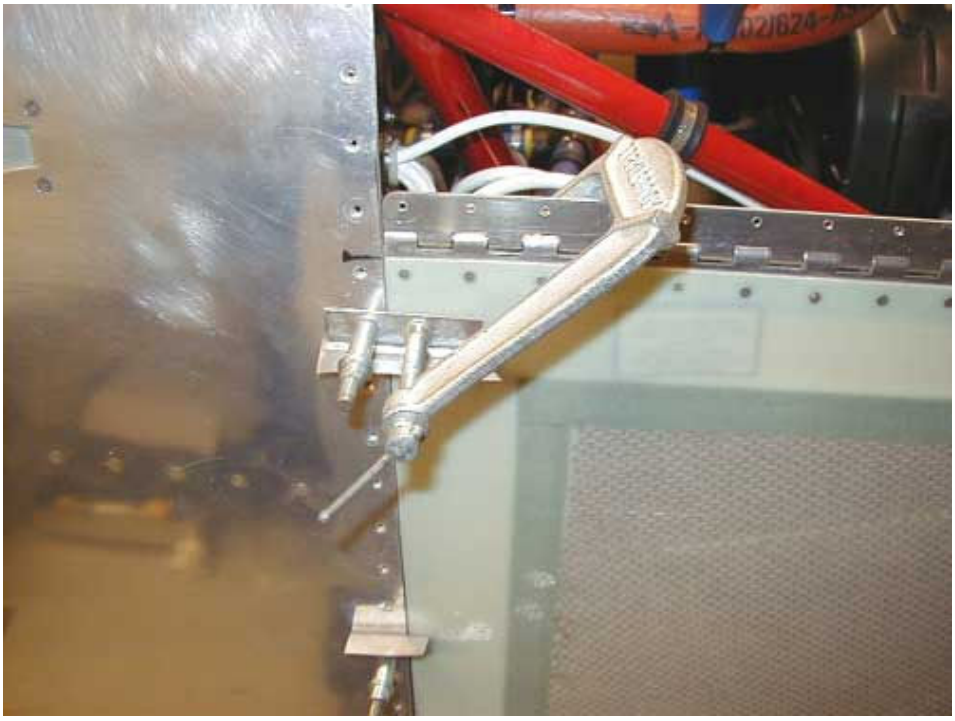
When you've got the fit as good as it's going to get, it is time to trim the firewall seam. Prop the lower cowl in position with the wooden disk installed and secure the cowling in

place with Bungee cords and wedges of cardboard between the disk and cowl ring. Raise the rear edge tight against the lower skin. Place a bright shop light inside the cowling so that you can clearly see the edge of the firewall and trace where the cut needs to be with a sharp pencil. An alternative way to do this is to mark a line around the fuselage skin exactly 1" back from the firewall edge, then measure exactly 1" forward and mark the cowling. Whichever way works best for you is fine.

If you have trouble drawing a straight line, nothing beats a strip of tape. You can't tell in this photo, but there is a bright light shining through the cowling to help locate the cut line.

Once the marks have been made, remove the cowling and make your cuts with the Dremel cutting wheel. It is always best to cut just short of the mark and sand to the final fit. When sanding, use long strips of coarse sandpaper fastened to a long block of wood. It takes practice to make nice straight sanding strokes and establish a clean, straight edge. Have patience... Sand to the lines with plenty of test-fits as you go.

It is useful to clamp the seams against the firewall as you continue to fine-tune the fit.

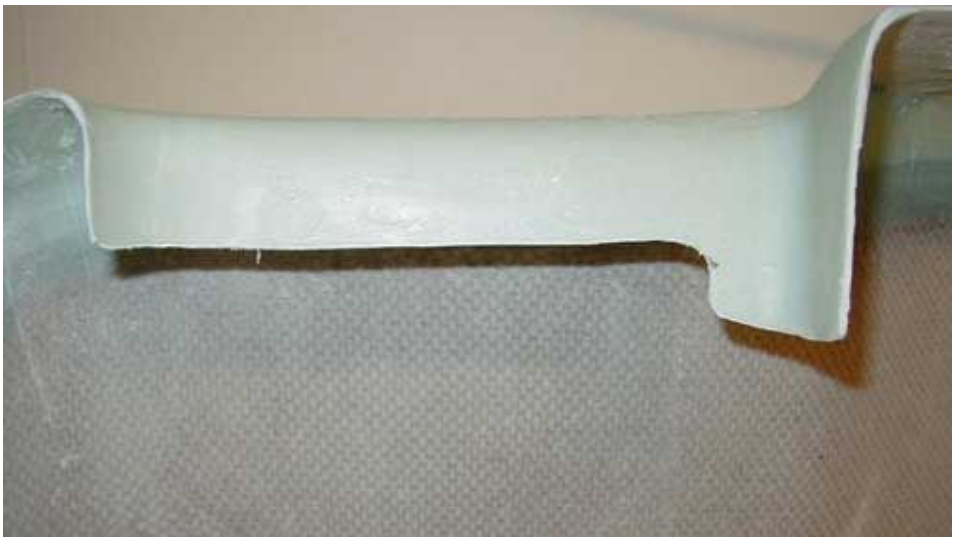


When you're finally satisfied, clamp it into position and mark the locations of your piano hinges or fasteners. You can install all of the lower cowling fasteners now if you choose. Consult the plans or vendor documentation for these procedures.

## Fitting the Upper Cowling

The upper cowling follows a similar process as the lower cowling, except you'll probably find it is easier to do now that you've gained experience and every stitch of clothing you own is already itchy. As before, let the rear edge of the cowling overlap the upper firewall skin while you concentrate on making the front seams fit correctly and make the cutouts around the radiator shrouds.

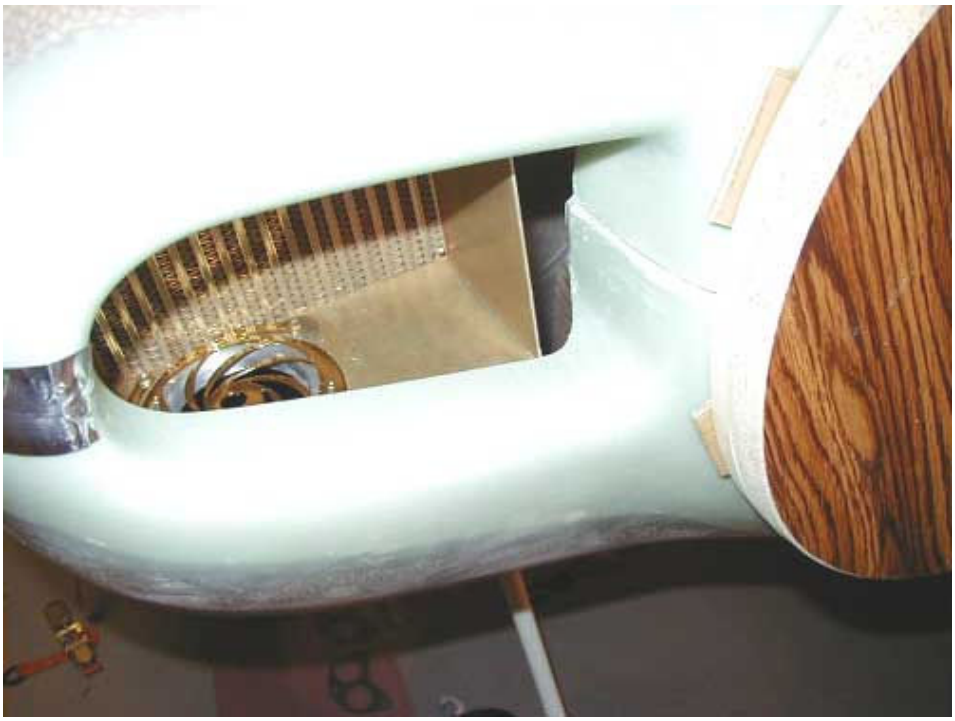
Here's what the rough upper cut looks like.



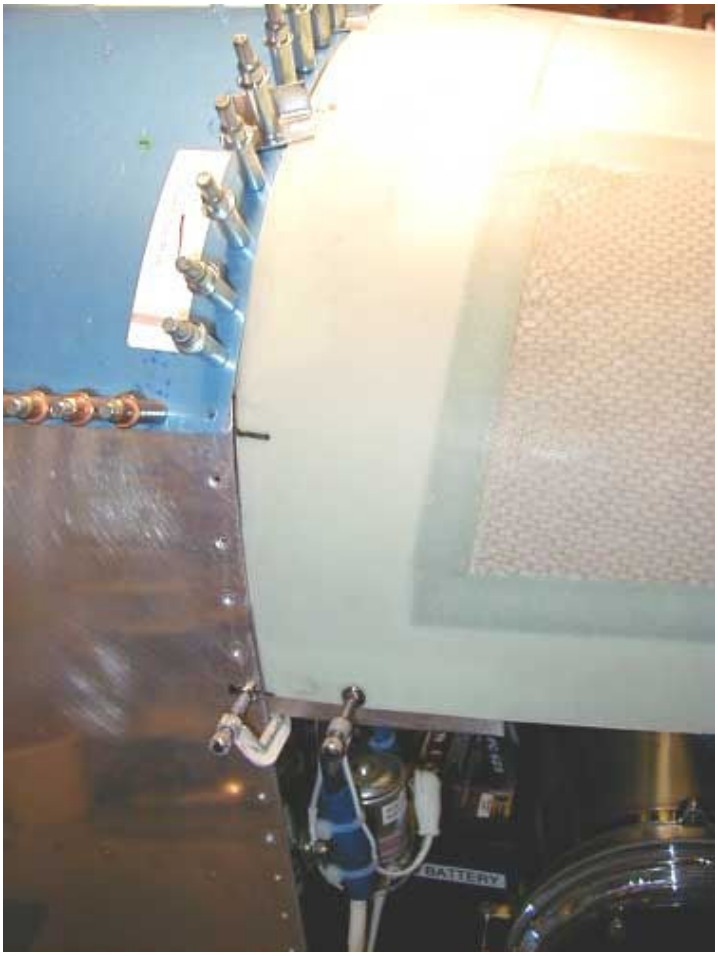
When it fits well, then go back and smooth out any curves to make it pretty. In the photo below, I continued to smooth out the upper right corner because I didn't like the look of it in this photo.

A bit-o-duct-tape works well to hold the seams together. It's a pain to peel off though.

And the final fit! Note the cardboard wedges between the prop disk and cowl ring.



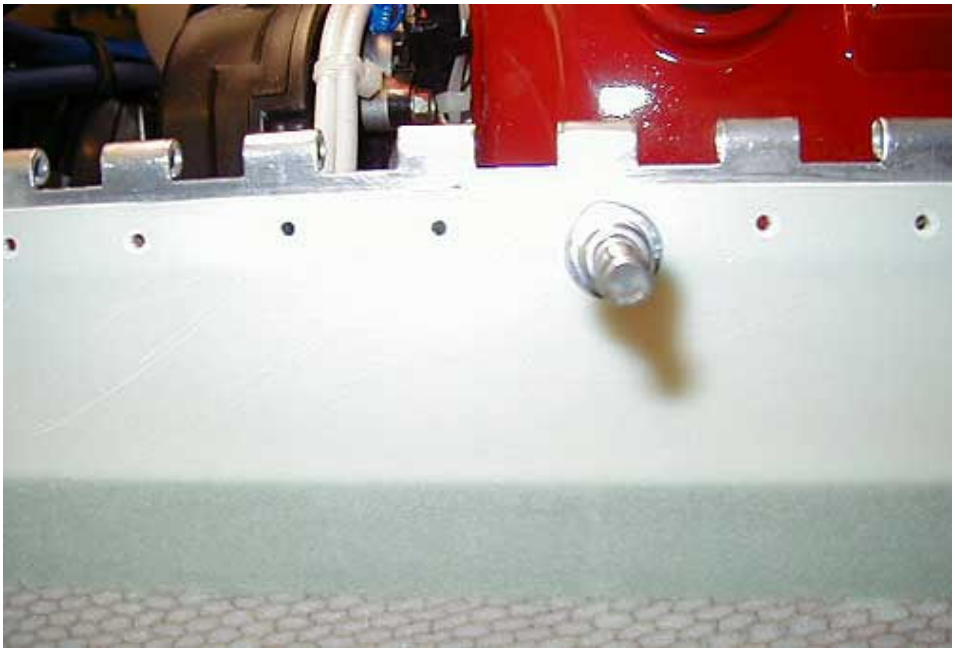
Fitting the rear seam works pretty much as it did for the lower cowling. Notice the black mark to help align it with the fuselage skin seam and the various clamps used to pull it tight. Take your time on this seam and get a good fit.




The final, and most critical cut is along the side seams. Here the top cowling is tucked inside the lower cowling and a sharp pencil is used to make the sanding line. Lots of block sanding will yield a perfect seam. Yes it can be done!

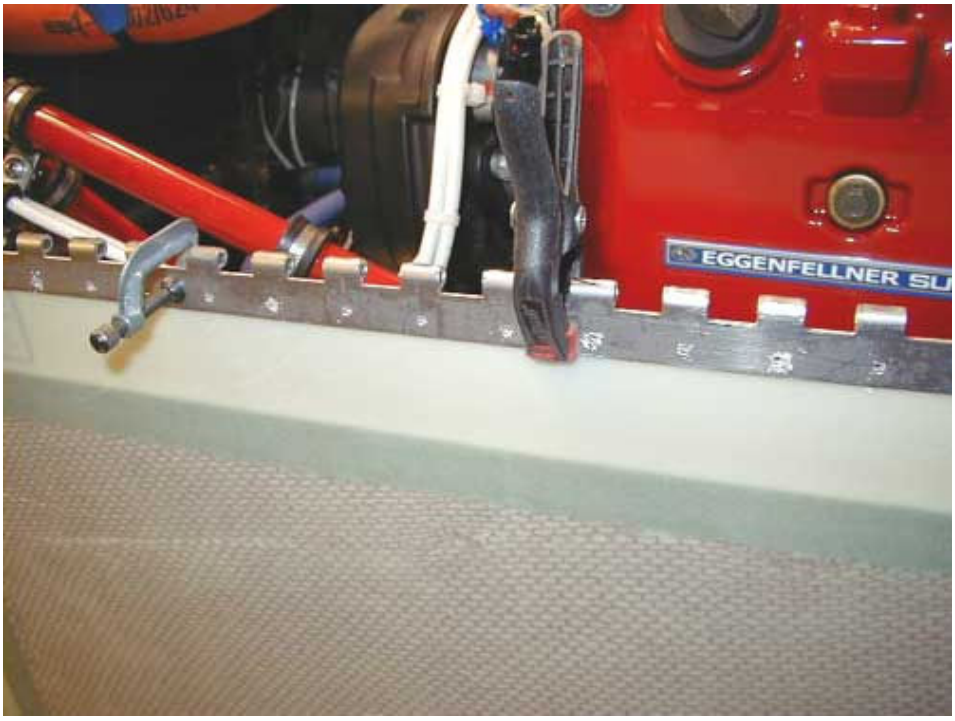
Here's a handy trick to make it look even better. Raise your hinge line just a little so that no light shows through the seam. It doesn't take much and this will help you to fit the

upper cowling in place too.



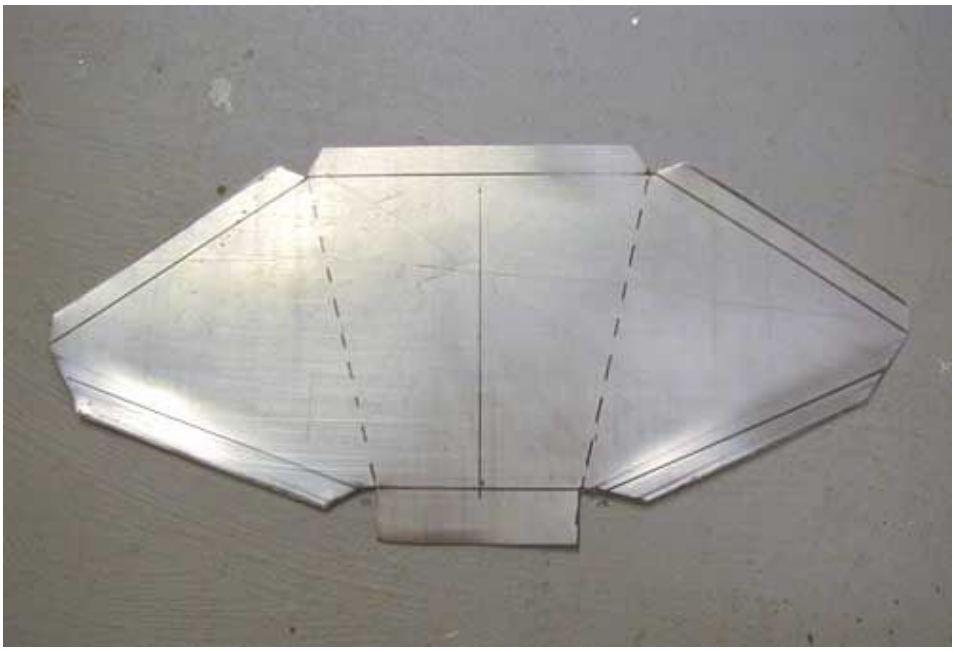
When drilling piano hinge, it is helpful to drill through both sides at the same time so the holes come out perfectly aligned. Note the piece of angle used to help hold the hinge plates parallel during drilling.

Back on the cowling, clamp the hinge plates to the outside of the cowling, using it as a drill guide, then remove it, countersink the fiberglass, and rivet it to the inside. Install the other half of the hinge using the full sized pin material, and drill a couple alignment rivet holes using the shop light behind trick to locate the holes. Drill and rivet the rest of them and your final seam should be tight and straight. We'll leave it to your own creativity to determine how to best terminate the hinge pins. Vans has a couple good suggestions, but builders have come up with plenty of alternatives.




## Oil Cooler Scoop

Some of the earlier motors came with a small fiberglass oil cooler shroud with the idea of fiberglassing it into the lower cowling. Personally, I don't want to do any more fiberglass work than necessary, so I chose to fabricate a metal oil cooler shroud out of 0.025" aluminum. Rumor has it that the newer motors come with a metal shroud *strikingly similar* to this one. Anyway, the message here is that your motor may differ from what is shown here, but you will get the general idea. Here is how I fabricated my own metal shroud.



After cutting, bending, smoothing, and drilling, I made a lower attach bracket out of a piece of 0.5" angle and riveted it to the sides of the shroud. This gives me six points of attachment as well as forming a nice beveled intake.

If you look closely at the photo below, you will see how I bent the lower attach angle downward so that it forms a better scoop lip and also hides the attach bolts. You'll see this again in later photos.

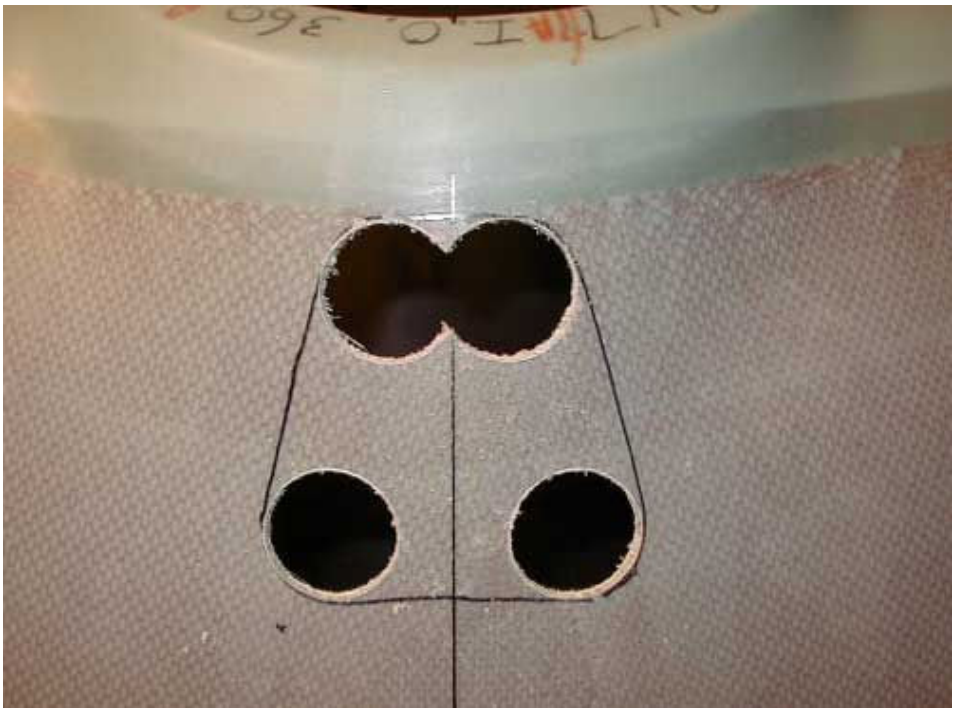
## Oil Cooler Cutout

...and you thought you were done with fiberglass work! Not so fast Superman, we've still got to cut a hole for the oil cooler inlet.

First, install the lower cowling without installing the upper cowling or wooden prop disk jig. Peek inside and see how the cowling mates with the oil cooler scoop. Draw lines inside the cowling to mark where the cutout needs to be. You have some room for

creativity here, just be sure not to make the hole bigger than the scoop! Some folks like triangles, I chose to do a semi-rounded trapezoidal thing.

Transfer your markings to the exterior if you like. In order to achieve nice round corners, I started the cut with a 1" hole saw. You are sawing through two paper-thin layers of fiberglass with a cardboard-like honeycomb interior core. Go easy!



Once you've got the corners done, rough out the opening with a hacksaw blade or jig saw. It is nice to cut this opening on an angle that will follow the angle of airflow.

Now sand the edges smooth with your Dremel and a sanding drum bit. Notice how I am angling the bottom edge for a more pleasing appearance. Sand it, then sand some more.

Obviously we need to do something about the honeycomb material and the now ragged edge. The best way to deal with this is to undercut the honeycomb layer with your Dremel and a cutting wheel. Be very careful not to cut into the thin fiberglass layers. The goal here is to slice away the honeycomb only so that you can pack the edges with filler.

I apologize for not getting photos of the filling process, but the general idea is to mix up a small batch of Super PolyFill or a combination of Epoxy Resin and Flox or Micro-Balloons and pack it into the edges with a popsicle stick. Pack it in there good and smooth off the edges. Once it sets up, do some finish sanding with various grits of paper until you end up with a clean edge.

Below is a shot of my final inlet cutout and oil cooler shroud. Not seen in this photo (by

design) is a piece of 1/4" foam used to seal and cushion the scoop-to-cowling seam. The seal is glued to the cowling with Automotive Goop (good gooey stuff). To finish off the inside of the cowling, I chose to spray VHT 1500-degree paint.

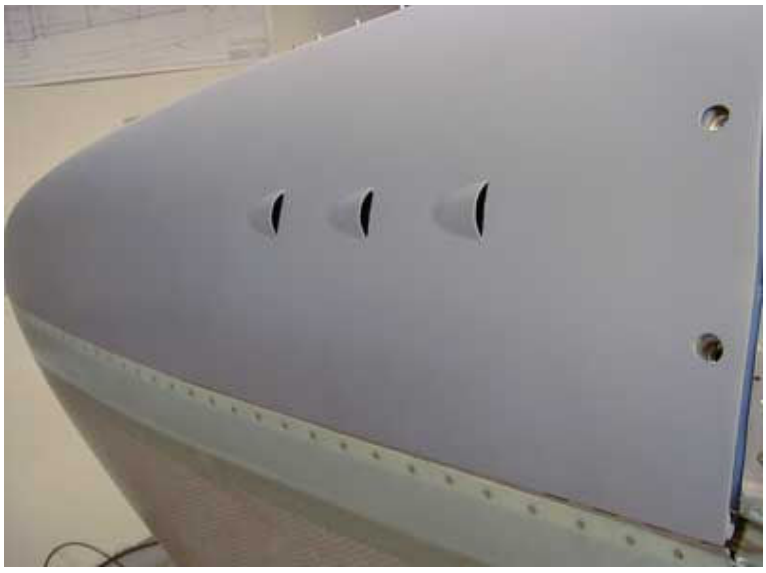
## Cowl Ventilation

OK, so you're feeling pretty good about your fiberglass skills now, right? Well here's another chance to show off your creativity. The upper cowling will need to have some form of ventilation to let engine heat escape when the aircraft is parked. Liquid cooled motors will tend to get slightly hotter immediately after shutdown because of the loss of coolant flow. Adding upper cowl ventilation will help to preserve the fiberglass and lower the risk of engine overheating. Every automobile has these. So must your airplane.

You come to a fork in the road Grasshopper...

If you take the expeditious path, you will create ten holes along the upper rear cowling where it is a single fiberglass piece, using a 0.75" UniBit drill. (Just below the red line in the photo). The UniBit cuts a nice clean hole which doesn't look too bad and let's the heat straight out. If you like, you can add a drip rail inside the engine compartment to channel rain water to the sides. Investment $0, Time 10 minutes.

If the artist in you is lured down the creative path, the goal is simple. Cut holes. Let heat out. Make it pretty. I particularly like the side louvers on the BMW Z3. You could fabricate a set of these in fiberglass or sheet metal. On my own bird, I used a series of Marine stainless steel deck pass-through fittings bonded into the honeycomb with SuperFill and fiberglass tape. It struck me after shooting a coat of gray primer/surfacer how shark-like this mod looks. My wife has commented about how fish-like the plane looked even before this. I like it, but it consumed several days of work, versus ten minutes if you go the easy path. Note that these vents are high on the sides of the cowl. Rain is unlikely to be a problem here and they are close enough to the top to let heat out, and even pick up a crosswind. If you overheated or sprung a cooling leak, you would see the steam escaping but it wouldn't cloud the windshield. That's my hypothesis anyway. Investment $25, Time 3 days.



## Cowl Flap Mod (optional)

Finally, as promised, here are a couple of photos of my cowl flap mod. This is NOT required. I chose to do this for no particular reason. I can tell you it was a lot of work for questionable return. Instead of cutting the usual nosegear slot in the lower cowling, I removed a large portion of the cowling, using the piece I removed as the cowl flap scoop.

To this piece, I riveted a couple short hinge sections along the front edge. Note how my nose leg fairing cutout now starts at the front of the cowl flap instead of coming in from the rear of the cowling. To fit the leg fairing well, it had to taper to a point in the rear. On the inside I have riveted a small reinforcement plate around the slot. To remove the lower cowling, I pull the short hinge pin and drop the cowl flap away first. Then the main cowling drops down with no clearance problems.

Along the sides, I have roll-formed and riveted 0.015 stainless steel plates. These follow the curvature of the cowl flap and have 90-degree tabs at the top to limit the travel of the cowl flap. When in position, these plates ride firmly against the inside of the lower cowling cutout. When closed you don't see them at all. I am using a short cable to operate the flap. In the closed position, the stainless sides come very close to the exhaust pipe (which is why I made them stainless). I will leave these side plates unpainted.

Whether or not this is a useful mod is open for debate. It looks cool, but adds weight, complexity, and a lot of time to the process. It is likely to have some positive effect on ground cooling, and who knows, it may even have some speed-brake effect if I deploy it in flight!

By the way, rinsing your skin with ice-cold water without soap or scrubbing action will help to dislodge fiberglass dust. The cold water closes your pores. Follow this with a normal soapy washing. Remove and wash the bottoms of your shoes before entering the house. Also, be kind to your pets and don't let them walk around on floors covered with fiberglass dust. Most importantly, be sure to do your laundry in a separate load with a second rinse cycle to be certain the dust is gone before your wife washes her pajamas in the next load. Trust me....

A final touch is the addition of a push-pull cable and bellcrank mechanism to raise and lower the cowl flap. The 1" short connector link between the bellcrank and cowl flap is an over-center mechanism. When you fully open the cowl flap, this short link goes over-center and locks the flap in the down position. The bellcrank axle is attached to the engine mount with a pair of Adel clamps. Functionally solid, but able to absorb vibration too.

THIS FILE shows how Tom Moore made his H6 cowl vents.

THIS FILE shows how Robert Paisley made his STi cowl vents.

RETURN TO INDEX