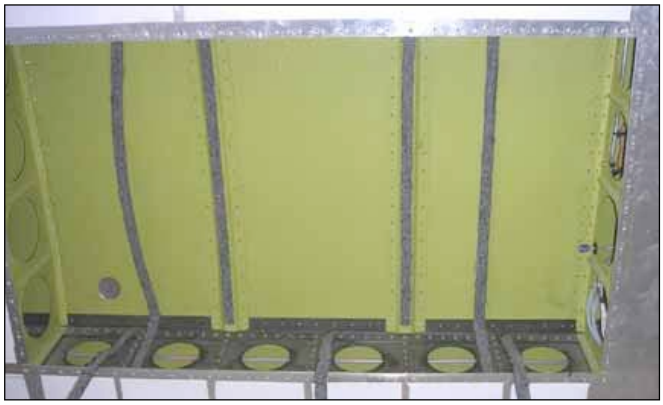
Wings: Install Gas Tanks

As the wing comes, the tank bay is ready to have the tanks installed. You just have to install the suspension straps and put the tensioners on them. When you finish skinning the top of the skin you'll put the tank bay stiffeners in.

The concept of the way in which the tanks are suspended within the wing is the same for both main and auxiliary tanks. For that reason, we'll deal with the main tanks in their entirety but, when discussing the aux tanks, only mention those operations that are unique to the aux tanks.

In a nut shell, the tanks are suspended inside the wing touching no surfaces. They have two padded metal straps going over each tank and three going under (aux tanks have only one strap over). The straps have tensioners so they can be snugged up. Some builders only put them in the bottom straps, but having them in all the straps makes positioning the tank easier and more exact.

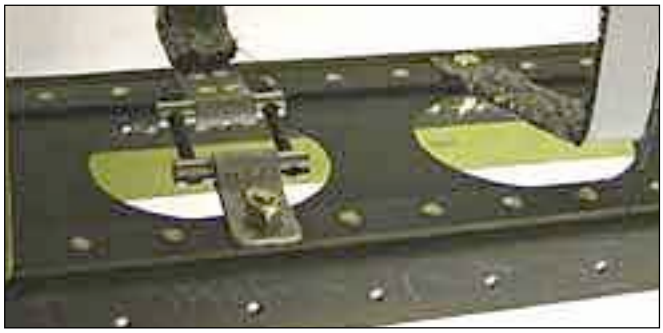


The tanks will be positioned vertically so they just barely miss hitting the tank stiffeners (two middle stripes), which will also be padded.

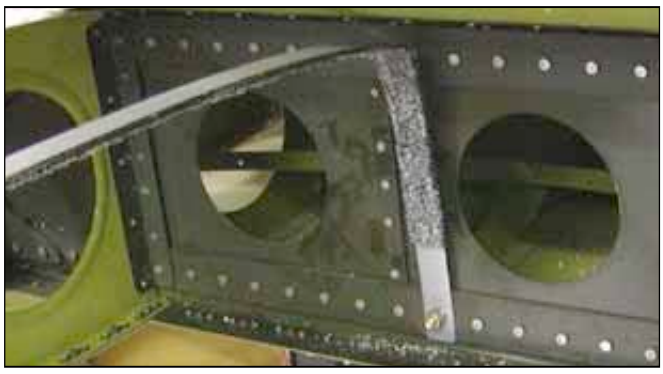
Each tank is vented through the caps, although many builders install a separate vent for each tank and vent the main and the aux tanks (if installed) together so, in effect, they are each double vented. See the pix for various venting approaches.

The first step in installation is to make up the straps required to suspend the tanks. The strap material is supplied in the kit along with the tensioners. They are the series of approximately 3/8" steel bar stock with holes drilled in them. See both the plans and Beartracks for the way the straps are fabricated. Briefly, however, at each station there is a one-piece strap that goes over the top of the tank and is bolted to the bottom spar caps.

The bottom straps are made in two pieces, with one end bolted to the holes left in the top of the spars. The other ends are folded around the tensioners and riveted (use AN4's). Each series of bottom straps (two pieces in each position) has one tensioner bar that is threaded and another that has just



Tensioners are installed on one end of each of the two bottom straps. Note how they are wrapped around the tension bar. The top one that's bolted to the wing two rivets in it, but the bottom one has four AN4 rivets holding it together



Outdoor carpet makes good tank strap padding. Contact cement it in place.

bare holes. Socket head, fine-thread bolts are put through the unthreaded holes and threaded into the other ones. When the bolts are tightened they put

Here's a tank strap building jib used by one builder to ensure his straps were identical and to make it easier to bend them.

tension on the bottom straps and draw the tank up against the top straps.

To properly position the tank, you'll have to cleco the .050 hat-shaped stiffeners to the inside of the wing as reference. However, you won't rivet those in position until you're completely finished in the tank bay and are ready to rivet the top skin down. If you rivet the stiffeners in place before that, you won't be able to lift the skin up for working clearance. Read the next section on tank stiffeners so you at least are familiar with their installation.

It's important the tank be positioned in the bay so that it has barely 1/16" clearance from the formed channel that is riveted to the bottom of the top skin in the tank bay (more on that stiffener later). Padding will be glued to the wing stiffener so that it more than fills up the 1/16" gap making for a snug fit.

When positioning the tank fore and aft, think in terms of having access to the tensioning bolts. Position the tank off-center, fore and aft, moving it forward just enough to give plenty of wrench clearance when pulling up the tensioners behind the tank.

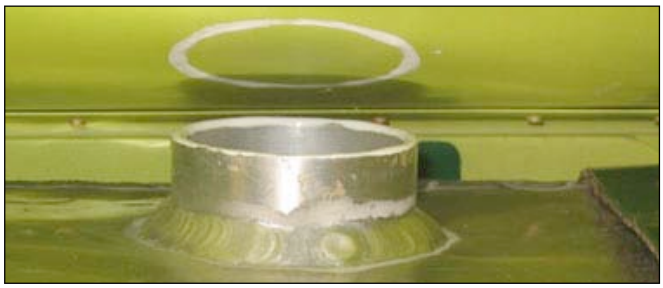
Cutting the Filler Neck Hole

Early in the installation process, you'll notice that you can't move the tank high enough in the bay because the tank filler neck hits the skin. Cutting the hole in the skin is one of those "make haste slowly" projects. Don't try to measure it because it's nearly impossible. It's better to do it on assembly.

Using a 1 3/4" hole saw cut a plug from a piece of fairly thick plywood. Then, sharpen a bolt and stick it through the hole in the center of the plywood disk. The fastest, most accurate way to sharpen the bolt is chuck it in your drill press and take a file or angle-head grinder to it while the drill is running. A cut-off large nail also works.

Firmly insert the plug in the tank neck with the bolt pointing up. Run tape around the edges, if necessary, to make it snug. MAKE SURE THE PLUG CAN'T FALL OR BE PUSHED INTO THE TANK. Put a couple of small finishing nails on the edge of the plug near the top to prevent that.

When you have the tank positioned where you want it, push up so the bolt point lightly marks/dents the skin. Now you have a center point for the tank neck opening.



An alternate to using the plug and bolt to mark a center point, you can put a transfer agent, lipstick works well, and press the tank against the skin.

Don't even think about using a hole saw to cut that hole because the aluminum is so thin it'll be distorted and torn up on the edges. A 2" Matco punch would do the job nicely, but only if you already have it. They are too expensive to buy just to punch two holes. It's easier and safer to simply use a compass to mark a circle around the center point Protect the surrounding area with 2" masking tape.

Cut most of the center out by drilling multiple, closely spaced 1/4" holes 1/8" or so away from the edge and slowly cut to the line with rasps and files. Finish it off with a large diameter drum sander in a drill motor or increasingly finer sand paper wrapped around a piece of broom handle.

Plumbing the Tanks

Installing the fuel lines is a subject for an entirely separate section. We don't want to be jumping back and forth from component installation to system installation. Go to Drawing #2, if you want to glance at the pumping, but don't spend much time there or you'll break the continuity of what we're doing here (installing fuel tanks).

Wings: Tank Bay Stiffeners

The position of the stiffeners is clearly indicated by the matching holes. Note how they lap over the spar flanges.

ONCE YOU HAVE INSTALLED THE TANK BAY STIFFENERS YOU CAN NO LONGER ROLL THE METAL IN THAT AREA UP OUT OF THE WAY. KEEP THIS IN MIND: DO NOT INSTALL THESE STIFFENERS UNTIL READY TO FINAL SKIN THE WINGS. We are mentioning it here only because we're working in the tank bay.

Once you have the wings finished, AND ARE RIVETING THE TOP SKIN DOWN, the tank bay stiffeners can be installed permanently.

The hat-section stiffeners in the top of the fuel tank bay not only prevent oil canning but are an important part of the structure. They aren't difficult to install, but it's best if we install them via "back riveting" a method that reverses the usual riveting system and greatly reduces the chance of distortion.

Stiffener position

First, look closely at the pictures of the stiffener in place. Notice that the ends overlap the spar flanges. DO NOT cut them short so they fit flush with the edge of the spars. You'll probably have to drill out two rivets at each end of the stiffener that are holding the wing skin to the top of the spar. Use a #40 drill and try to drill just into the head of the rivet, not all the way through. You only need a small hole in the top of the rivet to wiggle the drill and pop the head loose. This will prevent enlarging the holes.

View from the top, top skin held up. Stiffener on right is in the position it will occupy, when riveted to the skin. Left one shows the padding attached

Shimming Under the top skin.

Some of you perfectionists (remember, perfection is the enemy of completion) are going to worry about the fact that there is a .032 step or gap under the stiffener, where it climbs from the skin up onto the spar flange. The truth is you can just ignore that as you'll have to look really closely to see any discontinuity on the outside and you're more likely to introduce problems by shimming than solve any.

Back Riveting: the Concept

When driving a rivet in the normal manner, with the bucking bar on the shop end of the rivet (inside the wing) and the rivet gun on the head, there's always the problem of keeping the skin tight against the structure that it's being riveted to. Normally, the expanding rivet will pull the two pieces tight together, but not always. Plus, in the case of the tank bay stiffeners, they are more or less floating components and difficult to keep in contact. Back riveting uses the rivet gun on the inside of the wing and the bucking bar (although we're using a special tool, not a bar) on the outside.

What makes this concept work so well is a

The back shooting set includes a spring-loaded housing the goes down over the rivet's un-bucked tail and holds the inside metal tight to the skin. A good source is Avert Tools in Dallas.

special rivet set that has a spring loaded outside collar that bears against the inside structure, pushing it against the riveting back-up plate before the set comes down and beats the tail of the rivet into the right shape. This guarantees smooth contact between the inner structure and the skin and great-

The flat plate on the left is held against the skin or laid on the bench. The rounded set at the right is a "flush bucking bar" in that it is held against the outside of the skin and the rivet set with the spring loaded nose is used on the shop end of the rivet.

The rivets are taped into position so the wing can be held in any position without them falling out.

ly reduces distortion of the skin and oil canning.

Another benefit of back riveting is that it removes the possibility of leaving marks on the skin from a rivet set being at an angle.

The Procedure

First, you'll have to position the wing on your workbench so the complete tank bay is hanging off the end. Then you have a choice: have the open side of the bay up, so the rivet gun is pointed vertically down, or have the bay pointing down, so you're driving the rivets from the bottom. Both have their advantages and short comings.

If using the rivet gun from the top, the rivets will want to fall out of the holes so many builders tape them in place with Scotch tape.

Here the back riveting bar is held against the head of the rivet.

If using the rivet gun from the bottom, the rivets stay in place but using the rivet gun is a little awkward because you're working from the bottom.

Normally, when riveting, you'll have the pieces clamped together by clecos and you remove every other cleco and shoot every other hole so the metal stays pulled together. In back riveting, the rivet set itself pushes the two pieces of metal together so you can get by with clecos a little fur-

The spring loaded set on the rivet gun is used on the inside of the wing against the shop end of the rivet. The spring loaded housing holds the stiffener in contact with the wing skin.

ther apart. Still, you don't start at one end and rivet straight to the other end. Have a cleco about every third rivet. Shoot one of those in between and go down the stiffener that way, which puts every third rivet in. Then go back and get those you skipped. Then pull the clecos and shoot those rivets.

This may sound like overkill, but by spreading the rivet pressure around, distortion is again reduced. Riveting a whole line forces a lot of metal to expand locally and can lead to some noticeable metal movement.

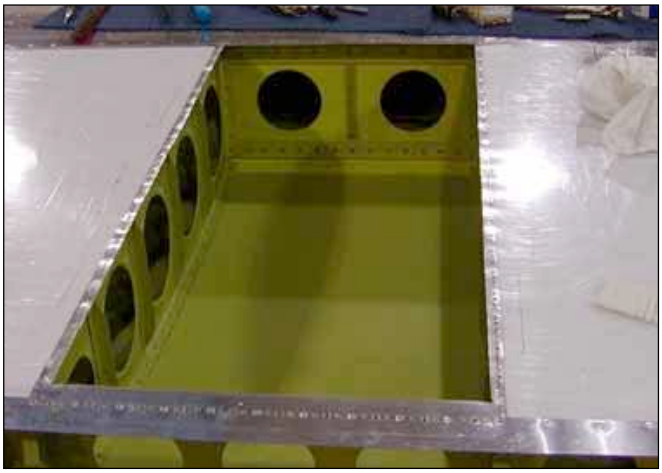
Wings: Aux Tank Installation

Installing the 11 gallon aux tank involves first cutting a hole in the wing, installing the mounting straps, plumbing the tank and then fabricating the cover (not supplied with kit).

Installing the aux tanks is exactly the same as installing the mains with two exceptions:

1. There are no tank bay skin stiffeners to worry about.

2. The tank opening in the bottom of the wing has not been left open, so you'll have to cut that out and fabricate a cover. You'll also have to drill out some spar cap rivets for the bolts.



When the tank bay is cut open, the metal should be smooth and flush with the rib/spar flanges.

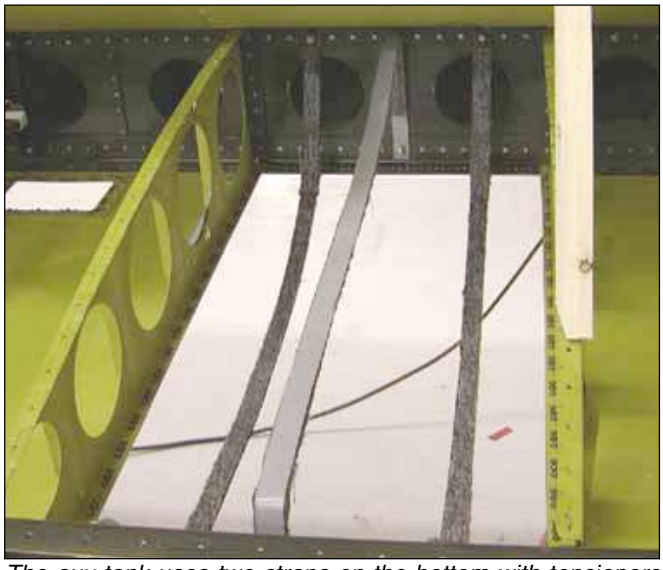
Cutting the Bay Open

First, make certain you start working in the right bay: it is the THIRD BAY IN FROM THE TIP. Also, there is a right and left tank: the tanks go in so the connections are inboard and the filler caps are outboard.

You're going to cut the skin out of that bay and trim it flush with the rib and spar flanges and leave about 1/8" edge at the rear so you aren't working too close to the rear spar face (protect it with layers of masking tape anyway). Once you've done that, you're going to make a .025" aluminum cover that overlaps the hole 3/4" on all four sides, drill holes so they fall midway between the existing skin rivets (to give room for nut plates, etc.), dimple the cover, countersink the flanges, install nut plates and you're done. Making and installing the straps to hang the tanks follows the exact same procedures we outlined while installing the main tanks.

To cut the bay open, start by drilling a 1/4" hole in each corner of the bay from inside the wing. Ideally, when we're done, we want to have a radius in each corner to reduce the stress concentrations, so drill those first holes far enough from the corners that you can file a radius into the corners by hand. We'll want to enlarge those holes to 3/8"" to get a file in them.

Yes, in theory, you could drill these guide holes right in the corners tangential to the flanges. That, however, requires a steady hand and a mistake can cause headaches. Keep the bit out away



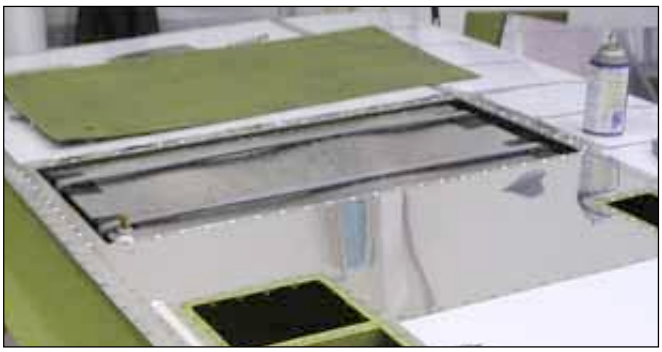
The aux tank uses two straps on the bottom with tensioners and one over the top. Make sure the top one doesn't touch the skin.

from the flanges just a little and file into the corners with a chain saw sharpening file. 5/16" and 3/8" round files are available from Bishop Company, www.bishco.com and are handy for a lot of other uses.

File the corners back so they barely touch the flanges. Then, turn the wings over and draw a guide line from the edge of one hole to the edge of the other. That indicates the edges of the flanges and is the absolute do-not-cross line.

Mark another line 3/32"-1/8" in from that first line. This is your cut line. Don't get the lines confused.

Do not try to cut the metal out with snips as it will distort enough that you'll work your tail off cleaning it up. If you have a steady hand, a die grinder with a cut-off wheel will work, but any mistake will be a big one, so it may not be worth the risk.



The finished installation with the cardboard cover pattern.

A garden variety jig saw will work fine but you have to do two things to prevent problems:

• Use a 24 or 32 tooth blade to reduce edge roughness. 32 tooth is preferred.

• Protect the skin with a double layer of 2" masking tape (duct tape will work too) on both sides of the cut so the saw can't touch the surface.

You're going to have to work hard to move very, very slowly while making these cuts. The jig saw will go through aluminum like butter so you won't have to do any pushing. Just guiding. Make sure you cut on the inside of the bay side of your line, away from the flange. If you leave the line, you're unlikely to cut into the flanges.

Finishing the Edges

You're going to have 1/16"-1/8" left to trim back and it will work quite quickly with a vixen file, which is available at body shop supply houses. However, a normal "smooth file" wood working rasp will work too, but it will leave a rougher edge that must be cleaned up with sand paper. Since you'll be working a lot of aluminum, it might be worth it to get a hold of a body file. They are identifiable by their half-moon cutting teeth that run all the way across the file like a cheese slicer.

When working aluminum anywhere in the airplane, your goals should always be the same regardless of what you're working on.

• No scratches of any kind anywhere in the material. This will require you to be careful in how you handle the pieces and where you lay them.

• The edges will be sanded down to at least a 320 grit finish.

• Both sides of every edge will be "broken" meaning they will be slightly rounded or chamfered so no sharp edges or burrs remain. Sharp edges give fatigue a place to start cracks.

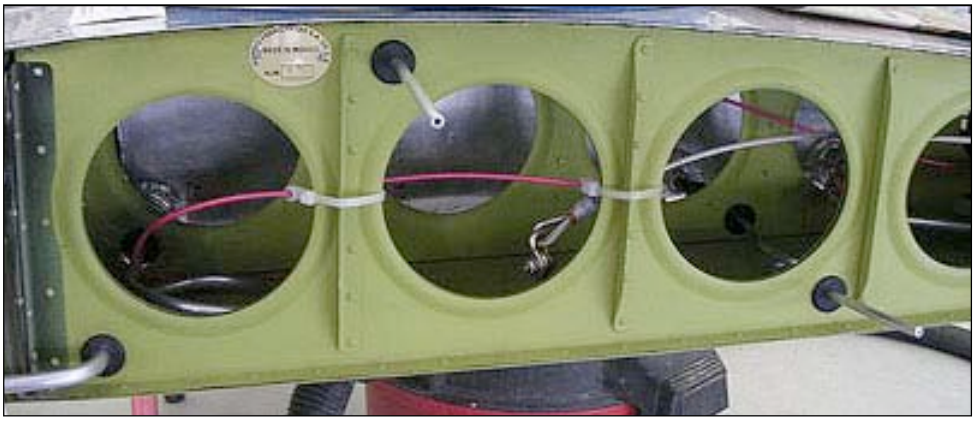
So, when finishing the edges of the hole you just cut in your wing, keep all the above in mind. If you can drag a nylon stocking down the edge and not have it hang up anywhere, you know you've done a good job.

The edges of the hole will be defined by the flanges around it. We'll get into the methodology involved in making and fitting covers as well as installing the bazillion nut plates (about 450 total) the wings use in a later section. Once you get the basics down, you'll find fitting covers to be an enjoyable exercise. We promise!

In the meantime, you still have to complete the straps, cut the filler cap holes, install the tanks, etc., just as you did the mains.

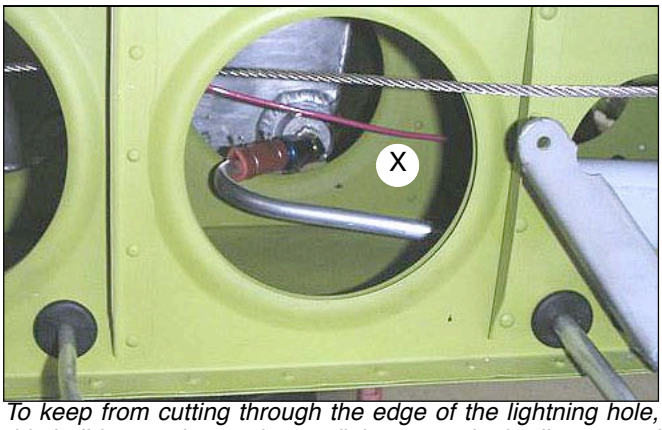
The plumbing aspect of the aux tanks will also be treated in a separate section.

Wings: Plumbing the Main Tanks



The two smaller tubes in he middle, top and bottom, are for the sight gauge. The larger one, 3/8", lower left and another (3/8") out of frame right connect to the main feed lines in the fuse - lage.

The plumbing for the main tanks is actually pretty simple and most of it is inside the fuselage, so we've already talked about it.



To keep from cutting through the edge of the lightning hole, this builder used a 45 degree fitting to angle the line up and over and then bent to come back through the rib in a "fat" area. The sight gauge lines come straight through with no bends. It would have been better to angle the fitting back and bring the line through the fat place in that rib (see "X")

Briefly you have four bosses welded on the inside end of the gas tanks. The two low ones in the front and the back (3/8" reduced to 1/4 NPT with finger strainers) are for feeding fuel to the engine. The two smaller ones (1/8 NPT) are for the lines that go to the top and bottom of your sight gauges.

The two feeder lines connect to the fuel lines you've already installed at the front and rear door frames.

On each of the connections, you'll install a finger strainer (Wicks FS-375) and a 45 degree, 1/4 NPT nipple (MS20823-6D). All of the fuel lines are 3/8" 5052 aluminum fitted with an AN818-6D nut and MX20819-6D sleeve coupling to connect to the fuel tank fittings. 3003 aluminum fuel line is also used and is softer and more bendable but harder to keep straight.

DO NOT USE TEFLON TAPE ANYWHERE IN THE FUEL SYSTEM, AS PIECES MAY GET IN THE FUEL LINES. Use liquid fitting sealer (Wicks #PST Locktite)

Clearance Holes

The fuel lines will have to pass through several ribs before they get to the root of the wing and the appropriate clearance holes must go into "fat" places in the rib: not close to either a flange or a lightening hole. See the pictures for proper placement. These holes are best drilled with a Unibit.

This builder came straight out of his tank, which required a notch in the stiffening bead. This is a no-no unless you go to the additional effort of fabricating a doubler for the area (.025), as he did.

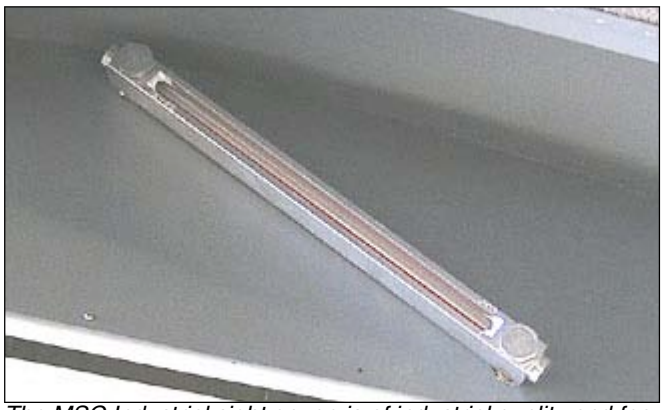
He doubled up all of his holes, which isn't necessary, although the large doubler seen on the second rib IS required, if cutting the hole bead.

The placement of these holes in relation to

the welded bungs in the tank is the reason for the 45 degree fitting. Drill the holes first, then set up the plumbing to go through them and don't forget to use a grommet at each hole to project the fuel line.

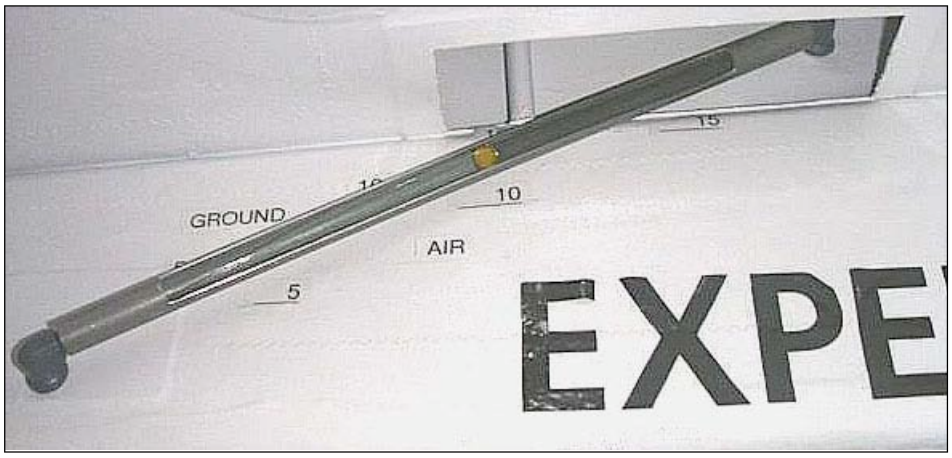
Sight Gauges

Although some builders have installed capacitance electric gauges in their main fuel tanks,



The MSC Industrial sight gauge is of industrial quality and features a cast aluminum housing. A downside is that these are GLASS and theoretically can be broken, which would empty that tank in the cockpit. A plastic cover may be called for.

this requires some welding (for flanges) because the tanks are set up for direct reading sight gauges. In essence, these are clear tubes on the inside of the cabin at wing level that are plumbed directly into the tanks and give an exact reading. There are several approaches possible. One uses a pre-fabbed gauge from MSC Industrial and the other is a hand fabricated unit.



The handmade sight gauge, courtesy of Peter Stevens of Salk Lake City, is about as simple and as direct reading as you'll get. The plastic ball is a must for clarity.

MSC Industrial Gauge

The MSC gauge has the disadvantage of being a little heavy because it is encased in a cast aluminum housing, but it has the advantage of being ready to install and plumb. The part number is G605-10-A-1 (it has 1/2-20 threads which need to be reduced down to 1/8) or G607-12-A-1, which has 1/8 NPT threads.

You'll run tubing from the smaller top and bottom bungs in the wing root. You use AN816-6D fittings and 1/4" tubing.

If you have aux tanks you'll plumb the 1/4" (or 3/8" for faster flow) feed line from the aux tank to a "T" fitting (AN824-4D) in the middle of the top feed line of the sight gauge. See the pictures.

Hand Made Sight Gauge

This sight gauge requires a little more work, but is much lighter and has the advantage of being able to insert plastic balls to show the exact fuel level. Without a float ball, it's difficult to read the gauges. However, inserting a piece of paper with a pattern on it behind the plastic magnifies the pattern and makes it easier to read the fuel level.

The handmade gauge is essentially a piece of plastic tubing inserted into an aluminum tube that has been partially cut away to give a view of the fuel. This was developed by builder Peter Stevens in Salt Lake City and we'll describe the fabrication using his words out of an e-mail.

"The materials for the sight gauges are as follows:

- *About three feet Superthane Ether clear plastic tubing, 5/16 ID 7/16 OD. You can get this at your local Hose Products Co. Probably about $3.*
- *About three feet Rigid Alum. Tube, 1/2" OD, .430 ID which equals .035 Wall. Aircraft Spruce has it as Part No 03-32500.*
- *Four elbow bulkhead -flare-to-hose fittings, Aircraft Spruce, AN 838 - 4D*
- *Two floating balls (orange). The only place in the world I could find them is at Univair at $4 a pair. Part # 10853-000.*

The Fabricating Process

DO NOT CUT THE PLASTIC HOSE UNTIL YOU REACH THAT POINT IN THIS INSTRUCTION. Leave it overly long until then.

Cut the Aluminum tubes to the length need - ed. This should be 11 3/4" to 11 7/8". Also, remember that you will need room on each end for the AN fitting.

Starting at least 1 1/2" from EACH end of the aluminum, remove about 170 degrees of mate - rial, lengthwise. This means you'll be cutting away slightly LESS than half of the tubing in the middle portion of the tube. This way, when you pull the tubing through you can push it into place so it will be captured by the remaining 190 degree semicir - cle. The reason you leave 1 1/2" of full tube on each end is that it will fully capture the plastic tub - ing at that point and serve as a CLAMP when you insert the fittings. You will see what I mean when you get to this point.

Clean up all of the aluminum tube edge with sand paper, so everything is nice and smooth and put a light coat of vaseline inside the tube.

Here is the trick for feeding the plastic tube into place: first, cut one end of the plastic tube in about three places lengthwise about an inch. This will allow you to compress it slightly so you can feed it in far enough to grab it with pliers. Pull it through the open side of the aluminum tube until you have enough to fill the aluminum tube plus a couple of inches. While the plastic tube is still out of it's bed, insert the split part into the slot and through the opposite end, grab it and pull it tight with pliers. This will leave part of the center por - tion looped up and out of the side of the aluminum tubing.

Now press the plastic into its aluminum bed the full length of the cut out. Once this is done, cut the plastic off at each end precisely at the edge of the tube, which will remove the portion you slit to get it into the tube.

Next, use a little vaseline on the 90 degree barbed fitting and push it to the hilt on one end. You will now see why you do not need a clamp. It will clearly be force-fit into the plastic tube

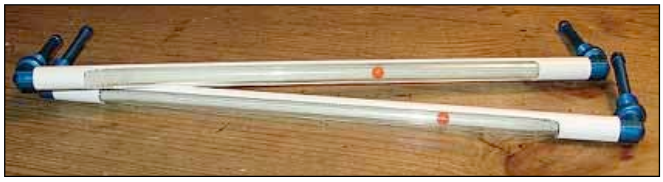
Next, AND DON'T FORGET THIS ONE, drop one of the ball floats into the tube, then repeat the step of inserting the second fitting. ***The ball is critical to the ease of reading and shouldn't be omitted****.*

Voila! You now have a great sight gauge."

Thanks, Peter.

Venting the Fuel Tanks

The fuel tanks vent fine through the fuel caps, plus, you can run a 1/4" vent line from aux tank to the main, if you want to double vent it. However, some builders add an extra vent. One version of them is nice as it has some ram effect.

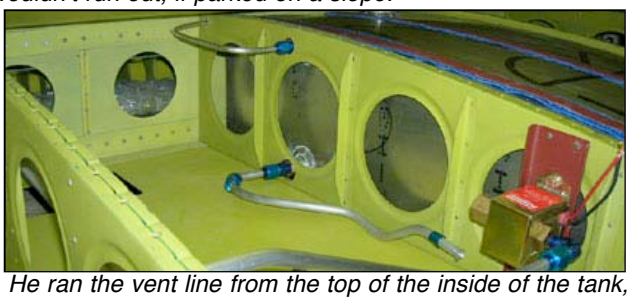


This is how the finished units look. White shows off the balls.

This cool little streamlined event is available from XXXX

Vent from the rear. It's about an inch long.

This builder vented his tanks on the "uphill" side so fuel wouldn't run out, if parked on a slope.



He ran the vent line from the top of the inside of the tank, around the front and out the bottom outboard.

Wings: Plumbing the Aux Tanks

The fuel from the aux tank is pumped into the mains through a Facet pump that is mounted on the face of the rear spar. Drill out some spar rivets and mount a .050 aluminum plate with the appro - priate size rivets or bolts. Position it in the middle of a lightening hole for access. The fittings used on the line are coupling MS20823-4D and nut AN816-4D, 818-4D, MX20819-4D

The aux tanks are plumbed so that fuel is transferred via a pump into the mains. The connection is run from the bottom boss at the inside end of the aux tank, through the pump (Facet 40171) and "T"s into the top of the sight gauge. The reason for running it into the top of the sight gauge is that even if you don't have a plastic ball in the sight gauge, when the pump is running and there is fuel in the aux, it fills the sight gauge. When the aux runs dry, bubbles show in the sight gauge. If you have the ball, it forces the ball to the bottom and the ball pops up the top, when the aux tank is empty.

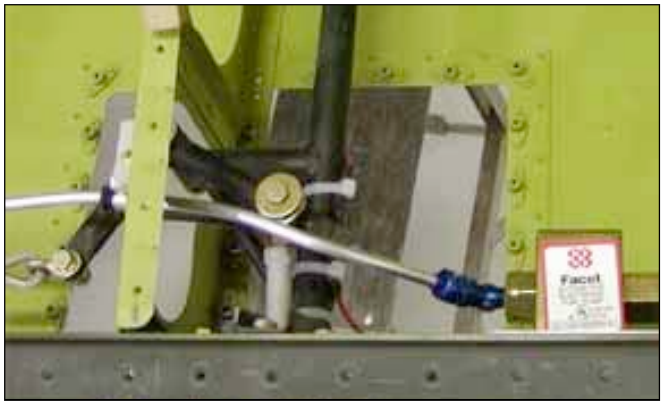
Plumbing Aux to Main

You'll run a 1/4" line off the bottom fitting on the end of the aux tank. To do this, it'll have to come through a rib. Drill the hole with a stepped Unibit (gives super round, super clean holes) to about 7/16 so it'll accept a rubber grommet or plastic snap ring around the fuel line. Some builders put a reinforcing doubler around the hole using .032 and a number of AN3 rivets. To avoid using a ninety-degree fitting to make the turn aft (there's no room for it), bring the line out in a large curve and back to an Adel clamp (see photo).

The feed line comes out of tue aux tank and into the pump via the bottom line in the aux tank. Doublers are added to the ribs where the material is removed. There is no room for a 90 degree fitting at that point so the tubing is "looped."

Mount the Facet pump on a piece of .050 aluminum that you bolt to the rear spar just inboard of the aileron bellcrank. You'll have access to it through the large access panel later. Drill out four of the spar attach rivets (use a No. 21 bit) and use AN3 bolts.

To get the out-going line over the aileron actuation rod, you'll have to use a 45 degree fitting, which gives plenty of arch to clear everything or bend the line into a gentle "S" turn. You don't have to worry about supporting the tubing at that point. It will have more than enough strength to support itself.



Notice how the aux tank line that runs from the pump to the sight gauge has to go up and over the aileron linkage.

The line will run down the back of the tank bay false spar and you'll support it with a rubber-insulated Adel clamp about every ten inches. Where it hits the rib that forms the end of the tank bay, we're going to want to make a ninety degree turn forward, so we'll install a ninety degree bulkhead fitting that will allow a tight turn (and hold the line in place), so the line can be Adel clamped to the second rib in from the root.

Inboard bay, looking forward, right wing. An AN ninety-degree bulkhead fitting is used to make the corner and an AN"T" fitting put in the top sight gauge line.

Take a look at the photos and you'll see where the line "T"'s into the line that goes from the tank to the top of the sight gauge.

When routing fuel lines (or any line for that matter) it is important to note that everywhere a line goes through aluminum, it is either connected via a bulkhead fitting or, if the line itself goes through the metal, there is a grommet/snap ring pressed into the hole. Fuel line should not be allowed to contact other metal and will be held in position with Adel clamps. It also shouldn't run long stretches in mid-air with no support. When in doubt, snuggle it up against some structure and throw an Adel clamp around it. If you can easily flex it with your fingers, it needs support.

Aux Tank Quick Drain

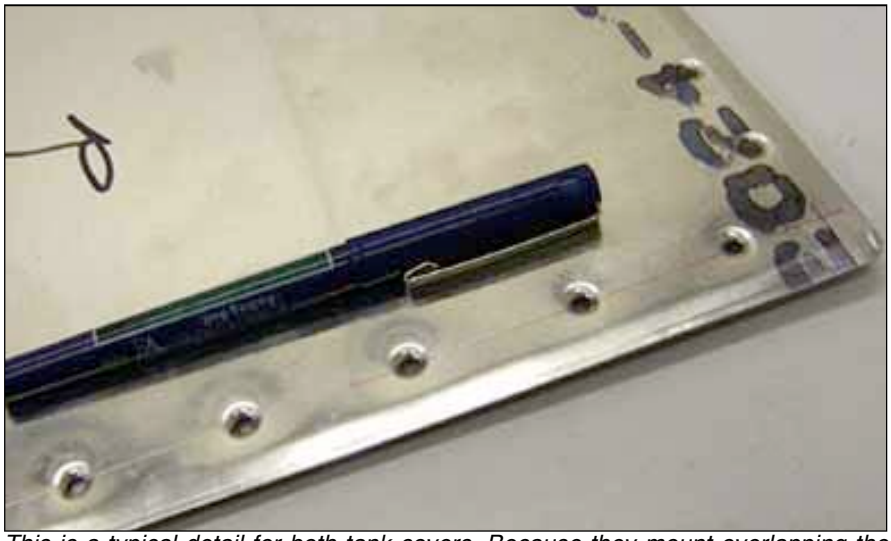
There's a boss on the bottom of the aux tank on the inboard, rear corner. That's to install a quick drain. Thread it for a 1/8" NPT thread quick drain (Wicks CAV 110).

You'll need to cut a hole in the bottom of the wing large enough for the quick drain. This is yet another place where using a Unibit (the stepped type drill bits) will give much cleaner, perfectly round holes with clean edges and zero distortion.

Locate the hole for the quick-drain by cutting the head off a rivet and standing it up in the drain with a dab of something on

A flush mount (Wicks CAV 110) quick drain is recommended for all the tanks..

Wings: Making Tank Covers and Installing Nut Plates



This is a typical detail for both tank covers. Because they mount overlapping the wing skin, rather than flush, You'll put a slight break in the outer edge. Otherwise, the edges will curl up, when the screws are tightened. After dimpling, you'll deepen the dimples using a flush set in the squeezer and a flush machine screw.

The aluminum (.025) for the main tank covers is provided, but you'll have to buy your own, if you're installing the wing tanks. The procedures are exactly the same for both covers.

General Concepts

The procedure to be used in installing the tank covers includes the following steps and we're going to start with the wing bottom up, tank bay hanging off the end of the bench:

1. Establish a rivet pattern that is centered on the flanges and spaced according to the plans. Be sure to avoid existing rivets including allowing space for the nut plates.
2. Drill #40 holes in flanges
3. Position cover on wing and back drill main screw holes.
4. Drill cover holes to #30
5. Lightly bend each edge of cover.
6. Dimple holes in cover.
7. Adjust dimples in cover
8 Install nut plates
9. Countersink wing skin/flanges.

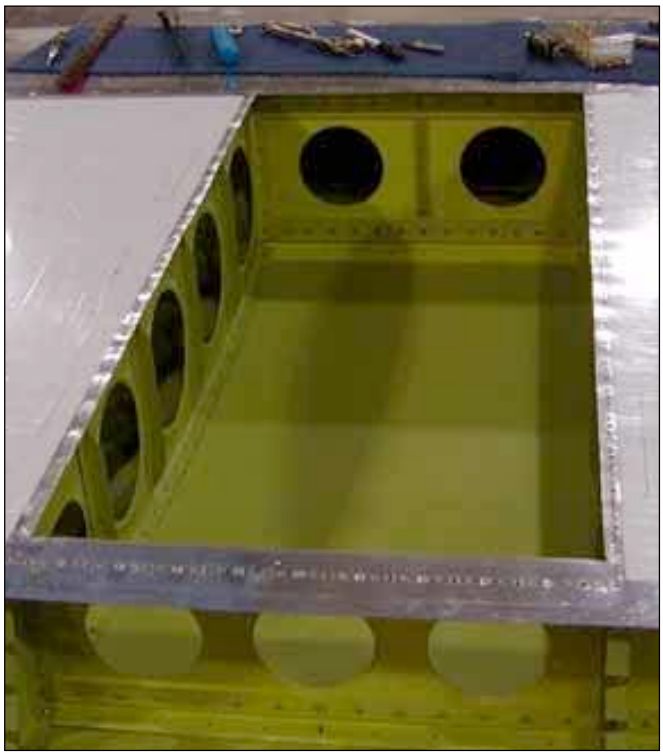
Establish hole Pattern

We want to layout the pattern for the bolt holes on the flanges and drill them first, so there is no possibility of causing interference problems with existing rivets, which might happen when drilling blind through the covers.

Measure the flanges and determine what dimension from the edge establishes the centerline of the flange. Then, draw a line that distance from the edge on the outside of the skin with a Sharpie. Your holes/bolts/countersinks will be on those lines.

The nut plates should be centered on the lines and spaced as per the plans. You'll be using regular nut plates (K-1000) everywhere except in the corners, where you may find it neater, although not necessary, to use ninety degree MS21073-06 units, or "one lug" nut plates to work around the corners. When laying out the centers for the bolt holes, remember that the nut plates extend a solid 3/8" on each side of that. Don't drill a hole where a rivet will interfere although you can sometimes angle a nut plate to avoid existing rivets..

To aid in laying out the pattern, get one of those inexpensive fan-type jigs that expand and



Aux tank bay: notice how the nut plates have to be spaced between existing skin rivets.

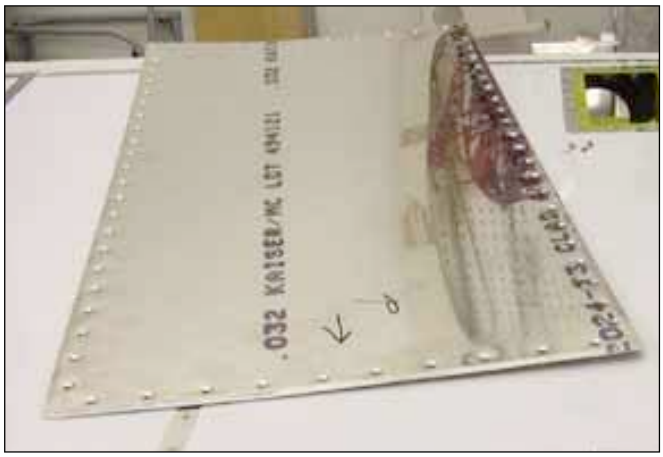
contract. Every aircraft supply house has them. It's far less tedious than trying to do it with a tape measure and much more exact.

Drill Guide Holes

Drill the centers for the nutplates as indicated by your marks on the flanges. You can do this from the outside/bottom of the wing. Use a #40 bit at this stage and we'll match-drill them and the cover at the same time to a larger size.

Position Cover on Wing and Drill

Our goal is to have the holes in the covers



The aux tank bay cover, which is identical to the main tank cover except for dimensions. No aluminum is supplied in the kit for the aux tank cover.

wind up equidistant from all the edges with the panel centered over the bay.

There will be a little trial and error here, but you can give yourself a headstart by measuring the exact size of the opening, subtract that from the width of the cover. Divide the results in half and that should be the distance from the edge of the bay to where the tank cover edge lies to have the cover centered over the hole. You'll have to do this in both directions: left/right, fore/aft. Lightly mark the wing, which is still bottom side up, and position the cover to those marks.

Once the cover is temporarily taped in place, reach underneath and put a Sharpie through a hole at each corner. Then take the cover off and turn it over and see if those marks are centered on the cover. If happy, put the cover back in place and securely tape it down.

To back-drill the covers through the flange holes, it'll be easier, although not necessary, if you turn the wing over, bottom side down, and for some of the holes you'll need a helper on the other side with a back-up block (you can reach most of them yourself). Use a block at least six inches wide, so they don't inadvertently miss the hole with the block and get a drill bit in the hand.

Using the existing holes in the flanges as guides, drill a hole in the middle of the line on all four sides and cleco them in place. Then, work out from the middle to the corners, drilling and clecoing as you go.

Once all the holes are drilled to #40. Remove the clecos and, as you do, drill the holes to #30.

Take the cover off and leave the holes in the cover #30, but drill the the bolt holes in the flange to 9/64 (the cover holes will open up while being dimpled). When all the holes are done, go back with a deburring tool and knock down the edges of of all the holes you can reach.

Dimple Holes in Cover

This is a fairly easy squeezer operation but it does require a little care to make sure the squeezer is square to the surface of the sheet so you don't distort the immediate area. This is another area where an extra set of hands is very helpful to steady everything and keep it square. If you want to eliminate all worry in this area, you can build a little table that clamps your squeezer vertically and the cover lays flat on it. This, however, is overkill, as a little care in using the squeezer will suffice.

Once you've gone completely around the cover, you have to do it again using a smooth set in the squeezer and a #6 countersunk screw in the hole. The rivet dimple isn't quite deep enough to seat a bolt/screw but re-squeezing with the screw finishes it up.

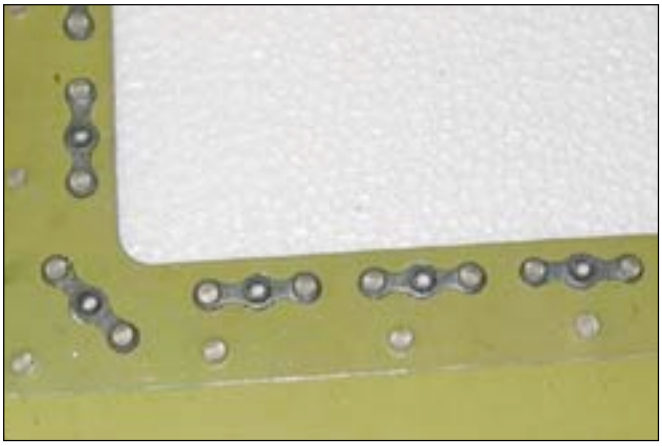
Install Nutplates

This one place where buying the right tool makes life about a thousand times easier: buy the nut plate installation drill jig. It'll save a ton of aggravation. The jig centers in the hole with guides for the two 3/32 holes on either side. Since you have hundreds of nut plates to do, it's a good investment and not expensive.

You'll work your way around the entire bay with the drill jig until every hole has two matching 3/32 holes. Then, you'll set the stop on your cage

The K1000 nutplates install easily. If the corner hole is moved in a little from this position, a regular nutplate can bridge it. Otherwise , use the MS21073-06 as shown. Note the nice radius in the corner of the cut-out. This prevents stress cracks.

This simple little thingamabob will make drilling for your nut - plates much easier. All supply houses have them.



In a lot of applications you can just run a K-1000 at an angle for the corner nutplate.

When countersinking for tank or general access covers, try to cut the minimum needed so you barely touch the nut plate.

countersink to countersink the 3/32" holes just enough that a flathead AN3 rivet will drop into place. Once you have the countersink cutter set to the right depth, doing these holes becomes a no-brainer operation. This, however, is a fairly precise operation so don't use a cheap cage countersink, as they tend to change adjustment under use.

Since the cover is dimpled, that means you have to make room in the flange for the dimple. You can do this several ways, but rather than using countersunk nut plates, which are expensive and don't solve the entire interference problem anyway, we'll machine countersink the flange.

This countersinking operation requires just a little precision in setting up the countersink, because there isn't quite enough metal in the flanges and skin to cut deep enough for the dimple. You have to cut just the slightest amount into the nut plate. And we mean just the slightest amount. We don't want to weaken the nut plate by over-depth cutting with the cage countersink. Again, however, a little care in setting up the countersink means you can safely make the cuts without even thinking about it. Practice on some scrap first.

On the other hand, don't even think about trying to freehand it with a regular countersink that doesn't have the adjustable cage.

Clean Up the Covers

Now that all of the tank bay covers are finished, let's go back and clean them up.

First make sure all the edges are sanded down to a 320 grit and the edges slightly rounded. Now go to the corners of the covers and slightly round the corners. It doesn't take much. Just enough to get rid of the unsightly square corners that will catch the rag every time you wash it and generally speak of uncaring craftsmanship.

Wings: Running Wiring

The use of plastic tubing as electrical conduit has the advantage of not having to worry about wires rubbing against anything and, if you keep a messenger line in the conduit, you can always add wires later. Hardware store plastic tubing is fine for this and Vans sells a nice aluminum tubing that works well too.

If you're building a super light, basic airplane (good for you!), you can skip this section because you probably don't have electrons running around out in the wings. For those of you who have nav lights or a fuel transfer pump for the aux tanks, read on.

General Discussion

Regardless of what you're wiring, you have to give some consideration as to where the wires are going to be routed, how best to protect them and how to guarantee the reliability of the connections.

Your best source of detailed information on wiring is the Tony Bingelis series of books. There are far too many details and caveats for us to go into here. However, we will throw out some rules of thumb:

1. Don't use cheap crimping or stripping tools. Good ones will make the job go smoother and more reliably with less chance of over, or under, crimping.

2. Use name brand components, even the little ones, like butt connectors and terminals. There's a lot of cheap stuff on the market and you don't want to nickel and dime an airplane project. There is NOTHING more aggravating than trying to trouble shoot a bad connection.

3. Always anchor a wire with an Adel clamp a few inches from where it connects to the unit. This cuts down on vibration fatigue at the terminals

4. For long runs like nav lights to wing root, run it through a piece of flexible conduit like the clear plastic tubing found at the hardware store and Adel clamp it to every other rib. To thread wire through the conduit, use compressed air to blow a string through the tubing as a messenger line. Then, when pulling bundles through, always include one extra thin wire as an in-place messenger line, just in case you want to run another wire through later.

5. When mounting components (pumps, power packs, etc.) it's always better to overbuild the mount than underbuild.

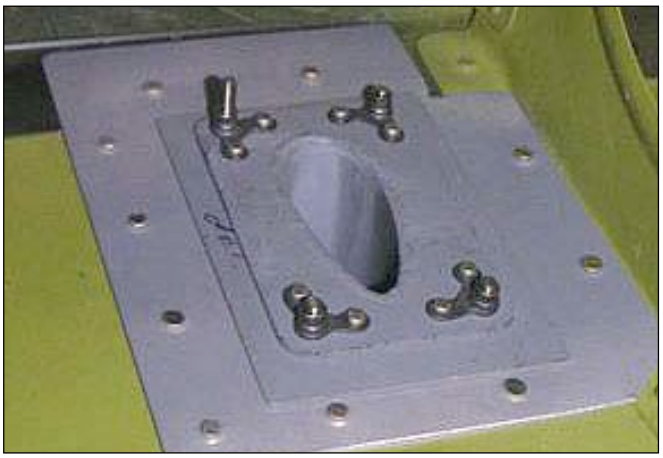
The conduit brings the wiring out to the strobe power pack, which is securely mounted. Before closing this up, another Adel clamp will hold the wires to the rib to keep them from flexing.

Wings: Install Pitot System

One of the more common pitot systems, the AN5812, comes in a heated version and depends on ports on both sides of the fuselage for static pressure .

There are a wide variety of pitot tubes and systems available, but they all do the same thing: they measure the difference between the dynamic pressure generated when the oncoming air rams directly into a tube and the static outside pressure. The difference is read out on the airspeed indicator in mph or knots.

The exact type of pitot tube you use is unimportant as long as it is accurate and easy to install. However, it should be noted that most pitot systems take their dynamic pressure from a tube out on the wing, while the static pressure can come from a variety of sources. The most common static source involves plumbing into a small port on each side of the aft part of the fuselage. This requires the port be in an area that is neither high or low pressure, so it's location is critical to the accuracy of the pitot system. Plus there's a fair amount of plumbing in the fuselage.



Details of the structural doubler that must be added to mount the AN5812, as shown above.

If a heated pitot is necessary because you think you'll be flying hard IFR, you have no choice but to go with one of the pitot masts that requires a secondary static pressure source, e.g. ports on the side of the fuselage, plus it will have wiring running to it.

If you are going to be doing nothing but VFR flying, then a far simpler system is represented by the single mast type that consists of one tube nested inside another. The inside tube reads the dynamic pressure (ram air), while the outside tube has holes drilled around the edges and those act as static ports (see the photo). This kind of system requires a hole in the leading edge for the mast, a mount on the face of the spar and lines running to the airspeed and altimeter. These lines can be nothing more than plastic tubing.

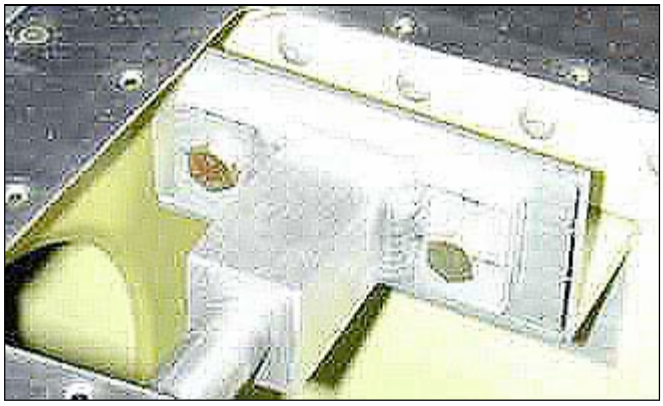
The single-mast type of pitot tube is actually one tube inside another. The inner tube receives the dynamic pressure while the space between the two tubes is vented to the outside via holes around the mast and provides static pressure. This is the view from the bottom. Bear Tracks shows how to build a single tube aluminum pitot that is similar in appearance but uses separate static ports.

Mounting the Single Mast Pitot Tube

Mount the base of the pitot tube on the face of the spar. The best location for this is in the large

access panel just outboard of the strut attach points. This area gives access to both sides of the spar. Use AN3 bolts.

First, we're going to drill a hole in the leading edge that's positioned correctly to avoid any interferences for the mounting bolts on the spar. Then we're going to position the pitot system to match the hole and be ninety degrees to the spar face.



This builder located the pitot tube too low in the wing so to avoid interference problems with the lower spar cap fabricated this "Z" shaped mounting bracket. If the unit is mounted just a little higher in the wing, it can bolt directly to the spar face.

Inspect the spar face through the big access panel in front of the strut end and select a spot on the spar face as a likely spot for the pitot mount that has no interferences. Then draw a line from that, up over the leading edge. Make sure the line is ninety degrees to the edge of the access panel, which will make it ninety degrees to the leading edge and spar face.

Eyeball what you think is the middle of the leading edge. Then do a similar precise measurement of about where you think that will hit the spar. This is to keep from drilling a hole that puts the base of the pitot tube in an awkward place or requires mounting holes in something critical like a spar cap. The hole in the leading edge should hit the spar at least an inch above the top of the bottom spar cap. By eyeballing this location first, we're just trying to prevent calamities, not locate anything permanently.

Mark the point on the leading edge where you want the pitot tube coming out and drill a #30 hole. Then, just to make sure we know what's going to happen, when installing the pitot tube, we're going to make up a little locating jig to check things out while it's still possible to shift the hole around.

Drill a 1/8" hole in a 2" piece of 1 x 2" wood. Drill the hole with a drill press so it is square to the surface of the wood. Then stick a piece of 1/8" welding rod or clothes hangar through the hole in the leading edge and into the block of wood. Move the wood around until the rod isn't binding and the block is flat to the spar face: that's where the mount for the pitot tube will wind up. No further action required: we're just making sure everything is clear.

If you're satisfied with the hole location, enlarge the hole to 5/8" (if using the Steen pitot tube) with our trusty old Unibit.

Thread the pitot mast through the hole (you may have to sand the hole just a bit for clearance) and screw it into the pitot base. Now slide the base around until it is resting firmly on the spar face with no tipping or angles indicated and mark the mounting holes with a Sharpy.

To drill the 3/16" holes in the spar, you may need an angle drill attachment. Find an RV builder and borrow his, although this is yet another excuse to buy another neat tool, which is one of the by-products of building airplanes: plenty of excuses to buy tools. **By the way: don't forget to deburr the holes you just drilled in the spar.**

Install the appropriate fittings that allow you to push 1/4" plastic tubing over them. Route the tubing clear of everything, install an Adel clamp every few ribs and you're good to go.

Wings: Installing Inspection Panels and Nut Plates

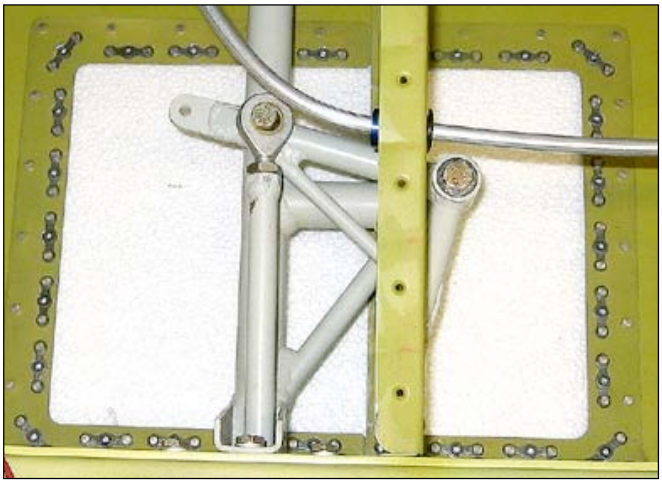
The outside marker line shows the underlying frame outline and the inner one estab lishes the line for the attaching rivets.

With a couple of fairly minor exceptions, installing the smaller inspection panels involves exactly the same procedures as outlined in making the tank covers. The biggest difference is that the inspection port covers are flush mounted, so a mounting frame has to be installed first.

All of the parts involved in installing these, e.g. the inner frames and the doors themselves are supplied in the kit completely finished and ready to use. Your only actions will be:

- Install inside mounting frame
- Drill mounting holes
- Dimple covers
- Install nutplates

Before doing anything, lightly chamfer the edges of all the components, including the inside edges of the inspection holes in the wings. we want no sharp edges.



The frames are supplied trimmed and ready to use, but the builder must drill and dimple them before installing. The kits come with this particular frame already installed.

Installing Mounting Frames

When installing the frames, we're going to position them inside the wings and clamp them in place with a number of side-clamp clecos or "C" clamps (Get the side-clamp clecos—very useful tools). Then we'll drill a few holes to establish their position, remove them and cleco them to the outside skin and drill the rest of the holes. This eliminates the possibility of the frame flexing inside of the wing and is easier.

Positioning the Frames

This is more or less an eyeball exercise in which you mount the frame inside the hole with an equal amount showing all the way around. Although the distance isn't critical, using a dial caliper as a spacer makes it easy to even them up exactly. Once you've done one, the caliper is set for the rest.

Run a pencil or marker around the edge of the hole marking the frame so the position is hard to mistake AND make arrows on the part so you know which is the front and back. Remove it and measure the distance from the line to the outer edge of the frame. This establishes the outer-most limit for the rivets that attach the frame to the wing skin. It also shows you how far the frame extends under the skin. We'll call that Dimension X.

Draw a line around the opening on the wing skin that is Dimension X from the edge. That establishes how far under the skin the frame goes. Now split the difference between that line and the edge of the opening and that is the position of your rivet line.

Side cleco the frame inside the hole, positioned by the lines you earlier drew on the frame. Drill a #40 hole in each corner of the cut-out where your rivet lines intersection. . These index the frame in position. You could drill the holes through the skin and the frame right now, but you have to be

sure the frame is well supported. It's actually easier to drill the holes with the frame clecoed to the outside of the wing so you have something to push against.

Remove the frame and draw lines between the four holes. Now cleco the frame to the outside of the wing and drill #40 holes spaced down the rivet line as per the plans. Remove and deburr all the holes before dimpling the wing skin and the frame. Rivet the frames in place using MS20426AD3-3 rivets and a squeezer.

Prepping the Inspection Doors

This is a duplicate of what we went through when making the tank covers: dimple, then deepen the dimples with a flush set and a #6 flat-head screw in the hole.

Mounting the Nut Plates

The only difference between what you'll do here and what we did when mounting the nut plates for the tank cover is that we are countersinking in thinner skin. When doing the tank covers, the combination of the ribs and the skin was about .050 thick. The frames are .032, so you have to be careful, when machine countersinking for the dimples. It's easy to cut too deeply into the nutplate. Using countersunk nut plates is another, more expensive, approach.

Wings: Riveting the Wing Skin Down

This one picture answers almost all the questions, including how much easier it is, if you find a local RV builder to help you. The skin is rolled back until the last three or four rows of holes, then you reach in through the lightening holes.

The shortest, least painful and most efficient way to close out the wing skins is to befriend a local RV builder (or two) and have him help you with the riveting chores. With one of those to help, you can close both wings on a long Saturday.

Whether you have one of the Van's Armada to help or not, you'll still need an extra set of hands to handle the bucking and riveting chores. Put the most skilled of the two inside the wing with the bucking bar, as that's where a lot of dings come from.

This is also true when you install the tank bay stiffeners.

Riveting: the concept

Tony Bingelis has explained riveting nicely in one of his books (we're sure you have all four, right?) so we're not going to touch on more than just the basics here. We will, however touch on riveting, as it applies to the BH.

Riveting Equipment

There are no driven rivets in a quick build Bearhawk that can't be driven with a 3x gun and a 2X will handle most of them. You'll need #3 (3/32) and #4 (1/8") universal sets and a flush set. Make the flush set a swivel head unit with rubber bumper around it. That practically eliminates the possibility of marking the skin.

Working With the Wing Skins

The most common question asked about putting the wing skins down is "How to you reach inside to do it?" The answer is, you don't reach inside. You roll the skin back, toward the leading edge, and one of you stands on one side with the rivet gun and the other stands on the open side with the bucking bar. You work each row of rivets spanwise, rolling the skins down, as you go.

Working this way, you can reach all but the last three or four rivet rows at the trailing edge in front of the rear spar. Then you recruit someone with smallish hands to reach through the lightening holes in the rear spar with a small bucking bar. Since most of the rivets are AN3's, the bucking bar can be quite small. For access, you'll have to drill out the temporary aluminum pop rivets that hold the aileron cove covers in place during shipping. When finished, you pop rivet those back in place. They are non-structural so aluminum pop rivets will work nicely.

Riveting Technique
NEED, NEED, NEED

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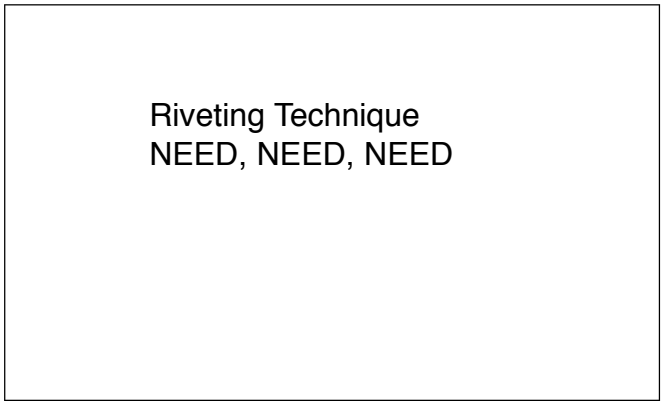
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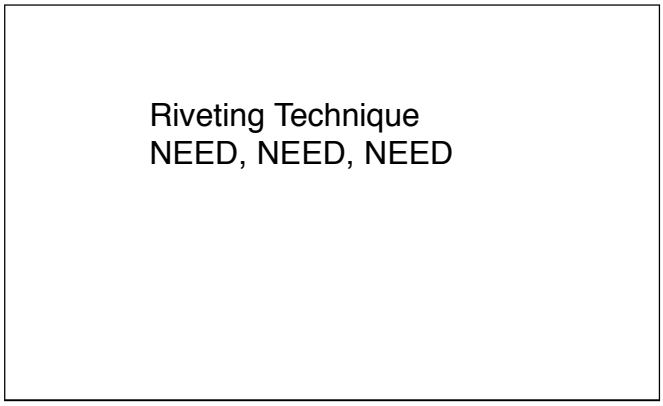
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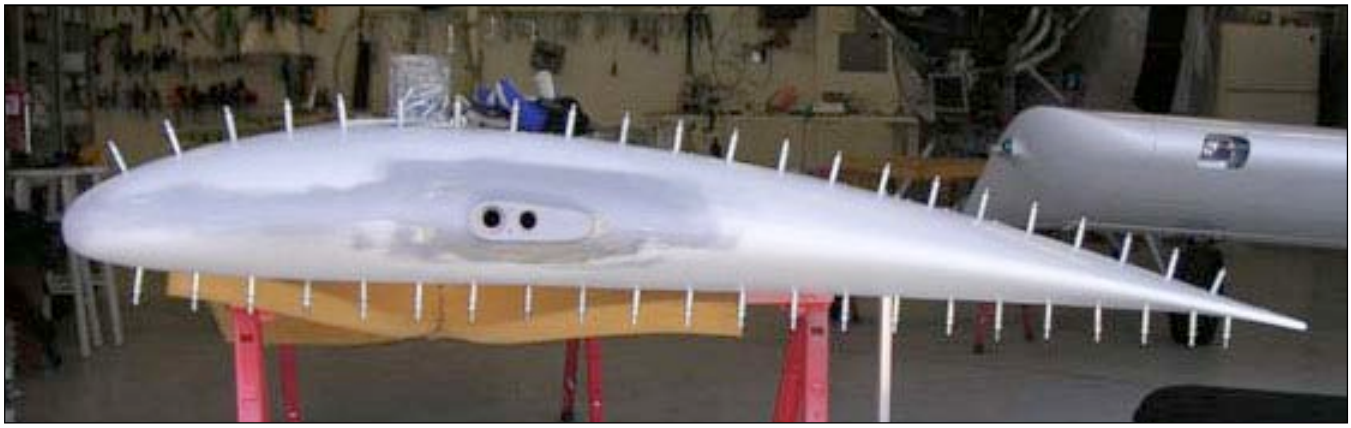
Wings: Installing Wing Tips



The fiberglass wing tips can be mounted either flush or over lapping the wing skin, which is a much easier, more common way of doing it. This builder has incorporated his own custom made strobe/nav light mount.

Working with molded, open sided fiberglass parts, like wing tips and nosebowls, is a little frustrating: they are never exactly the same because they move a little while they cure. This is especially when they are as light as airplane parts. So, you may have to do a little creative messing around to get the tips to fit the way you want. Or they may be perfect and will slip right into place.

First, there are several different ways the tips can be mounted. The majority of owners lap the fiberglass over the outboard rib attaching them with screws and Tinnerman nuts or nut plates and machine screws. A few pop-rivet them in place permanently (they must not have wing tip lights) and a few others go to the effort of mounting them flush.

Lap-Mounting

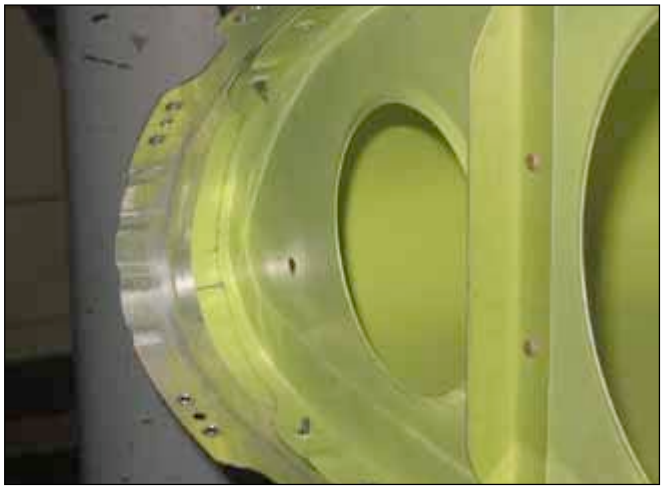
Lapping the tips over the outboard rib is by far the easiest. The best, although most laborious, approach to this is to install nut plates. Then use machine screws. If you decide to use countersunk screws, ideally, you should have countersunk washers under them to protect the fiberglass, but those can be really ugly because some are big, look for the small ones. If you don't use them, you run the risk of the screws working their way through the fiberglass. That, however is unlikely.

One way to beef up the hole area in an invisible manner is to counter sink a couple sizes too large. Then fill the holes with a mush made of epoxy and aluminum powder. Back it up with Scotch tape. When it sets up, sand smooth, redrill and counter sink and you have a hole with a reinforcement ring cast in. This is, however, overkill for most folks.

Flush Mounting

Flush mounting is for the perfectionists amongst us. The best flush mounting method we've seen so far involved drilling out the skin rivets in

This builder flush mounted his tips by inserting a strip of .025 aluminum between the skin and the tip rib.



Careful fluting of the flange at the nose let it make the radius without distorting.

Strobes/nav lights need a solid base to attach to. This builder epoxies and fiberglassed a plywood mount in place and faired it in with foam and microballoons. Don't use Bondo, as it is really heavy.

the tip rib and inserting a piece of .025 aluminum that sticks a half inch or so under the wing tip to mount nutplates on. The tip dimension wasn't designed for this, so a little slicing and compressing of the fiberglass tip itself may be called for.

Nav Lights

The tips in the kit have no provisions for either navigation lights or landing lights. Builders who want navigation lights have to hand form a platform on the tip to mount the light/strobe unit. This usually entails making a 1/4" plywood base the shape of the light to be used. It is bonded and screwed in place, then faired in with the lightest material available, which is usually balsa covered with a layer of microbaloons or automotive glazing putty . Try not to use automotive body filler like Bondo because it is really heavy.

Landing Lights

If you don't want to put the lights in the nosebowl, the wing tips are a good place for them, although several builders have cut their leading edges for them. Install between ribs #11 and#12 usinga one piece, .032 doubler that looks similar to the frames used for mounting the inspection panels. It should be 1 1/2" wide, all the way around the light cutout and attached with MS20426AD3-3 rivets on approximately 1" centers.

Putting the lights in the tips involves hand forming a lens, or, better yet, modifying an RV-10 lens. See the photos.

Landing lights in in the tips can be accomplished using an RV-10 lens and a light kit from Creative Air, www.creativair.com.

To mount it in the wing, a .032 doubler must be riveted around the cut out. The lights used here are auto high beams.

Cowl-mounted landing lights also work. The one on the right is retractable.

Wings: Aligning the Trailing Edges

As shipped, the trailing edges of the flaps and ailerons are only temporarily pop riveted in place and can be moved to cre - ate perfect visual alignment. The tip, however, may require a little fiberglass work.

Although trailing edges that don't line up fore and aft don't effect the flying characteristics one bit, but they don't look good. Especially when it's so easy to get everything straight.

Flaps and Ailerons

Hopefully, when you were setting up your flaps and ailerons, you made an effort to get the trailing edges more or less lined up with the root rib, because that is fixed in place and everything else has to true up to that (although we do have a fair amount of adjustment available to us). The wing tip is a different story.

The early wing tips are just a little short, so it's common to see that the aileron can't be made to line up with it. This nothing to be worried about.

For one thing, the trailing edge aluminum on the control surfaces is not riveted in position permanently at the factory. It is just pop riveted in place for shipping purposes. Drill out those soft, aluminum pop rivets and you can move the trailing edges in and out to get them lined up. When you have them where you want them, rivet them permanently using Avdel or other aircraft quality blind rivets. However, they still won't line up with the tip. There is, thankfully, an easy fix.

Lining up the Wing Tip

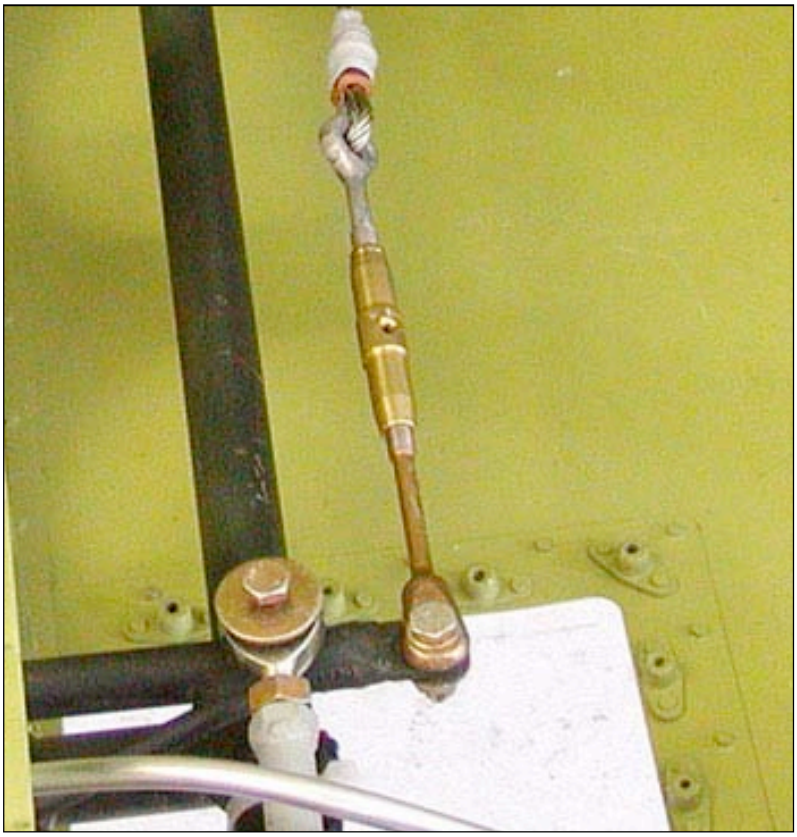
After you have the T.E.'s of the surfaces perfectly lined up with each other and the root rib, build up the back of the wing tip with just a little epoxy and fiberglass. It won't need much, but this is a sure fire way of making certain no one makes fun of your T.E. alignment, or lack thereof.

Now this is straight!

Wings are Finished: Now what?

For one thing, if you want, you can hang them on the airplane and finish the fuel and control cable runs, which, assuming you started with the fuselage, is another way of saying, you're getting really close to having a complete airframe. Now we're getting down to the fine details.

Wings: Install cable runs



There are three turnbuckles in the aileron cable system that are the secret to adjusting and maintaining tension. Two, like this one, at the aileron bell - cranks and another one side of the middle of the cabin roof.

By the time you get to this point, you've already gotten a good handle on how the control system works and what needs to be done now.

You've already installed most of the cable runs in the wings and only have to complete the connections with the controls in the fuselage.

Aileron Connections

There are actually only three aileron connections to be made to the fuselage from the wings.

• The connection with the control stick at the bottom of the lift struts on both sides.

• The connection in the top of the fuselage that ties the two wings together.

Control Stick Connections

When connecting the aileron cables to the stick assembly, first don't forget to use the four little 1/4" x 3/16 bushing provided in the kit, as shown in the plans. Then fix the stick in a vertical position so it can't move AND fix the ailerons in a neutral position with aileron chocks. With the turnbuckle that you installed in the aileron cable at the bellcrank adjusted to a middle position, pull the cable you've already run though the strut on each side to the bottom of the control stick rod and install a thimble. To get an accurate measurement, pull it as taut as you can by hand around the thimble, clamp it and make Sharpy marks on the cable that you can later line up as you Nicopress the thimble in place.

Do the same on the other side. The ideal situation would then be to remove the cables and measure them and make them both the same length before nicopressing the thimble in place. That will make control rigging easier later on.

Connection in the Cabin Roof

Adjust a turnbuckle (AN140-22S) to its mid-range and temporarily wrap the cables around the bolts at each end while positioning it in the the rear cabin roof so there is no interference. Pull them as taut as you can by hand. Measure them one against the other and average the length, making them the same length.

Wings: Root Fairings

Use grocery store poster paper to make patterns for the wing root fairings. Once you have the shape worked out, make the fairings out of .025 aluminum and fasten them to the wing root with Tinnerman nuts and PK screws. Where the windshield hits the wing, there will be some funky intersect angles, so don't plan on putting screws all the way around he leading edge, as there will be gaps under the fairing.

unsightly joint at the back, you can make them out of four pieces with the fourth piece being a folded trailing edge piece that goes about a foot up the back of the joint, top and bottom.

The fairings will be joined to the wings with #6 PK screws and Tinnerman nuts. The edge that bears against the airplane will have rubber "J" molding glued on the edges to protect the fabric.

The wing root fairings are nothing more than flat strips shaped to follow and lap the wing root rib and slightly over lap the cabin structure on the top and not-quite-touch the fuselage on the bottom. The fairings are attached to the wing but not the fuselage.

Fairing Shape

The easiest way to work out the shape of the fairings is with posterboard available in the school supply section of your local grocery store. The fairings will be in three pieces: one in the front and one top and bottom. The front piece will run back almost to the spar and the top and bottom pieces will run off the trailing edge where they can be screwed together. Or, if you want to eliminate the

The upper end of the strut can be nothing more than flat wrap aluminum but neither of the fairings, top or bottom, are fas - tened to the strut in any way. The shape and strut-attach bolts locate them. These fairings are just one of many places in the Bearhawk where giving some thought to streamlining will net out free speed. Small details like those exposed bolt heads create drag and can add up. .

The lower strut fairings aren't screwed to anything. Their shape holds them in place. The gear fairing is screwed to the gear leg only

Looking up at the bottom of the aileron hinge cut-out on the aileron. Tail of airplane is at top of the picture. A flat fairing is made with an inspection hole for the bolts.