SECTION 6 THE EMPENNAGE

ASSEMBLING THE SKELETON OF THE HORIZONTAL STABILIZER

See DWG 3. Begin by clecoing the two HS-902 Front Spars and the HS-907 Front Spar Doubler Plate together. Match drill, enlarging the pre-punched 1/8" holes to #30.

Fabricate the HS-908-L and HS-908-R Attach Angles from AA6-187x2x2½ aluminum angle and fit them to the front spar sub-assembly. Drill the alignment hole. The angle should have only 9 #30 holes in it. Do *not* drill (even with a small pilot drill) the 3/16" holes. The phrase "drill in assembly," means that *all* the parts that the hole penetrates should be aligned before the hole is drilled. Several builders a year call in to the help line, "I pilot drilled the widget first — even though it said "drill in assembly" — and now I won't have edge distance on the second part when I install the first." There may be no practical repair.

Cleco the HS-908-L/R attachment angles to the front spar by matching the pre-punched hole in the spar with the alignment hole drilled in the angle. Clamp a piece of angle to the lower flanges of the attach angles to hold them in proper alignment and match drill them to the spar, using the holes drilled during fabrication of the angles as drill guides.

Cleco the two HS-903 Rear Spars together with HS-906 Rear Spar Doubler Plate and match drill, enlarging the pre-punched 1/8" holes to #30.

Cleco the eight HS-912 Outboard Hinge Brackets to the rear spar sub-assembly and match drill, enlarging the pre-punched 1/8" holes to #30.

Mark the individual parts of the front and rear spar sub-assemblies as "right" and "left" so that the parts may be reassembled correctly.

Prepare the HS-904 Main Ribs and HS-905 Nose Ribs by filing away any burrs around the lightening holes and notches in the rib flanges. Smooth the edges on a Scotchbrite wheel. (Sec. 5B)

See Section 5N Fluting, before proceeding.

Check that all HS-904 Main Ribs and HS-905 Nose Ribs webs are straight and that all but two HS-904 and two HS-905 ribs (these ribs will be used at the inboard ends of the stabilizer halves) have all their flanges adjusted to be 90 degrees from the web. A straight edge laid over the pre-punched holes makes a good reference when fluting.

The aft flanges of the two inboard nose ribs and the two inboard main ribs should be 11 degrees open and the forward flanges of the two inboard main ribs should be 11 degrees closed. These flanges are easily bent by hand for an exact fit when the stabilizer skeleton is assembled. Flute the ribs between the pre-punched holes and adjust the flanges as required.

Fabricate two HS-909 shims from AS3-040 material. Match drill these shims to the aft side of the front spar at the most inboard main rib locations. The HS-909 shims are installed later between the front flanges of the most inboard HS-904 Main ribs and the front spar.

Cleco all the HS-904 and HS-905 ribs to the front and rear spars and enlarge the pre-punched 1/8" holes to #30.

Disassemble all parts and deburr all #30 holes, all the rib and spar edges, and the edges of all the lightening holes. If the powder coated hinge brackets will be painted later scuff them with a scotchbrite pad until the gloss is removed.

Set-up the jig cradle blocks by fastening them to the bench. They should be spaced so they support one skin. The inboard block falls between the two inboard HS-904 ribs and the outboard block falls between the hinge brackets and the outboard HS-904 rib. Check with a carpenter's level and use shims if necessary to make them level and plumb.

Mark the HS-901 skins as "right" and "left". (The skins are identical, so you are simply designating which skin will be used on which side.) Insert one of the HS-901 skins into the jig cradle. Use tape to hold the trailing edge closed.

Cleco the HS-905 nose ribs into the HS-901 skin. The forward web of the inboard nose ribs must be fluted slightly to make the nose end slightly narrower. (Sec. 5N)

Cleco the appropriate half of the front spar sub-assembly ("right" end of spar goes with "right" skin and vice versa) to the nose rib flanges and to the skin. Do not use the full spar sub-assembly at this point, only the HS-902 Spar and the HS-907 Doubler are required.

Cleco the HS-904 main ribs to the front spar and to the skin. Be sure to cleco the HS-909 shims between the front spars and the inboard HS-904 main ribs.

Cleco the appropriate half of the rear spar sub-assembly ("right" end of spar goes with "right" skin and vice versa) to the main rib flanges and to the skin.

Match drill the skin to the skeletal structure, enlarging the pre-punched 3/32 inch holes to #40.

Disassemble the stabilizer half (label the parts for position as you disassemble) and deburr all holes.

Dimple all the #40 holes in the rib flanges *except* the holes in the HS-904 main ribs that are in the small tabs that fit under the HS-902 spar flanges.

Machine countersink the #40 holes in the spar flanges. See Section 5E about how to set the depth of the countersink.

Machine countersink the required holes on the forward side of HS-906, the aft side of HS-903, and the forward side of HS-907. Study DWG 3 carefully and countersink only the appropriate holes.

Dimple all #40 holes in the skin.

Repeat the process for the opposite stabilizer half beginning with clecoing the HS-905 nose ribs into the HS-901 skin.

Prime all parts as required/desired. A light coat of primer is recommended for all non-powder-coated parts, however primer is required only on non-alclad, non-powder coated parts. The HS-908 angles are the only non-alclad, non-powder-coated parts in the RV-9A horizontal stabilizer.

ASSEMBLING THE HORIZONTAL STABILIZER

Rivet HS-902 spars, HS-907 front spar doubler, and HS-908-L and HS-908-R angles together to form the front stabilizer spar. Leave holes for the ribs open as appropriate.

Rivet HS-903 spars, HS-906 rear spar doubler, and HS-912 hinge brackets together, forming the rear stabilizer spar. Leave holes for the ribs open as appropriate.

Select a skin and place it in the cradle blocks. Cleco in the correct (inboard, mid, outboard, right or left) HS-905 nose ribs and rivet them to the skin.

Note: All riveting on ribs should begin at the leading edge and progress to the trailing edge.

Fit the intermediate HS-904 ribs (the main ribs that have no associated HS-905 nose rib; in other words, not the inboard, center, or outboard main ribs) to the front spar sub-assembly and rivet.

Install the front spar/main rib sub-assembly in the skin and cleco. Support the free end of the spar/rib sub-assembly with blocks to hold the spar straight.

Install the inboard and mid HS-904 main ribs and rivet them to the HS-902 front spar and HS-905 nose ribs. Be sure to install the HS-909 shim between the inboard HS-904 and the front spar. Use blind rivets on the mid nose rib-to-front spar-to-main rib joint.

Rivet the HS-902 front spar to the skin.

Rivet the HS-904 ribs to the skin. Leave the outboard HS-904 rib until last so that accessibility to the other ribs is improved.

Repeat all the assembly steps on the opposite stabilizer half.

Cleco the rear spar sub-assembly to the stabilizer and rivet it to the ribs and skin.

Assemble the two HS-911 Inboard Hinge Brackets and the VA-146 bearing (the –6 rivet length is correct. See Section 5D). Bolt the inboard hinge bracket sub-assembly to the rear spar. Install the bolts with heads aft to allow clearance for elevator movement. You will find bolt torque specifications in Section 5 of the Builder's Manual or your Standard Aircraft Handbook.

Congratulations! You've finished the first major sub-assembly on your new airplane.

BUILDING THE VERTICAL STABILIZER

The assembly of the vertical stab and following references can be found on DWG 6. Construction of the vertical stabilizer is very similar to the horizontal stabilizer.

DRILLING THE VERTICAL STABILIZER

Cleco the VS-808PP spar doubler to the VS-803PP rear spar. Then cleco on the hinge brackets VS-410PP, VS-411PP and VS-412PP (See Exploded Isometric View).

The VS-410PP hinge brackets have two holes missing from the pattern. Use the holes in the spar channel and

spar doubler as drill guides and back-drill the entire six-hole pattern through the upper VS-410PP only. The corner holes in the lower VS-410PP will be drilled for bolts later, in assembly with the fuselage (See DWG 27/27A).

Prepare the ribs VS-704, VS-705, VS-706 and VS-707 (See “Edge Finishing”, “Fluting and Straightening Ribs and Bulkheads”, Section 5B & 5N).

Cleco the ribs to the front and rear spars.

Final drill #30 VS-808PP, VS-410PP, VS-411PP and VS 412PP to VS-803PP.

Drill all rib to spar attach holes to #30.

Cleco on the VS-801PP / VS-901 skin.

Drill/match drill to final size all the holes attaching the VS-801PP / VS-901 skin.

Mark the location and orientation of VS-803PP, VS-411PP and VS-412PP. Disassemble, de-burr, dimple, machine countersink and prime parts as desired (See “Countersinking”, “Dimpling”, “Hole Deburring” and “Priming”, Section 5A, 5B, & 5E).

Note as shown on DWG 27/27A the lower portion of the rear spar must lay flush against the F-712/812 bulkhead assembly. Therefore the rivets in this region must be flush on the forward side of the rear spar that mates to the F-712/812 bulkhead (See Rear View, SEC A-A and “Countersinking and Dimpling”, Section 5).

FINISHING THE VERTICAL STABILIZER

Cleco VS-803PP to VS-808PP, VS-410PP, VS-411PP and VS-412PP together. Then tape over the holes that will attach VS-704, VS-706 and VS-707.

Rivet the rear spar together remembering the flush rivets on the lower rear spar.

Rivet VS-704, VS-705, VS-706 and VS-707 ribs to the front spar.

Cleco on the VS-801PP / VS-901 skin.

Rivet on the skin. Begin at the intersection of VS-707 and VS-702 and work towards the tip, then restart at the same place and rivet along the front spar toward the root and along the VS-707 rib starting at the front and riveting toward the rear spar.

Cleco on the rear spar assembly and install the remaining rivets along the rear spar and end ribs with a squeezer. If you plan a strobe or other lighting installation on the vertical stabilizer, be sure to provide for the necessary wiring runs and access details before the rear spar assembly is riveted on.

Blind rivet the rear spar assembly to VS-707.

FITTING THE STIFFENERS TO THE RUDDER SKIN

Pre-punched holes in the R-915 rudder stiffeners match corresponding pre-punched holes in the R-901-L and R-901-R rudder skins.

Trim individual stiffeners from strips consisting of two stiffeners. See diagram on DWG 7. Shorten all the stiffeners (except the lowest) by trimming the excess from the forward end. Use the pre-punched hole pattern in the rudder skins to determine the correct amount of trim. See note on DWG 7.

Before you begin actually drilling stiffeners and skins, be sure that you are placing the stiffeners on the inside surfaces of the right and left rudder skins. Study the exploded isometric view on DWG 7.

Match drill the stiffeners to the rudder skins. Having a tabletop you don’t mind drilling into will make the job easier. You can drill through the part right into the table. A cleco run into the hole in the table will not hold the part up off the surface.

Disassemble and debur the holes. BE VERY CAREFUL deburring the thin R-901 rudder skins -- it doesn't take much pressure or over-enthusiasm (one turn is usually plenty) to ruin a hole in 0.016 aluminum. You do not want to be left with a knife-edged hole when you are done.

Because 0.016 is too thin to machine countersink, it must be dimple countersunk. Use a C-frame deep-throat dimpler/riveter as shown in Section 3. Remember that the pressure needed to dimple 0.016 is quite low.

Dimple the stiffeners and skin, and prime the parts if you choose. Now you are ready to rivet the skin and stiffeners together. BACK-RIVETING is the best technique here. See Section 5F. Be sure you fully set the aft

rivet in each stiffener…if you leave these standing too tall, they will interfere with the opposite skin when the rudder is assembled.

When back-riveting, the flush head rivets are taped in place with Van’s Special Riveting tape (See VAN'S ACCESSORIES CATALOG), Mylar, or Scotch 811 tape (masking or regular Scotch tape does not work well.) The flush heads are placed on a flat, smooth plate of steel or hard aluminum. A small flat, cupped, or special sliding-sleeve set is used to make the shop head. If you are careful to keep the bucking surface clean, this method almost ensures clean, well-set rivets.

BUILDING THE RUDDER SKELETON

Cleco R-904 Bottom Rib to the R-902 Spar. Enlarge the 0.125 hole in the center of the forward flange of R-904 to 3/8 using the hole in R-902 as a drill guide.

Fabricate R-917 Shim per DWG 7.

Use a 3/8 bolt to fasten the R-405PD rudder horn squarely on the rudder spar and final drill the four holes through the upper edge of the rudder horn to #30 using the pre-punched holes in the spar as a drill guide.

Cleco the rudder horn to the R-904 bottom rib to check the fit. If necessary radius the top of the rudder horn so it nests nicely in the radius of the rib flange. Drill 4 #30 holes in the aft edge of R-405PD located per the detail view on DWG 7.

Cleco the R-904 bottom rib and R-405PD rudder horn to the R-902 rudder spar. Slide the R-917 shim into place between the rudder spar and rudder horn and drill to #30. Use the pre-punched holes in the spar as a guide.

Cleco the R-606PP, R-607PP, and R-608PP reinforcement plates to the R-902 rudder spar. NOTE that the R-606PP lower reinforcement plate goes on the forward (flange side) of the spar web, while the R-607PP and R-608PP plates go on the rear.

Flute the R-903 tip rib and R-912 counterbalance rib. Use a ruler along the holes to make sure they are straight. Use a hand seamer to adjust the flanges square to the web.

Cleco the tip rib and the counterbalance rib to the top of the spar and drill to #30.

Cleco the R-913 counterbalance skin to the R-903 tip rib and R-912 counterbalance rib. Match drill #40 the counterbalance skin to the ribs using the pre-punched holes in the R-913 counterbalance skin as a drill guide.

Cleco the R-901R&L rudder skins to the ribs and spar. Fit the R-916 rudder trailing edge and cleco it in place. Drill all remaining holes in the rudder to final size.

Trim the excess material from R-710 rudder brace. Fit the R-710 between R-405PD and R-904. Cleco the aft edge of R-710 to the bottom of R-904 and drill #30. Match drill through the forward edge of R-710 using the holes in R-405PD as a drill guide.

Make the R-918 rudder bottom attachment strips shown on DWG 7 and clamp them in place. Drill them to the skeleton, using the existing holes as drill guides.

Disassemble the rudder and deburr all the holes. Dimple the skin, spar and ribs.

The aft three 3/32 holes in the upper edge of R-901-L and R-901-R should be drilled to #30 and dimpled. These holes will later be used to attach the R-909 rudder tip. While the holes could be opened up to #30 when drilling the tip to the rudder, it would be nearly impossible to dimple the skins because the rudder is so narrow at that location.

Drill the E-614-020 counterweight to the R-912 counterbalance rib. The forward tooling hole on the R-912 rib matches with the forward hole on the counterweight. Use the aft hole in the counterweight to match drill into R-912. Remove the counterweight and machine countersink the holes for a #10 countersunk screw. De burr the holes in the counterbalance rib and dimple for a #10 countersunk screw.

Although the rudder and elevator spars are 0.032 and could technically be machine countersunk, we strongly recommend that these parts be dimpled. Be careful that the dimple dies do not drag along the web of the spar and gouge it. It may be necessary to grind a flat side on the dies to obtain the necessary clearance.

The trailing edges of both the left and right R-901 skins are dimple countersunk and both sides of the R-916 rudder trailing edge are machine countersunk. These rivets will be double flush. The shop head actually turns out looking pretty nice when it is driven into a dimple. Prime all the components desired.

RIVETING THE RUDDER

Install the reinforcement plates and platenuts on the spar.

Rivet the R-904 rib and associated parts.

Rivet the R-912 counterbalance rib to the R-902 spar. Then rivet the R-913 counterbalance skin to the counterbalance rib, but not the spar. Install the E-614-020 counterweight (see exploded view on DWG 7).

Cleco both skins to the spar.

There are six rivets on each side that join the R-901 skins and the R-913 counterbalance skin and three that join the rib, counterbalance skin and spar. Set these, then rivet on the R-903 tip rib. Blind rivets are used for the first time here. They are simple to set with a hand pop-riveting tool, but they are difficult to drill out. Make sure that the heads of the rivets are firmly against the rib before setting.

Rivet the skin to the skeleton. A rivet squeezer will reach almost all the rivets, depending on the throat depth. In the narrow spaces at the end of the ribs a narrow bucking bar will be necessary. If one isn't available, these holes may be enlarged to 7/64" and MK-319-BS blind rivets may be substituted for the last one or two AN rivets. Both rivets have heads that fit the same dimple.

The trailing edge is the last in the sequence. Building a truly straight trailing edge is one of the more difficult things to do in the empennage kit. Take your time and work as precisely as possible. A wavy or bowed trailing edge doesn't look good, and in more extreme cases will affect the flying qualities of the airplane. Strive to build a trailing edge that does not vary more than 0.100" from a straight line.

One way to help keep the trailing edge straight is to bond the components together before setting the rivets. The bonding agent is fuel tank sealant, which is also used to bond the foam ribs in the trim tab.

Trailing edges are riveted with "double-flush" rivets. These are standard rivets, but instead of setting the shop head on a flat surface, it is set in a dimple and ends up flush with the skin surface. However, a double flush rivet will not look the same on both sides. The factory flush head will set almost perfectly flat. The finished shop head will be flush with the skin, but it will not fill the dimple completely...it's been described as "an acorn sitting in a dimple." Do not fall in the trap of trying to use a longer rivet and "fill the hole." The rivet will bend over instead of setting properly.

Begin by using one of the skins as a guide and drill the trailing edge pattern of holes into a rigid, straight piece of aluminum angle. Cleco the trailing edge together, with both skins and the AEX wedge clecoed to the angle and check the alignment. The angle should hold the trailing edge straight. Because the rudder tapers in thickness, the trailing edge cannot simply be clamped to the table. Lay the rudder with the trailing edge and clecoed angle off the edge of the table so it can remain straight.

Disassemble the trailing edge and clean the surface completely, using the directions for cleaning the fuel tank components in Section 7. Mix (follow the mixing directions on the can) and apply tank sealant thinly and evenly to both surfaces of the AEX wedge and cleco the trailing edge together, including the alignment angle. Any good two part epoxy such as T-88 can also be used here. Wipe away any sealant that squeezes out and make sure that the parts fit tightly. There should be no globs of sealant holding the skin and wedge apart, for instance.

Check the alignment once more, and set the assembly aside. Let the sealant cure for a couple of days. After curing, remove the angle and the clecoes.

Insert rivets into the trailing edge holes with the manufactured head on the top side. Tape all the rivets in place and flip the rudder over. Put blocks on either side of the back-riveting plate, so the rudder can stay flat as it slides over the plate. Weight the rudder down to the worksurface so it remains straight while riveting.

Back-rivet about every tenth rivet just enough to to lock everything in place…don't set the rivets all the way just yet.

Back-rivet the rest of the trailing edge rivets, but for now, set the rivets only about halfway. Set every fifth or sixth rivet and check constantly to see that the trailing edge is not bending one way or the other. If the rivets are set fully in only one direction it can leave a "hook" in the trailing edge. Start with the rivet set parallel to the rivet and tilt it to set the rivet flush to the skin as the rivet sets.

Flip the rudder over and set the trailing edge rivets to the final size with a mushroom set, again checking constantly.

A little finesse will produce a nice double flush joint, but you must constantly guard against bowing the trailing edge.

COMPLETING THE LEADING EDGE OF THE RUDDER

Before the rudder can be installed on the vertical stabilizer, its leading edge must be formed. The object here is a smoothly curved surface that fits neatly between the skin overhang of the stabilizer. Simply pulling the overhanging skins together results in an angle or crease where they cross the edge of the spar, so the curve is started by rolling the edge of the rudder skin. You will need a piece of 3/4 or 1" steel water pipe, a broomstick, or something of similar diameter, about four inches longer than the skin.

Tape the edge of the skin to the pipe along its entire length. Use vise grips or small pipe wrench clamped to the pipe as a handle and roll the skin around the pipe. Keep pressure down toward the worksurface and away from the spar to keep the skin from bending right at the spar. This will not produce the final shape, but it will produce a curve in the skin that allows the skin to be closed with a minimum of spring-back. Fig. 5-8 in Section 5

illustrates the process.

Finish the bend by hand, squeezing the skin until the holes match. Drill the holes full size, then clean up the holes (it is hard to get to the inside of the curved skin with a deburring tool, but in this case a quick rub along the holes with a scotchbrite pad is good enough) and rivet. See the Rudder Leading Edge Detail on DWG 7.

Except for the fiberglass tips (those come after all the empennage surfaces are built, so you may do them all at once) the rudder is finished.

BUILDING THE ELEVATORS

The elevators are built much like the rudder; stiffener-supported skins riveted to a skeleton and attached to the horizontal stabilizer with rod end bearings. Both the elevators and rudder are balanced surfaces, having lead weights forward of the hinge lines to counteract the weight of the structure behind it. This improves the control "feel" and helps prevent flutter. Besides the rudder taper and different leading edge configuration, the other major difference between rudder and elevators is the installation of a trim tab in the left elevator. This need not be an especially difficult task, but it does require careful attention to detail. Probably the majority of builder mistakes on the empennage are made on the left elevator and trim tab. Fair warning! Because of the complication of the trim tab, we'll leave it to last and start with the right elevator.

THE JIG

Because the elevators are constant chord and thickness, the only required jig is the flat table.

FITTING THE STIFFENERS TO THE ELEVATOR SKINS

Pre-punched holes in the stiffeners match corresponding pre-punched holes in the E-901-L and E-901-R Elevator skins.

Trim individual stiffeners from strips of multiple stiffeners. See diagram on DWG 5. Stiffeners that are installed on left elevator forward of trim tab must be shortened. See diagram on DWG 4. All stiffeners that are provided in multiple strips are "left-hand" stiffeners, there is only one "right-hand" elevator stiffener and it is installed in the left elevator, just outboard of the trim tab. This stiffener mates to one of the "left-hand" stiffeners to close the elevator structure just outboard of the trim tab. See DWG 4 for right-hand stiffener location and stiffener mating detail.

Match drill the stiffeners to the elevator skins. De-burr the holes.

The left elevator uses the E-615PP reinforcing bracket, supporting the trim cable or servo in place of the most inboard stiffener on the lower skin surface. Match drill E-615PP to the left elevator skin and deburr the holes. Dimple E-615PP for #6 screws now because it is nearly impossible to dimple after it is riveted to E-901-L.

Dimple skins and stiffeners. The aft three or four holes for the rivets that attach the E-912 tip should be dimpled now as well. Once the elevator is joined at the trailing edge, these holes will be nearly impossible to dimple the skins because the elevator is so narrow at that location.

BUILDING THE ELEVATOR COUNTERBALANCE ARMS

Assemble the elevator tip ribs and counterbalance skin before they are mounted on the elevator. Cleco the E-903 and E-904 ribs together using the pre-punched holes in the rib webs. Adjust the flanges and flute as required so the ribs match each other accurately.

Use the pre-punched holes in the E-913 counterbalance skin (and E-901 main skin) as a guide for checking the straightness of the tip ribs. Match drill the pre-punched 1/8 inch holes in the webs of E-903/E-904, enlarging them to #30.

Bevel the aft and aft inboard edges of the counterbalance skin to improve appearance where the E-901 skins overlap the counterbalance skins. Drill the pre-punched 3/32" holes in the flanges of E-903/E-904 and E-913, enlarging them to #40.

Disassemble the counterbalance sub-assembly, de-burr all holes, and dimple holes where required.

BUILDING THE RIGHT ELEVATOR SKELETON & FITTING IT TO THE SKIN

Fit and match drill the E-910 reinforcement plates to the E-902 spar.

Cleco then match drill (#40) E-906 end rib to the E-902 spar. Deburr the parts, then rivet the rib to the spar. It's OK to bend the rib flange slightly for rivet gun clearance. The spar and rib are riveted together with flush head rivets, so the Wd-605 control horn will fit over the intersection without interference.

Cleco the E-902 spar and end rib to the bottom surface of the E-901-R skin.

Clamp the Wd-605 control horn around the corner formed by the E-902 spar and the E-906 rib. Carefully align the tube of Wd-605 with the spanwise centerline of the E-902 spar. Once Wd-605 is fitted and clamped in place,

match drill to E-902 and E-906 using the pre-punched holes in Wd-605 as drill guides. If you are going to paint the Wd-605 later, scuff the powdercoated surfaces with a scotchbrite pad.

Match drill the pre-punched 3/32 inch holes in the elevator spar, root rib, and skin, enlarging them to #40. Although using blind rivets for the complete line of rivets along the bottom of the spar is permissible, it may be possible, depending the squeezer yokes available, to use solid rivets for many locations near the bearing cut-outs. Holes for CS4-4 blind rivets should be drilled to #30. Holes for solid rivets should be #40.

Cleco the elevator counterbalance sub-assembly to the E-902 spar and E-901 skin. Match drill the pre-punched 1/8 inch holes to #30 and match drill the pre-punched 3/32 inch holes to #40.

Take the assembly apart and do all the boring (but necessary) deburring, dimpling and priming.

Rivet two E-910 plates and two K1000-6 nutplates to the aft side of E-902.

Rivet the E-903 and E-904 rib webs together. Rivet the E-913 counterbalance skin to the ribs beginning with the two center rivets at the counterbalance leading edge and working aft. Be sure to leave the holes that mate with E-901 open.

Rivet the spar assembly, E-906 rib and Wd-605 together.

Back-rivet the skin stiffeners to the upper E-901-R skin.

Rivet the E-902 spar to the top of the skin, but do not rivet the E-906 rib yet.

Rivet the stiffeners to the bottom of the E-901 skin.

Rivet the E-903/904/913 assembly to the E-902 spar.

Place the elevator top side down on a flat table. Place weights on the elevator to hold it down against the surface and rivet the spar to the bottom of the skin. Cleco the lower skin to the elevator spar, root rib, and tip rib. Rivet the skin to the bottom of the spar, using blind rivets or a combination of solid and blind rivets. The exact combination depends on the tools in your shop.

Leave the elevator weighted onto the table and rivet the root and tip ribs to the skin, leaving the aft three holes (top and bottom) open. This will allow access for deburring and dimpling the trailing edge.

FINISHING THE RIGHT ELEVATOR TRAILING EDGE

The elevator trailing edge is created by riveting the upper and lower skin surfaces to an extruded aluminum spacer with a triangular cross-section, just like the rudder. However, unlike the rudder, the wedge is not pre-punched and must be match drilled to the elevator skin. The same technique of using an angle to hold the trailing edge straight will be used again, so the first step is to match drill the angle to the elevator skin.

Cut a piece of AEX wedge 11.9 aluminum trailing edge stock to the proper length

Draw a fastener line on the upper surface of the trailing edge wedge 7/32” to ¼” aft of the forward edge. Place the trailing edge in the elevator and position it so that the fastener line is centered in the pre-punched holes in the elevator skin upper surface. Drill #40 through the pre-punched holes in the elevator upper surface through the trailing edge spacer and out through the elevator lower surface. The axis of the hole should be perpendicular to the elevator chord plane, not perpendicular to the elevator upper surface. See DWG 5. Initially, drill every 10-12” and cleco into the angle. Make sure the wedge remains straight as each hole is drilled. Once the entire trailing edge is drilled and clecoed at this initial spacing, go back and drill the holes in between.

To finish the trailing edge, follow the same procedures used for the rudder.

FITTING THE ELEVATOR TO THE STABILIZER

Install the rod end bearings as shown on DWG 5 and install the completed elevator on the horizontal stabilizer with bolts through the HS-911 and HS-912 hinge brackets. The distance of the rod end bearing bolt hole from the spar is shown, but may be adjusted to assure that the elevator swings smoothly. Align the trailing edge on the extended chordline of the stabilizer “in trail.” The counterbalance arm should align evenly with the stabilizer.

Secure the elevator in this position and double check all dimensions. The elevator must be the correct position before the next hole is drilled.

Insert a drill bushing (any small metal tube may be used as a bushing. It should have a 1/4” outside diameter so that it fits snugly into VA-146 and an inside diameter about 3/32”-1/8”) into the center bearing. Find a drill that fits snugly inside the bushing.

Using the bushing to guide the bit, drill the hole in the Wd-605 elevator horn for the bolt that attaches the horn to the center bracket.

Take the elevator off the stabilizer and drill the pivot hole to final size.

BEGINNING THE LEFT ELEVATOR

The left elevator with the trim tab seems to be the most frequent source of builder error in the empennage. It IS slightly more difficult than the right elevator, but with the practice and experience you've gained on the rudder and right elevator, and with careful attention to the plans, you will get good results.

BUILDING THE LEFT ELEVATOR SKELETON & FITTING TO THE SKIN

Fit and match drill the E-910 reinforcement plates to the E-902 spar.

Cleco the E-902 spar to the E-901-L skin. Cleco the E-905 left elevator root rib to the E-901-L skin. Cleco the E-907 elevator trim spar to the E-901-L skin. Match drill the pre-punched holes in the spar, trim spar, and root rib flanges to the proper size. NOTE that the bottom skin attaches to the spar with CS4-4 rivets which require a #30 hole. The spar and rib will be riveted together with flush head rivets, so that the Wd-605 control horn will fit over the intersection without interference.

Cleco the elevator counterbalance sub-assembly to the E-902 spar and E-901 skin. Match drill the pre-punched 1/8 inch holes to #30 and match drill the pre-punched 3/32 inch holes to #40. Disassemble, de-burr holes, dimple, and set aside for priming. When preparing the parts for riveting, countersink the holes in the top of the E-907 elevator trim spar to receive the dimples in the skin. This will leave a smooth surface on the bottom of the spar flange where the hinge will attach.

Back-rivet the skin stiffeners to the top of E-901-L. Rivet the E-903 and E-904 rib webs together. Rivet the E-913 counterbalance skin to the ribs beginning at the counterbalance leading edge and working aft. Be sure to leave the holes that mate with E-901 open.

Rivet two E-910 plates and two K1000-6 nutplates to the aft side of E-902. Rivet E-905 to E-902 as shown on DWG 5.

Rivet the WD-605L to the rib and spar, just as you did with the right elevator.

Rivet the E-902 spar to the top of the E-901-L skin.

Back-rivet the stiffeners to the bottom side of the E-901-L skin. Rivet the K1100-06 nutplates to E-615PP and rivet the E-615PP to the skin.

Rivet the counterbalance assembly to the E-902 spar.

Rivet the E-921 gusset.

Cleco the bottom of the E-901 skin to the E-902 spar. Rivet the two rivets top and bottom that join the E-913 counterbalance skin to the E-901 skin.

Rivet the bottom of the E-901 skin to the E-902 spar.

Rivet the E-907 elevator trim spar to the bottom of the E-901 skin. Rivet the tip and root ribs to the skin, but leave the last three rivets on the tip rib open for now, so you can deburr the trailing edge later.

FINISHING THE LEFT ELEVATOR TRAILING EDGE

The elevator trailing edge is created by riveting the upper and lower skin surfaces to an extruded aluminum spacer with a triangular cross-section.

Cut a piece of aluminum trailing edge to the proper length. Draw a fastener line on the upper surface of the trailing edge spacer 7/32 to ¼ inch aft of the forward edge. Place the trailing edge in the elevator and position it so that the fastener line is centered in the pre-punched holes in the elevator skin upper surface. Drill #40 through the pre-punched holes in the upper surface through the trailing edge spacer and elevator upper surface. *The axis of the hole must be perpendicular to the elevator chord plane, not perpendicular to the elevator upper surface*. During the setting of the rivet, the manufactured head and shop head will conform to the angle of the skin.

While the elevator trailing edge is clecoed closed, match drill the overlapping stiffeners that close-out the elevator just outboard of the trim tab using the pre-punched holes in the E-908-R stiffener as a drill guide.

After drilling, remove the trailing edge spacer, deburr the drilled holes and dimple the skin. Dimple the holes in the E908-R stiffeners for CS-4-4 rivets. The trailing edge spacer is machine countersunk on both sides to fit the dimples in the skin. The trailing edge should be back-riveted with the manufactured head on the upper surface. When back riveting the trailing edge, start driving with the gun held parallel to the rivet and then tilt the gun perpendicular to the skin while driving.

All remaining holes should be riveted either with blind rivets or a special “bucking bar on a stick” arrangement can be used to install solid rivets.

Fit the elevator to the stabilizer and drill the pivot hole in Wd-605.

BUILDING THE TRIM TAB

Mask around the locations of the foam ribs on the skin.

Scuff the rib location with 150 grit aluminum oxide sandpaper.

Clean the scuffed area with acetone until all sanding residue is removed.

Remove the masking. If you are priming, mask over the scuffed and cleaned foam rib bonding areas before spraying. The adhesive requires a clean, scuffed, non-glossy surface, void of primer, for a good bond.

Use the pattern provided and cut out the foam ribs and clamping “V” blocks. A band saw works well on the foam. Use a sanding block to finish the edges exactly to the pattern lines after saw cutting.

Modify the E-917 and E-918 trim tab horns to the appropriate shape for your installation – manual or electric. Drill, dimple and rivet the trim tab horns to the bottom of the trim tab skin.

Complete the trim tab trailing edge bend, using the home-made brake shown in Section 5, Figures 5-5 & 5-7. Make sure that it is fully bent with no ballooning or puckering when clecoed to the trim tab spar.

Complete the bends on the end tabs to close the trim tab inboard and outboard ends. Drill #30 holes in the “underlapping” end tabs using the pre-punched holes in the overlapping end tabs as drill guides. See the photographs on page 6-11 on how to complete the end bends.

Cleco, drill, deburr, and dimple the skin and spar and hinge. On the top row of trim tab spar holes, dimple the skin, machine countersink the spar, and leave the holes in the hinge un-modified.

Rivet the trim tab spar lower flange to lower surface of the trim tab skin. Access is difficult here, so you must watch carefully to avoid damaging the upper surface with the back end of the bucking bar. If you wish you may substitute MK-319-BS blind rivets (available in Van’s Accessories Catalog) along the bottom of the spar.

Mix up some fuel tank sealant and spread a thin (not more than 1/32” thick), level layer around the entire foam rib and insert the ribs into the trim tab at the proper locations.

Cleco the trim tab skin to the trim tab spar and hinge.

Slip clamping V-blocks on to the trim tab directly over the rib locations to squeeze the skin tightly to the ribs.

Set the rivets in the trim tab spar and hinge. Set the blind rivets in the ends of the trim tab, making sure they don't interfere with the rivets in the inboard end of the elevator. The Wd-415 stopnut assembly shown in the Trim Tab Detail of DWG 4 comes in a later kit, along with the trim cable.

Leave the clamping V-blocks in place for about 7 days while the adhesive/sealant fully cures.

After the adhesive is fully cured attach the trim tab to the elevator. Position the tab in place so that the trailing edge matches the elevator and you have the proper gap between the tab and elevator. After clamping, drill through the elevator into the trim tab hinge and cleco as you go.

Remove the trim tab, pull the pin and rivet the hinge half to the tab spar on the elevator.

Bend the trim tab hinge pin as shown and fasten with safety wire. It is easier to bend the wire if it is heated to a dull red with a torch. (The hinge pin supplied is too short, longer hinge pin will be supplied with the fuselage kit.)

FINISHING THE ELEVATORS

Trim the E-614 elevator counterweights as required so that they will fit into the end of the elevator tip ribs as shown on DWG 5. Bolt the E-614 elevator counterweights to the elevators as shown in DWG 4 and 5. The weights are probably a little too heavy at this point. Final adjustments are made after the elevators are complete and painted. It is impossible to make the elevator balance exactly until it is finished, and then unbolting the weights is impractical. The best approach is probably to leave the weights a little heavy, then drill the inboard weight with a series of small holes until the elevator balances. A correctly balanced elevator will remain “in trail”.

Install the elevators on the horizontal stabilizer and make a preliminary check for alignment and travel. There should be no binding in the hinge line -- the elevator should swing easily through its entire travel.

Make a preliminary check for elevator travel. Up travel (trailing edge up) should be 25-30° and down travel (trailing edge down) should be 20-25°. This is best measured with a protractor or an electronic “smart level”. Set the instrument to zero as it rests on the elevator skin with the elevator in trail. Deflect the elevator as far as possible and check the reading.

The flange of HS-903 has a small relief in it to allow the elevator horns enough swing. This may be enlarged if/as required to allow for full control surface movement. It is acceptable for the elevators to swing more than the specified amounts without contacting the HS-903 because hard control stops will later be installed in the fuselage.

You must make a final check for correct elevator travel and install the control stops when the empennage is installed on the fuselage.

FITTING THE FIBERGLASS TIPS

There are several ways and times that fiberglass tips may be mounted. Some builders prefer to wait until the airplane is complete before installing any of the fiberglass, then do it all at once. Others like to complete each assembly as they go. It's your choice.

Remember to consider things such as lighting installations, access to lights and bolts, etc. If you choose to install the empennage tips at this point, here are some generic instructions.

The molded fiberglass parts provided with the kit are designed with a aluminum-over-fiberglass joint, rather than the reverse found on most production aircraft. The aluminum, averaging 0.025” thick, leaves a far less obtrusive lap joint than fiberglass, averaging more than 0.060”. It is very difficult to mold a recess so thin into small fiberglass parts, however, so the joints may require some filing or sanding for a really smooth fit. During molding and storage, fiberglass parts may shrink or warp. Fortunately, fiberglass has some thermoplastic qualities, which means that it can be heated and reformed and will hold the new shape as it cools. Dipping the fiberglass part in very hot tap water will make it pliable until it cools, so parts may be, to a small degree, reformed. Larger parts may be heated with a hair dryer or (carefully!) with a heat gun.

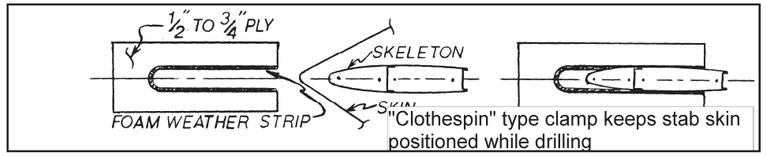
Empennage tips are attached with flush head CS4-4 blind rivets.

The fiberglass must be machine countersunk and the skins dimpled to accommodate the rivet head. DO NOT plan on using the machine countersink bit on aluminum again -- fiberglass is very abrasive and will dull it immediately. Save it for fiberglass work.

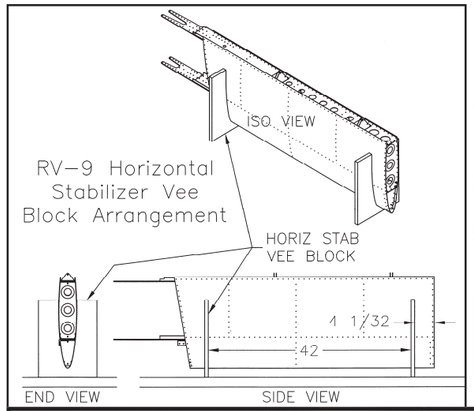
If you foresee the need to remove any of the fiberglass tips to service antennas or strobes, etc., they may also be attached with #6 countersunk screws and nutplates (not included in the kit) riveted to the fiberglass. Use the same spacing specified for the rivets.

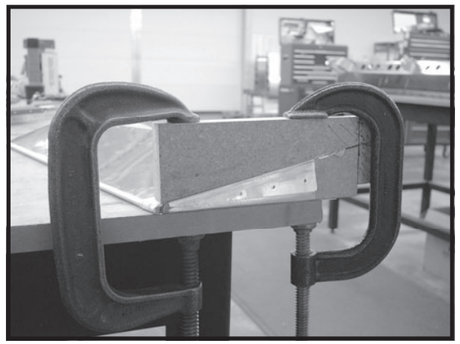
Auto body filler (“bondo”) may be used sparingly to fair and smooth the intersection. Don’t overdo it -- a clean but visible seam between the tip and the aluminum looks better than a smoothed over one, and bondo has a tendency to crack and spall over time if it is applied over 1/16” thick.

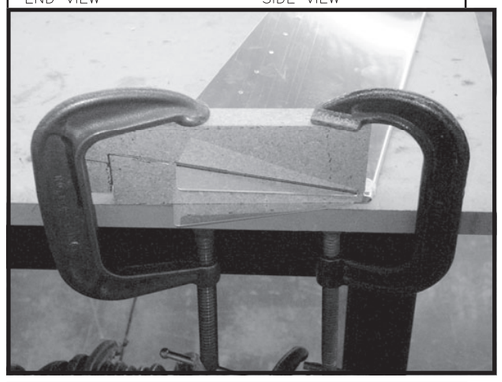
The aft sides of the HS-910 and VS-909 stabilizer tips are open. These must be plugged or capped for structural and cosmetic reasons. This may be done in a variety of ways, as shown in Fig. 6-12. A balsa or softwood plug may be fashioned and bonded into place; a foam plug may be inserted and sealed with a layer of fiberglass, or a soft aluminum cap fashioned and pop riveted in place.

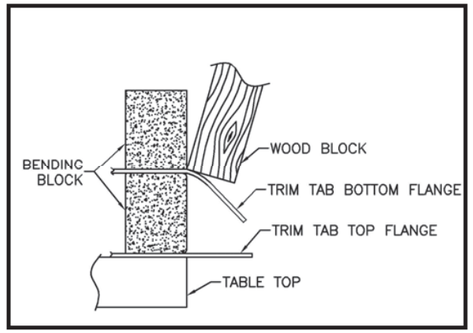


"Clothespin" type clamp keeps stab skin positioned while drilling

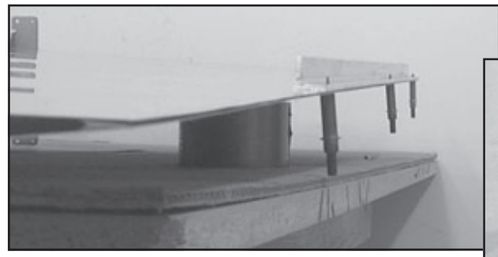


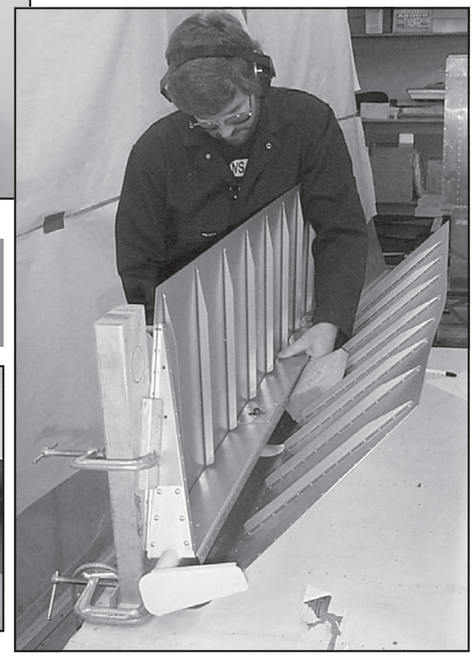




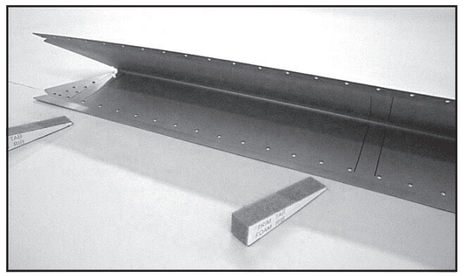


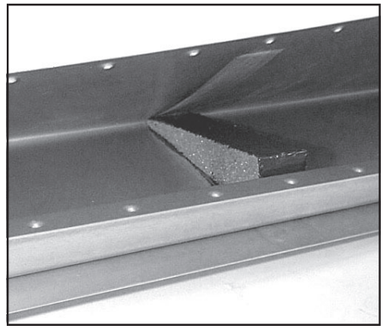
Below: A board clamped to the bench helps hold the elevator while the top of the spar is riveted. A large sponge helps hold the skin open and keeps the bucking bar from denting the opposite skin.





Above: Using a piece of aluminum angle to hold the trailing edge of the rudder straight during bonding and riveting. One straight piece, the full length of the rudder, is required...the short piece is just for the photo.





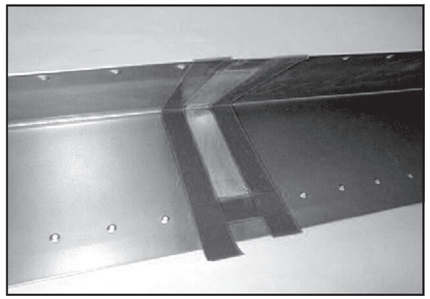


Fig. 6-6: Foam ribs stiffen the trim tab. After the ribs are cut and sanded (above left), the skin is prepared by masking the contact area. The aluminum is sanded and cleaned carefully, (above) and the rib is bonded into place.

FIGURE 6-12

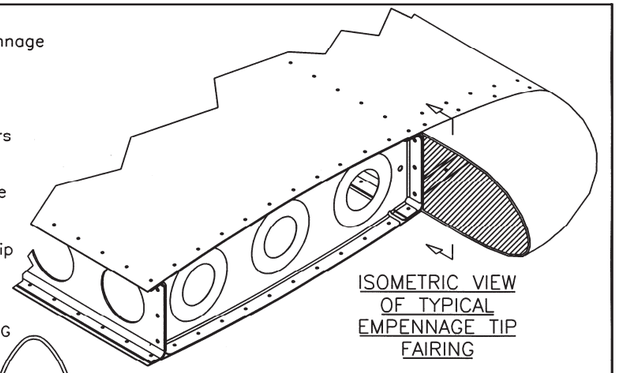
The open ends of the following empennage tip fairings must be closed:

RV-6 & RV-8: Elevator and rudder

RV-9: Horizontal and Vertical stabilizers

The open ends of the RV-6 & RV-8 horizontal stabilizer tip fairings may be closed if desired.

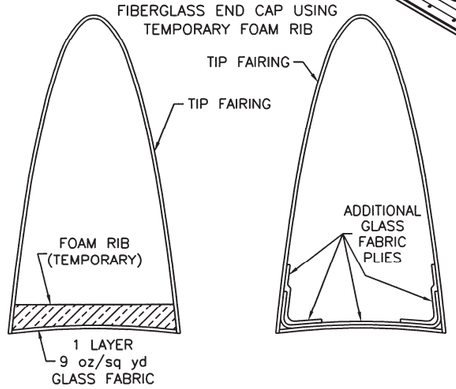
A couple of possibilities for creating tip fairing end ribs are presented here.



ISOMETRIC VIEW OF TYPICAL EMPENNAGE TIP FAIRING

OPTION 1:

FIBERGLASS END CAP USING TEMPORARY FOAM RIB



STEP 1

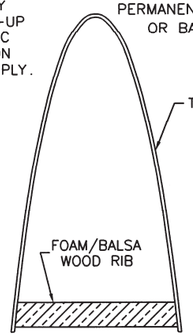
FIT FOAM RIB, TEMPORARILY BOND IN PLACE, TRIM 1 LAYER GLASS FABRIC, BOND IN PLACE OVER FOAM RIB

STEP 2

AFTER CURE, CAREFULLY CHIP-OUT FOAM RIB, LAY-UP ADDITIONAL GLASS FABRIC REINFORCEMENT PLIES ON INNER SURFACE OF FIRST PLY.

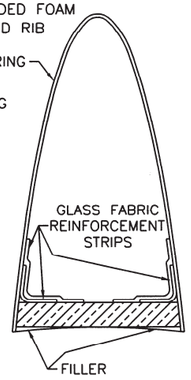
OPTION 2:

PERMANENTLY BONDED FOAM OR BALSA WOOD RIB



STEP 1

FIT FOAM/BALSA WOOD RIB AND PERMANENTLY BOND IN PLACE



STEP 2

AFTER CURE, BOND IN GLASS FABRIC STRIPS AND USE FILLER TO FILL GAPS AND SURFACE IRREGULARITIES

NOTES

SECTION 7: BUILDING THE WING

OVERVIEW

The wing assembly sequence begins with the construction of the main and rear spars. Leading edge and tank assemblies are then fitted to the main spar. The wing main ribs are then prepared and installed to the spars. The skeleton is placed in a holding fixture where the main skins are fitted. The wing is then checked for overall dimensions and twist. The leading edge and main skins are then taken off for dimpling, priming, and subassembly prior to final riveting on the wing. The bottom skins are left off until last. The internal parts of the wing (aileron and flap hangers, aileron and flap braces etc.) are installed. Riveting the lower outboard skin closes the wing.

GETTING READY

Make the wing stand shown on DWG 15, this is the jig that the wing is constructed on. Also on DWG 15 is a simple tool for aligning the ailerons and flaps.

The biggest fixture project is the wing cradle shown on DWG 15. If you take the time to build this before starting wing construction, you will have a convenient, safe place to store the finished wing panel. Some builders add custom details, like swiveling casters, to make the wing stand even more useful.

PREPARING THE MAIN SPAR

The W-906 main wing spar is supplied completely assembled and gold anodized for corrosion resistance. Carefully inspect the spar for shipping damage. Use a large marking pen to mark the orientation of the spar (“right top”, “forward”, “left bottom”, etc.) and study the plans until you understand how the spars are installed. You do NOT want to build a wing upside down!

To begin wing construction, rivet the tank skin attach platenuts to the spar as shown in DWG 11.

Machine countersink (trying to dimple the 0.063 thick spar flange will result in severe distortion!) the platenut attach holes in the W-906A spar flange. See Section 5E. Use a microstop countersink with a #30 pilot to countersink the screw holes in the spar to the proper depth for the #8 screw. The pilot will center in the countersunk platenut well enough to keep the hole round and concentric. (Tip: cut a #8 screw short so that it enters the K1100 nutplate easily and use it to gage the depth.)

Attach the K1000-06 platenuts for the W-822 access plate to the W-906A flange (note that the access plate uses #6 screws on the spar flange and #8 screws around the perimeter…) Dimple the access plate for a #6 screw, then machine countersink (see section 5E) the spar flange to fit the dimples. Use a #40 countersink cutter to center in the platenut.

Attach the two K1000-4 center section attach plate-nuts to the forward side of the spar. Countersink the W-906C doubler plate to allow the flush heads of the rivets to rest on the aft side of spar. This allows the doubler plate to fit flush against the F-904G vertical bars (DWG 11).

Spot prime all countersunk holes where the anodizing has been removed.

Fabricate the W-933 Tie-down Bar (DWG 11) from the AEX Tie-down x 7.5 stock. Trim it to length and tap one end to receive the tiedown ring. Drill one of the top attach holes on one of the angles (#12 drill bit), to use as a match hole with the spar.

Bolt the match hole to the spar and drill the remaining three holes that join the bracket to the spar bars, using the holes in the spar as a guide. Slip a bolt in each hole as you go. With the tie-down assembly bolted to the spar, drill the four holes in the W-933 flanges that hold on the W-823PP bellcrank brackets, using the holes in the spar web as a guide.

Drill and rivet the platenuts to the W-933.

Reinstall the W-933 assembly and the W-823PP bellcrank brackets on the spar.

The tie-down rings are not supplied in the kit, as they are simply 3/8 inch eyebolts available from most hardware stores. Weld the eyes closed to add strength. If you prefer you can order forged tiedown rings (p/n Bolt Eye 3/8x16TD in Van’s Accessories Catalog.)

ASSEMBLING THE REAR SPAR

The W-907 rear spar assembly, shown on DWG 10 & 11, is a “Z” section channel, reinforced where it joins the fuselage and at the aileron brackets.

Deburr the edges of the W-907A rear spar channel, W-907B reinforcement fork, W-907C doubler plate, and the W-907D and W-907E doubler plates.

Begin rear spar assembly by clamping the W-907D and W-907E doubler plates to the spar. Vertical placement is correct when the flanges of the spar and the reinforcement plates are tight. Lateral placement for W-907E is determined by aligning the outboard edges of W-907E and the W-907A spar channel. To place W-907D measure the distance between the outboard edges of W-907D and W-907A (See DWG 11).

Using the spar as a template, drill and cleco W-907D/E to the W-907A spar channel. Mark and carefully cut out the holes for the aileron pushrods. You can use a Unibit to remove a major portion of the area, and then use a round file or a rotary cutter in a die grinder to remove the remaining portion. Carefully smooth and deburr the inside of the holes

Cleco the W-907B reinforcement fork and the W-907C rear spar doubler plate to the W-907A spar channel and drill the rivet holes to full size.

Deburr, prime and prepare the rear spar components for riveting. Note that some of the holes in the W-907C get machine countersunk for flush rivets (DWG 11 and Fig. 7-1). Drill the holes to final size (#40) and dimple the upper spar flange along the length of the W-907B. When the spar is assembled, getting to these holes with a set of dimple dies is quite difficult (Fig. 7-1.)

Some rivets in the rear spar reinforcements also attach ribs, aileron brackets, aileron gap fairings and the flap gap fairings (DWG 11). Tape over these holes so you do not inadvertently put a rivet in one.

Rivet the components of the rear spar together.

PREPARING THE WING RIBS

You will save time if you set up and prepare all the ribs for both wings at the same time.

Begin preparing the ribs by deburring the edges of the flanges and lightening holes. A small Scotchbrite wheel mounted in a die grinder prepares the inside edges of the holes quickly and easily. Pay particular attention to the forward parts of the leading edge ribs. Remove all bumps around the notches to insure that the skin fits well.

Wing ribs come in seven flavors. Part numbers are marked on the ribs at the factory, but if you cleaned them off by mistake, they may still be identified:

- There are three types of main ribs, W-910, W-911 and W-912. At first glance they look identical, but they are not. W-910 is 0.032 thick and has extra pre-punched holes on the rear web for the W-925A flap hinge bracket. W-911 is 0.025” thick and these holes are omitted. W-912 is the same shape and thickness as W-911, but the 7/16’’ dia. hole near the front flange for the Pitot tube line is omitted.
- Leading edge ribs W-908 and W-909 come in two sizes. The W-908 rib is slightly (0.032”) undersized around the perimeter to accommodate the W-919 joint plate, is 0.032" thick, and does not have holes in the curved flange.
- Tank ribs differ in thickness and hole pattern. T-903 ribs, used on the ends of the tanks, are 0.032” thick. The internal T-904 ribs are 0.025” and have a pattern of large holes to allow the fuel to run from one bay to another. The holes in the upper side are for venting air, and are located at the high point of the tank in a three-point attitude and in cruise flight. DON’T CONFUSE LEADING EDGE AND TANK RIBS. They look much the same, but the tank ribs are shorter.

Ribs may be either “left” (suffix L, i.e.: W-909-L) or “right” (suffix R, i.e.: W-909-R). You may identify the “hand” of a rib by holding it with the leading edge away from you with the flange closest to the tooling holes toward the floor. If the flange is on your left, the rib is an “-L”, if it is on the right, it is an “-R”.

Adjust rib flanges 90^{o} to the web using hand seamers.

The forming process leaves ribs bowed, particularly the leading edge ribs. Straighten the webs with fluting pliers. Place the center of each flute at the midpoint between the prepunched holes. Use a straightedge or holes in a wing skin to check for straightness of the line of rivet holes. The straighter the parts, the better they will fit.

Make provisions for running wires if you intend to install wingtip position lights, strobes or landing lights. Drill holes in the ribs for grommets, or conduit sold in VAN’S ACCESSORIES CATALOG. Opening up the tooling holes works well. Be careful not to interfere with the pitot line or control systems. Leave the tooling hole in the outboard tip rib undrilled for now. The smaller hole is useful for aligning the aileron. The 7/16" hole in the inboard ribs of the left wing get plastic grommets for routing the pitot tube line.

MAKING THE AILERON AND FLAP ALIGNMENT TOOL

Later, it will be necessary to accurately determine the neutral aileron and flap position. The neutral position is easily found by utilizing the two tooling holes in the W-912 wing main rib. An imaginary line running through the center of these holes passes through the trailing edge of the aileron or flap. A simple alignment tool makes getting ailerons and flaps correctly aligned an easy matter. This tool is shown on DWG 15, View C-C'. Because it needs an 'uninstalled' W-912 wing main rib, it must be made before the wing skeleton is assembled.

To make the alignment tool you will need two 3/16" bolts and a 1"x2" board at least 42" long. Drill two 3/16" diameter holes into the board using the tooling holes in the W-912 main rib as a guide. The first hole should be within 2" of an end. (If there is a chance an extended period of time will pass between the time you make the jig and when you use it, you may want to choose a more stable material such as aluminum angle, etc. At the very least, double check a wood jig for straightness or twist before using it later.)

Put an AN3 bolt into each hole, and use the shanks of the bolts as a stop for a straightedge. Draw two parallel lines the length of the board and tangent to the bolt shanks. The lines straddle the shanks. Set aside this tool until you're ready to align the aileron.

When it comes time to align your aileron fit this tool into your now installed W-912 main rib by inserting the bolts though the board and into the tooling holes. Position the aileron trailing edge between the two lines drawn on the board to find the neutral position.

The flap neutral position is found by matching it up to the aileron trailing edge, assuming you have built ailerons with no twist.

ASSEMBLING THE WING SKELETON

MAIN RIB/SPAR ASSEMBLY

Cleco the W-910, W-911 and W-912 ribs to the main and rear spars. Be sure the proper ribs are in the right locations and that wire and pitot tube routings are aligned (DWG 9 and 10). The ribs do not have all their flanges facing the same way (see DWG 9 and Fig 7-2). If the rib flanges are facing the wrong way, bucking the rivets for the W-904/905 wing skins is difficult.

Drill the holes attaching the ribs to the spars to full size.

Remove the ribs and do the necessary deburring and priming.

Reassemble the ribs and spars with clecoes (Fig. 7-2.)

Put protective tape on the W-906B/D spar flange bars to prevent bucking bar damage when installing the top and bottom most rivets (see Fig. 7-3.) Rivet the main ribs to the front and rear spar, EXCEPT for the outboard W-912 rib, which is riveted to the rear spar, but not the main spar. Place the manufactured head of the rivet on the rib flange (side with thinnest material), to prevent distorting the parts.

WING STAND

Although the matched-hole process eliminates the need for the traditional wing jig, mounting the wing in a stand will make it easier to build. A stand allows access to both sides of the wing and makes it easy to take measurements and assure the wing is straight. The wing has no washout, twist or taper.

The stand (shown on DWG 15) is simple; two vertical posts run from floor to ceiling. Horizontal arms of steel angle or wood, bolted to the posts, support the main spar. The size of the posts and arms is not important, but they must be sufficiently strong and rigid to support the wing.

Clamp or bolt the wing skeleton to the horizontal arms of the H-frame. To provide a mounting point on the outboard end of the wing, drill and bolt a temporary 5" long piece of aluminum angle, (visible in Figs. 7-4 and 7-5) parallel to the spar web, to the outboard rib with 3/16" bolts. The small additional holes in the ribs will not compromise strength.

The center of the skeleton will sag toward the floor when it is mounted in the stand. To make installing and removing the skins easier, support the skeleton in the middle. Run a fishing line along the rivet holes in the main spar. Then adjust the middle of the skeleton with a 4x4 wood block and shims, screw jack, etc., (almost anything that will remain stable works) placed under a rib. Raise the skeleton just enough to bring the rivet holes even with the fishing line along the length of the spar.

FITTING THE WING SKINS

Wing skins are pre-punched with pilot holes for the ribs and spars. The vinyl can be left in place when fitting and drilling the main wing skins to prevent scratches. (Do not do this with the Leading Edge or Tank Skins.) Remove the vinyl before dimpling to prevent pounding trapped drill shavings into the skin with the dimple die.

FITTING THE WING WALK DOUBLERS

Both wings have doublers under the main skin next to the cabin sidewall to help support the loads imposed by people entering and leaving the airplane. Make the W-927 wing walk doublers (DWG 11) from AS3-025x15 1/16x26. Lay W-902 on a bench and slip the doubler underneath it. Align the inboard edges and set the forward edge of the doubler 9/16" aft of the forward edge of the skin. Using the skin as a guide, drill three holes for each rib in the wing-walk doubler. Use the 8th, the 15th, and the 22nd hole from the forward edge. This divides the ribs into quarters.

FITTING THE MAIN SKINS

Cleco the forward row of holes in W-902 and W-903 skins to the matching holes in the main spar. Cleco the W-902 and W-903 skins in place using a cleco in every fourth hole.

Don't forget to insert the W-927 doubler between the ribs and the W-902 skin, The W-927 doublers nearly butt against the aft edge of the main spar channel and overhang the rear spar by about an inch. The main skins overlap at the eighth rib from the root. The outboard skin should fit on top of the inboard one.

Gently pull ribs into position if the matched holes do not align with the skin holes. Drill all the holes to final size. Start drilling in the upper middle of the panel and work down and out toward the edges, work out any slack as you go.

Move the clecoes down one hole and drill all the remaining holes.

FITTING THE SPANWISE STRINGERS

Make the two J-stringers (W-926A/B) by cutting to final size as shown on DWG 9.

Mark a centerline on the back of the J-stringers 3/8 " from the unbent edge. Slip the W-926B into place so that it just butts up to the edge of the W-903 skin. Hold the W-926B in position at the outboard end (keep track of your fingers!), drill the outboard-most hole and cleco in place. Drill the W-926B to the skin and cleco every other hole. Clamp the W-926A inboard J-stringer in place at the W-910 inboard rib, locate it, and drill it to the skin. The two stringers overlap just outboard of the skin overlap. The outboard stringer goes on top (against the top wing skin).

Repeat the process with the W-904 and W-905 bottom skins. Adjust the ribs as necessary by reaching through the lightening holes to push or pull the ribs slightly. (We use a broomstick with a protruding screw in one end. The screw is padded with tape or some tubing. It isn't high tech, but it works.) Drill all the holes final size.

Note that the overlapping main skins result in an exposed skin edge just behind the tank (Of course the tank is not on right now.) Mark the skins for beveling. See DWG 11. Only the corners -- not the entire edge -- of both skins are beveled using a file, sanding block, etc., so the forward edge ends up even (or close to it) with the tank skin.

Remove the bottom main skins before fitting the leading edge and tank skins.

LEADING EDGE ASSEMBLY

BUILDING THE CRADLE

Construct a cradle to hold the tank and leading edge during construction. This cradle is just a variation of the horizontal stabilizer cradle, with wing shaped cutouts instead of control surface cutouts. Don't waste time making the cradle perfect, since it simply holds the leading edge, and has no bearing on alignment. Use a L.E. rib to trace the shape. Pad the surfaces of the cradle to prevent skin scratches.

FITTING THE LEADING EDGE

Remove the vinyl from the inside surface of the W-901 leading edge skin.

Place the W-901 leading edge skin in the cradle. The ribs are much easier to install with it pre bent to shape in the cradle.

You will have to trim the aft flange on the fifth leading edge rib from the tip to clear the spar rivets. Hold the rib in place on the spar and mark to remove just enough of the flange to clear the rivet heads.

Cleco the W-909 ribs into the W-901 Leading Edge Skin. Install the clecoes on the top first; working from the front to the rear. Then cleco the bottom, also working from the front to the rear. The most inboard rib (W-908 Leading Edge

Rib) is not pre-punched with holes; it will be installed later. Mark the ribs so they may be reinstalled in the same location.

Remove the leading edge assembly from the cradle and place it on the spar. Put clecoes through the spar into the ribs. Also cleco the W-901 Leading Edge Skin to the wing spar through about every third hole.

Slide the W-908 rib into place starting at the lower aft edges of the leading edge skin. Back drill the rear flange from the spar and cleco in place. Mark a line on the W-919 Splice Strip 5/16” from the edge. This line will match up to the holes in the skin, leaving 7/8” exposed to support the tank skin. You can pre-bend the W-919 to make it fit better around the tip.

Work the W-919 Doubler strip (with the vinyl removed) into place between the W-901 Leading Edge Skin and W-908 Leading edge rib. You can gently tap the rib or strip with a soft hammer to coax things into place. When the strip is in position you will see the line through the pre-punched holes in the Leading Edge skin. The rib is in position when the distance from the rib to the inboard edge of the strip is the same as the distance from the inboard edge of the skin to the edge of the strip.

Drill all of the pre-punched holes in the leading edge skin.

Note the pre-punched hole for the tie down anchor. It will be drilled to final size using a Unibit after the skin is removed.

Leave all of the clecoes in place and get busy on the tank.

ASSEMBLING THE FUEL TANKS

The fuel tanks are also the inboard leading edge of the wing, so they are constructed in a manner similar to the outboard leading edge. However, the tank is removable so the tank ribs can not be permanently attached to the spar. The tank is attached to the wing two ways. Flush machine screws fasten the skin to the spar flanges and bolts hold the T-912 fuel tank attach brackets (mounted on the rear tank baffle) to the spar web. The tank is also held to the fuselage by the T-905 attach angle. Fuel tank construction and details are on DWG 12.

FITTING THE TANK SKINS TO THE RIBS

Complete any remaining rib preparation details. Bend flanges 90° and flute ribs. Use a square to check the flanges and a straight edge and/or skin to check the ribs for rivet hole alignment.

Remove the vinyl from the T-901 Tank Skin and place the skin in the cradle.

Attach the ribs to the skin with clecos through every other hole.

Trim all T-911 and T-911-INBD stiffeners as shown on DWG 12. Round all stiffener corners, deburr edges, then final drill them to the T-901 skin.

FITTING THE ATTACH ANGLES TO THE REAR BAFFLE

The relationship of the T-902 baffle and T-912 attach angles to the tank is fairly complex, so take the time to understand how everything goes together before you pick up the drill. The picture becomes clearer if the baffle is placed in the tank assembly now in the cradle, and the Attach Angles placed in position on the baffle. Use the isometric view on DWG 12 as a reference. Mark all parts so they may be returned to the same position.

Use the W-932DG Drill Guide to drill (#30) the first hole on both of the flanges of 6 of the 7 T-912 Attach Angles. The guide ***must be accurately centered*** on the flange. (Do not drill one of the flanges of the most inboard Attach Angle. These holes must be offset on this flange. They will be back-drilled through pre-punched holes in the spar. If the bolts were centered, the heads would interfere with the web of the Attach Angle.)

Mark a line down the flanges centered on the 1/8" holes.

Enlarge the 1/8" hole in one flange of each of the six outboard T-912 Attach Angles to 3/16". When you are done, six of the attach angles will have a 1/8" hole in one flange and a 3/16" in the other. The seventh attach angle will have one 1/8" hole in one of the flanges and the other flange will be blank.

Cleco the T-912 Attach Angles to the T-902 Baffle. Position them so they are perpendicular to the Baffle and the centerline is centered in the pre-punched holes in the Baffle. Clamp the angles in place and drill the remaining holes using the Baffle as a guide.

Remove the T-902 Baffle. Deburr it and the T-912 Attach Angles.

Replace the T-902 Baffle on the tank assembly and cleco every other hole though the T-901 Tank Skin.

Place the T-912 Attach Angles on the tank assembly. Cleco the end Attach Angles to the T-902 Baffle from the

front. Fasten the middle angles with a couple of temporary AACQ 4-4 blind rivets (clecoes will interfere and the soft AACQ rivets are easy to drill out.) The inboard attach angle only has one set of holes.

FITTING THE TANK TO THE WING

Place the tank on the spar. Cleco the T-901 Tank Skin to the spar. The platenuts in the spar will hold 1/8 clecoes.

Use a 3/16" cleco to secure each T-912 Attach Angle to the spar. Drill the remaining holes through the Angles using the holes in the spar as a guide. Use a sharp bit and go slowly -- the angles can move around if the drill is pushed too hard.

Drill the three bolt holes on the inboard bracket on the main spar.

Drill the screw holes in the splice strip.

Finally, check for twist in the wings. On each end of the wing, hang a plumb bob made using fine thread, from underneath a cleco holding the W-904 or W-905 bottom skins to the main spar. Measure from each plumb line to the rear spar. If the measurements are within 3/32" the alignment is acceptable.

DRILLING THE TANK ASSEMBLY

Remove the tank from the wing, and drill all rivet holes to final size. (Doing so off the wing prevents accidentally drilling into the wing spar stiffener bars).

Machine countersink the spanwise rows of holes in the T-901 tank skin that attach the skin to the T-902 baffle. Have the baffle in place so that the pilot has a good hole to guide the countersink. This makes it easier to slide the baffle into position on final assembly.

Drill the spar attachment screw holes and the W-919 screw holes to final size using a #19 drill.

Permanently label the position of each T-912 attach bracket so that you will be sure to get them back in the same location later. Remove the attach brackets and the rear baffle.

Drill the attach brackets for the K1000-3 platenuts (except for the inboard most one where the platenuts mount on the main wing spar web.) Install the three platenuts for the inboard bracket on the main spar. Deburr and prime all attach brackets and rivet the platenuts to the attach brackets.

Fabricate the T-905 tank attach angle and pre drill with the rivet holes per DWG 12.

Hold the T-905 in place on the rib and drill the attach holes, clecoing as you go.

Remove the T-905 attach angles.

Modify the shape of the T-410 reinforcement plates as shown on DWG 12. The detail can be used as a full sized pattern.

Test fit the plates to the inside of the tank. They should fit closely to the skin and can be adjusted slightly if required. When you are happy with the fit, back drill the T-410 rib reinforcements to the inside of the end ribs using the holes previously drilled from the T-905.

If you plan to use the capacitive fuel gauge senders offered in the VAN'S AIRCRAFT ACCESSORIES CATALOG you should complete their installation at this point using the instructions supplied in the sender kit.

FINAL PREPARATIONS

Modify the inboard end ribs as shown in the right side view of DWG 12. The large hole for the access cover is best cut using a flycutter on a drill press.

Stiffener ring T-407 and access plate T-708 are supplied pre-punched. (The T-708 access plate is designed to mount the Stewart-Warner float-type sender offered in VAN’S ACCESSORIES CATALOG. If you wish to install a different sender, the T-411 plate is available without the sender mounting provisions).

Place the T-708 cover plate on the rib with the flat forward edge aligned with the stiffener bead, and an equal distance to the top and bottom rib flanges. Drill all of the screw holes, clecoeing as you go (be sure the hole for the fuel pick-up tube is oriented toward the top of the tank). Remove the T-708 and cleco the T-407 in place.

Drill all of the platenut rivet attach holes. Remove the T-407, deburr all holes, dimple the rivet holes in the rib, and machine countersink the rivet holes in the T-407 for the dimples. Rivet the T-407 and the platenuts in place. The gasket under the T-708 cover plate will seal these rivets, so they do not have to be set with tank sealant.

Fit and drill the T-406B fuel cap flange. Use the cap (installed in the cap flange) as a guide for centering the flange

in the tank skin opening. Note that the cap flange has two slight bends in it to help it to conform to the curve of the tank skin. Make the T-914 clip from a scrap piece of aluminum and drill it for installation sharing one of the cap flange rivets. Countersink the top of the T-406B to accept the dimples in the tank skin.

Center the VA-112 drain flange on the prepunched hole and drill it to the tank skin. Machine countersink the holes for the attach rivets.

Disassemble the tank and dimple the skins and ribs. Dimple the holes for screws with the C-frame tool and a hammer, instead of trying to form them with a rivet squeezer. It looks nicer.

Do not prime any area that will be on the inside of the tank. Fuel could have an adverse effect on the primer, or (worse) vice versa. The only part that must be primed is T-905. Do not dimple the rows of rivets along the rear of the tank that attach the tank skin to the rear baffle; they should have already been machine countersunk. If not, they should be done now, but the tank baffle must be clecoed in place to act as extra material for the countersink pilot.

At this point, all parts of the tank should be deburred, dimpled, and primed as necessary.

ASSEMBLING AND SEALING THE TANK

Plan on two or three work sessions to seal a tank. Working on both tanks at once will help to speed things up. Handy things to have on hand: disposable surgical gloves, a box of Popsicle sticks, a supply of clean rags, butcher paper (not newspaper) to cover the bench surface. Also helpful are plastic freezer bags. A small amount of sealant can be put in one, the corner of the bag cut off, and the bag squeezed like a cake decorator's pastry bag to apply sealant to parts. The tank is riveted together just like any other structure with one very important difference. Apply sealant between the parts to any seam through which fuel could conceivably leak. This includes every rivet. The recommended sealant, Thiokol MC-236-B2, (often called ProSeal, Black Death, or more unprintable names) is available through VAN'S ACCESSORIES CATALOG.

Although the sealant used to seal the tanks is not particularly noxious, only use it and the solvents used in tank construction with adequate ventilation. Use a respirator, gloves (which also keep oil from your skin off the surfaces to be sealed) and protective cream when sealing the tanks. Why expose your skin and lungs if you can prevent it?

Roughen all mating surfaces using a scotchbrite pad. Don't be bashful; score the aluminum well, so the sealing compound will have more surface to grip.

Clean the manufacturing residues and oils off all the rivets by sloshing them in a jar of solvent and drying them on a clean rag. Clean the mating surfaces of the skin, stiffeners and ribs. Clean every surface that the sealer is applied to. Recommended cleaners include naphtha or MEK. Builders have also reported excellent results with etching using a light phosphoric acid (brand names include AlumaPrep or Twin Etch).

It is essential that the surface of the aluminum be clean when the sealer is applied. Not just kind-of-clean or clean enough. *Clean.*

After cleaning, do not pollute the areas to be sealed. Don't even touch them. Oils from your skin will affect the bond of the sealant.

The tank sealant should be mixed as accurately as possible. This can be done by volume, or by weight using a home made balance as shown in Fig. 7-7. Follow the instructions supplied with the sealant. When mixing sealant, do not mix too much at one time. A batch the size of four or five golf balls is usually enough for one work session. The sealant provides 45 to 90 minutes of working time (less in warmer temperatures). Measure by volume or weight as accurately as possible and mix thoroughly before applying. To use the sealant as soon a possible, have all the work well planned and tools all laid out. Have a container of acetone, MEK, or lacquer thinner nearby for the frequent tool cleanings necessary during riveting. You can peel away overflow on areas you want to keep clean by strategically applying plastic tape before spreading the proseal (such as along any areas of the skin that have to mate flush with the wing spar or W-919 splice plate).

After thoroughly mixing the sealant, use Popsicle sticks to apply an approximately 1/16" thick layer to the parts being riveted. In the first work session rivet on the T-911 stiffeners. Back-riveting works well here, so spread a thin layer of sealant on the inside of the skin, covering the area the stiffener will contact, then insert the rivets into the skin from the outside and tape them in. Press the stiffener into place. Sealant will ooze out around all the stiffener edges. When the stiffener is firmly seated, back rivet it permanently into place. Even more sealant will squeeze out as the rivets set. Clean this away, making neat fillets around all the edges of the stiffener with the curved end of the popsicle stick. Dab a bit of sealant over every rivet head.

Rivet the VA-112 drain flange, T-406B fuel cap flange and T-914 clip to the skin, using sealant in the same way. Cover the aft tooling holes in the outboard T-903 end ribs by riveting on a small plate, or by filling the hole with an AN470AD6 rivet. (See Figs. 7-8, 7-11.) After each session clean everything that you do not want to have a permanent coat of sealant. It is much easier to clean up before the sealant sets.

For the next session, rivet all the interior ribs to the skin (if you can only do a few ribs at a time, that's fine.) Work in the "cradle." When assembling the tank, cleco all ribs to the skin. This keeps the assembly straight. You may want to start riveting with the rib next to the outboard one. After this rib is clecoed in place with sealant you can remove the outer end rib for easy riveting access. Remove the ribs one at a time, apply sealant, and rivet When riveting the ribs to the skin work from the leading edge to the trailing edge.

Insert the rivets and set them with a squeezer or a rivet gun, as appropriate. Use the Popsicle sticks to form the squeezed-out sealant into fillets in the rib/skin joint. Apply extra sealant to the rivet heads.

Next, install the inboard end rib. After the rivets joining this rib to the skin are squeezed, install the T-905 and the T-410 (fitted to the inside contour of the skin as shown on DWG 12) on the leading edge. Put a thin layer of sealant on the sealing surfaces. (If T-905 was installed on the rib before riveting the rib to the skin, the skin rivets around the leading edge would be very difficult to set.)

Seal and rivet the other T-410 to the outboard end rib. Three or four AN470 rivets is sufficient.

Apply a generous fillet of sealant around the inside of the end ribs where they join the skin, particularly at the very leading edge. Also make sure the outboard end rib aft tooling hole has been sealed. Finally, clean any excess sealant from the rear of the ribs and skin where the baffle will later rest and clean any sealant smeared on the outer surfaces. Once cured, it is difficult to remove. (Fig. 7-12, 7-13.)

CLOSING AND FINISHING THE TANK

If you are using a float type fuel sender, adjust and check it before closing the tank. Dimensions for the float arm of the IE F-385 B/C sender in VAN'S ACCESSORIES CATALOG are shown on DWG 12. Make an electrical check with a 12-volt battery and a fuel gauge, or a multimeter should show about 32 ohms when the sender is in the "full" position and about 240 ohms in the "empty" position.

Install the fuel pick-up tube and position it so it lies on the bottom of the tank. To insure that inadvertent rotation of the fuel pick-up tube AN bulkhead fitting does not lift the fuel pick-up off the bottom of the tank, fabricate and install the T-715 anti-rotation bracket. Use a small amount of sealant to seal the rivet holes.

Check all final details before installing the baffle and closing the tank. Check that the tank vent line is in, and its outlet is at the tank high-point. Check the vent line bulkhead fitting on the root rib for tightness, and that it has been installed with sealant.

Assured that everything is in order, apply sealant to the tank skin from the rivet holes forward. Upon installation the baffle acts as a squeegee and the bead of sealant will be pushed ahead as the baffle is moved forward. Use a maximum of 3/16" bead of sealant. (Fig. 7-10.) Too much, and the thickness can start to build up, making the tank difficult to install on the wing. Put a bead of sealant along the inside edge of the flange on each end rib. Put a heavy glob of sealant where each corner of the baffle will meet the end ribs (this is one of the most common locations for leaks).

Put a very thin smear of sealant around each of the rivet holes on the back flanges of the T-903/4 ribs.

With the tank sitting in the cradle, install the T-902 rear baffle assembly by dropping it straight down onto the rear flanges of the ribs.

Put a cleco in every hole of the T-901 skin to T-902 baffle joint. After clecoing, inspect the skin to see if it is pillowed out between the clecoes. The contact surface of the tank baffle flange may require pressure to force out excess sealant. The easiest method is to apply a c-clamp or strong spring clamp between each set of rivets and squeeze out the excess. If you are unsure, clamp the flange in a couple of spots and see if it makes a difference.

Twirl the AD-41H closed end blind rivets in sealant and set them in the top and bottom baffle-to-rear rib-flange holes.

The T-912 brackets are installed last. Check to be sure the platenuts have been installed on them because it is much more difficult to do once they are riveted to the tank. Put a very light smear of sealant over each hole for mounting the T-912 brackets. While double checking with DWG 12, cleco each T-912 bracket in place (be sure you get them oriented correctly because they will be very difficult to change. Install the AD-42H blind rivets in the T-912 brackets after twirling them in sealant. This may require modifying a rivet puller tool by grinding one side flat in order to get the tool close enough to the hole.

Finish all riveting and clean any excess sealant off the tank.

To mount the T-708 cover plate use an 1/8" inch thick bead of fuel tank sealant between the cover plate and the inboard rib. Dab a small blob of sealant on threads of each attach screw, insert into the holes, and tighten them sequentially until sealant bulges evenly about 1/32" from underneath the perimeter of the sender plate. Some builders may optionally seal the T-407 gasket to the tank with sealant as well, viewing the cork ring as sacrificial if the cover is removed. The sealant will also form a small gasket around each screw head.

Install the IE F-385 Sending Units with sealant using the appropriate hardware. DO NOT install the rubber gasket supplied by the manufacturer. Use the same procedure for sealing the sending unit as was accomplished above.

A continuous electrical path is necessary between the airframe and the sender plate so be sure that at least one of the screw heads is making metal to metal contact with the outside of the sender plate. Conduct a final electrical continuity test for the sender units with an Ohm Meter by probing the tank body and the sender center screw to ensure proper operation.

Wait at least 24-48 hours and then conduct a fuel tank leak check using the FUEL TANK TEST KIT available in the VAN'S ACCESSORIES CATALOG.

RIVETING THE WING SKINS

There is a definite order in installing the wing skins. First, the leading edge (built off the wing) is installed. Then the top main skins are installed. The wing is then rigid enough to remove from the stand and install the ailerons, flaps and work on the internal details. After that is complete, the wing is laid, top down, on a large table and the bottom skins are riveted.

WING SKIN PREPARATION AND ASSEMBLY

Remove the skins and J-stringers, deburr and dimple them.

Prepare the skeleton while it is still fastened to the stand. Enlarge the pre-punched rivet hole in the left W-901 leading edge skin and the left main spar flange to 7/16" for installation of the pitot tube fitting (see DWG 11 Wing Skins Bottom View).

Dimple the ribs with a hand squeezer. The 0.063 main spar channel is too thick to dimple so it is machine countersunk as directed in section 5E.

Dimple the 0.040 rear spar and “ream out” the dimpled holes slightly with a sharp deburring bit or microstop countersink. This “reaming” operation removes just a small amount of metal to make the skin dimple fit better and is not critical, so it can be done by eye. The usual tendency is to remove too much metal, so use a light touch.

Drill the W-919 splice plates for installation of the platenuts. Deburr all holes. Dimple the screw holes and the rivet holes for the rib and the platenut attachment. The holes for attaching to the rib and skin can be slightly reamed (like the rear spar) to gain a better fit between the skin, the splice plate, and the rib.

This is the point of no return; the point where things start going together permanently. Make a close inspection to assure everything is clean and proper before continuing.

ASSEMBLING THE WING LEADING EDGE

Rivet the Leading Edge Assembly by fitting the skin into the cradle and then clecoing in the ribs and the W-919 splice plate. After making sure that the holes at the aft end of the ribs are exactly aligned, rivet the aft most rivets on the top and bottom using a rivet squeezer. Finish the riveting by working from the rear towards the L.E. one hole at a time.

INSTALLING THE LEADING EDGE ASSEMBLY

Install the leading edge assembly on the wing skeleton. While the main skins are off, there is room to reach in and rivet the rib flanges to the spar web. This will require an off set rivet set. Remember the outboard W-909 and W-912 ribs are both riveted together in assembly with the W-906A spar web. After riveting the ribs to the spar, rivet the spanwise row of rivets, top and bottom, along the main spar web, using a rivet squeezer.

RIVETING THE TOP SKINS

Refit the tank on the wing and install about half the screws and bolts, so that it rests in its permanent position.

With the outboard leading edge riveted in place and the tank installed it is time to rivet the top main skins. While it is possible for one person to install the first set of main skins, it is much easier with two. Rivet the W-902 inboard skins first, because the outboard skins overlap them.

Begin by clecoing the inboard skin in position (wing walk doublers, too) and start riveting (leave out the J channels for now --they get in the way of some of the skin rivets.) To assure maximum skin tightness, rivet from the center rib of each skin outward towards the root and tip. Do this on both the inboard and outboard skins, saving the double row of rivets at the lap joint until last.

Many builders find that they can get a nicer skin finish (especially when they are using less experienced helpers) if they back rivet the wing skins. Use a large bucking bar laid over the rivet on the outside of the skin, and drive the

head on the rivet from the inside using an extended back rivet set available from some suppliers.

After the skins are riveted to the spars and ribs, slide the W-926 J stingers in from either end. Make sure they are overlapped correctly and rivet the J-stringers to the skins.

When the top main and leading edge skins are riveted on, remove the wing from the stand and put it on a padded worktable, top down. Block the wing so it doesn’t rock around on the table.

If you are installing leading edge landing lights (p/n LL DW-09 in Van’s Accessories Catalog) it is easiest to do it now, before the bottom skins are permanently installed.

FINISHING REAR SPAR DETAILS

INSTALLING THE AILERON BRACKETS

Assemble the W-913 and W-914 Aileron bracket assemblies as shown on DWG 13. Install them on the rear spar by lining up the matched holes, drilling, deburring, and riveting.

INSTALLING THE FLAP BRACKETS

Make the W-925B & C for each flap hinge bracket (3 on each wing) as shown on DWG 14. This operation involves a lot of drilling in confined areas. This is best accomplished with a compact angle drill or a long flexible bit on a standard drill. When riveting, use the most massive bar you can. A set with a small offset at the tip will make reaching the aft rivets, nearest the rear spar web, easier to reach.

Drill, deburr, prime, and install both the inboard and outboard W-925 flap hinge brackets using the prepunched guide holes in the W-910 and W-911 inboard ribs. Leave open holes for rivets that are common with W-925B and W -925C.

Clamp on the center W-925 flap hinge bracket. Run a tight string through all three brackets and check the alignment. Reposition the center bracket as necessary (you can trim material from the edge that butts to the rear spar if necessary) until the string is centered in the hole, then drill and cleco the bracket to the rib. After drilling, remove the bracket, deburr, prime, and rivet it to the rib.

Clamp a W-925C in place on each W-925A and drill from the matching holes in the spar and the rib.

Clamp the W-925B in place on each W-925A and drill the aft most hole using the hole in the rear spar flange as a guide.

Remove the W-925B and machine countersink the hole where it mates up to the dimple in the rear spar flange.

Cleco the W-925B through the aft hole and the spar flange. Use a straight edge laid diagonally between the rear spar flange and the rib flange to determine the proper elevation of the forward end of the W-925. It must lay flush on the bottom skin.

Clamp in place and backdrill W-925B through the open holes in the W-925A and the rib.

Attach W-925B to W-925A with clecos in every hole. Temporarily cleco the bottom skins in place and drill the skin attach holes in the W-925Bs, using the pilot holes in the W-904 and W-905 bottom skins.

Remove the skins and the W-925B and C angles. Deburr and machine countersink the holes in the W-925Bs for the skin dimples.

Prime and rivet the W-925B and Cs to the wing.

INSTALLING THE FLAP AND AILERON GAP FAIRINGS

Drill, deburr, dimple where required, and rivet the W-921 flap gap fairing (DWG 14) to the rear spar and wing skin. A few of the holes in the fairing at each end are back drilled from the holes already in the rear spar.

The rivets that attach the lower flange to the W-907C spar doubler plate at the inboard end are flush rivets to allow for clearance to the flap leading edge.

Drill, deburr, and dimple where required, and rivet the W-924 aileron gap (DWG 13) fairing to the wing and the rear spar.

AILERONS

PREPARATIONS

The construction technique for the ailerons is similar to that of the rudder and elevators. The aileron uses ribs at the

ends only while light angle stiffeners support the rest of the skin. The aileron must be kept flat while drilling and riveting. The best way to accomplish this is to build a very flat work surface.

A rectangular frame at least 2'x8' constructed of 2x4s. One inch thick MDF particleboard is fastened to both sides. The resulting surface is heavy, stable, and flat…above all, flat. A "saddle" fixture to hold the aileron vertical while riveting is also necessary. Use an FL-904 nose rib as a pattern. (Fig. 7-27 shows this fixture used with a flap, but it works just as well with the aileron.)

Refer to DWG 13 for aileron construction details.

DRILLING THE AILERON COMPONENTS

Cleco the A-908 reinforcing plates to the A-903 spar. Drill the two A-908 plates for the A-904 rib-attach holes by backdrilling through the aft side of the A-903 spar. Drill the hole for the AN3 bolt (the center platenut hole at the inboard end of the flap spar) to 3/16.

Drill and cleco the A-904 ribs to the A-903 spar.

You must hold the ribs in their proper lateral positions so you can mark the hole positions on the A-909 counterbalance tube. Cleco the A-901A nose skin to the A-904 nose ribs with the skin on upside down so the skin outer bottom surface is touching the rib flange bottom surfaces. Position the A-909 counterbalance onto the A-904 noseribs and mark the hole positions. Drill the holes in the A-909. Since clecoes interfere with fitting the nose skin, hold A-909 in place using soft 1/8 blind (AACQ) rivets that can be drilled out later when disassembling the aileron for priming, etc. (Fig. 7-14, 7-15.)

Both the A-901B aileron top skin and the A-902 bottom aileron skin are strengthened with A-910 stiffeners. These stiffeners are provided four to a strip. Once cut away they become "lefts" and "rights". Only A-910-L stiffeners are used on the left aileron, and only A-910-R's on the right aileron. Use the exploded isometric view of the left aileron on DWG 13 to determine the shape of the "left" aileron stiffeners. The extras should be right aileron stiffeners.

Later, the A-911 trailing edge wedge will be located by the aft edge of the stiffeners on the bottom skin. Be careful cutting out and deburring the trailing edges of the stiffeners so the Trailing Edge Wedge will be positioned correctly.

The stiffeners are match-drilled to the skins much like those in the empennage. Locate the stiffeners on the inside of the A-901B and A-902 rear aileron skins and drill into the table. Disassemble, deburr, and dimple the stiffener angles and skin. After priming, rivet the stiffeners onto the A-901B and A-902 skins, preferably using the back-riveting method described in Section 6.

A-905 aileron ribs are NOT symmetrical, so be sure you have them installed correctly. The tooling holes are nearer the bottom of the aileron. Cleco A-905-L and A-905-R ribs to A-903 spar, using the smaller holes in the center of the flange. (Fig. 7-16.)

Drill, deburr, and dimple the A-902 bottom skin/stiffener assembly to the A-905 ribs. Temporarily rivet A-902 to each A-905 (L & R) with two "keeper" rivets. Put one at the forward end and one near the center of each rib (these rivets are visible in fig 7-18). They can be set just very slightly to make them easy to drill out later. This is done so the aileron can lie flat during drilling. Remove the clecos from the ribs and flip the assembly over topside up.

Cleco the A-901B top skin to A-905-L and A-905–R ribs (Fig. 7-17.) Flip the assembly over again and cleco the A-901A nose skin to the A-902 bottom skin and A-903 spar.

Flip the assembly topside up, hanging the clecos along the spar over the edge of the table. Cleco the A-901A nose skin to the A-901B top skin and A-903 spar, with clecoes in every other hole (Figs. 7-18.)

Note that a small notch must be filed in the inboard A-904 nose rib (see Detail C, DWG 13) to accommodate the top bolt in the A-907. Use a pen and mark the rib to match the skin so that the rib notch can be filed out after disassembly.

Lay the assembly flat on the tabletop and use weights along the length of the aileron to keep it firmly against the table with no twist. A straight 1 X 4 board can be used to distribute the weight and hold the aileron flat to the table. The aileron must not move or twist during drilling.

The A-901A skin may have a slight bow in the top surface. As a check, lay a straight edge across it midway between the counterbalance and spar.). About 1/16" of rise is acceptable. The skin can be squeezed down by hand to adjust it if necessary. Drill every other hole in the spar, move the clecos and drill the remaining holes. Drill and cleco the (7 each) A-904 Nose Rib holes and the (13 each) A-909 counterbalance holes. Use a new sharp bit on the A-909 counterbalance because it is stainless steel and is difficult to drill. Turn the drill at a low rpm and use some cutting oil.

Install the A-911 extrusion into the trailing edge. It is located by butting it against the back of the lower stiffeners and held in place with the weights. Using the pre-punched holes in A-901B as a guide, drill the A-911 and A-902 at the

trailing edge and cleco right into the table as you go. Be sure to drill perpendicular to the chordline of the aileron, not the surface of the top skin. The difference is only a few degrees, but using the correct reference will give better results. See the drilling guide on DWG 5.

When the trailing edge is drilled, it is time to prepare for final assembly.

Disassemble the aileron. Deburr all of the aileron parts. Machine countersink the A-903 spar flanges (this will prevent bowing the spar that can be caused when dimpling since it is .040 " thick), the 3/32" rivet holes in the A-908's, and the A-911. Adjust the counter sink tool for the A-903 and the A-911. When the A-911 is properly machine countersunk on both sides the countersinks will intersect slightly, this is acceptable.

File out the notch that was previously marked in on the inboard A-904.

Dimple all of the holes in the skins. A low profile dimple die is required to dimple the most aft A-905/A-901B rivet. Countersinking a thin steel bar (we used an old iron splitting wedge) will work for a female die.

Prime all of the parts. The A-909 is stainless steel and needs no priming.

ASSEMBLING THE AILERON

Rivet the A-908 reinforcing plates and K1000-3 platenut to the A-903 spar.

Rivet the A-909 counterbalance to A-904 nose ribs and rivet the assembly to the spar.

Rivet A-905 ribs to spar assembly. Be sure to use flush rivets with the flush heads on the forward side of A-908 (Fig. 7-14.)

Cleco A-901B top skin to A-905-L &-R ribs. Flip the assembly over and cleco A-902 to A-905-L &-R. Cleco A-901A to A-902 and A-903. Flip assembly over and cleco A-901A to A-901B and A-903.

Squeeze the solid rivets in the A-904 nose ribs, 7 per side. Blind rivet the A-909 counterbalance to the A-901A nose skin. For a nicer finish you can use a small hammer and tap the top and bottom edges of the rivet heads down flush to follow the tight radius of the skin.

The next step is to rivet the skins to the spar. To hold the aileron in a suitable position for riveting, insert it into the "saddle" fixture. With the aileron in the fixture, remove the clecos holding the skin to the ribs. Reach down between the skins with the bucking bar set the rivets holding A-901A to A-901B and A-903. Next, set the rivets holding A-901A to A-902 and A-903. Be especially careful in this confined area that the bucking bar is not driven into the top aileron skin while you are concentrating on the bottom.

Remove the riveted assembly from the saddle jig and place it bottom up. Finish riveting A-902 to the A-905 ribs. Flip the aileron assembly topside up and rivet A-901B to the A-905s.

Turn the aileron topside up and insert rivets in all the A-911 Trailing Edge holes (remove the clecoes when enough rivets are inserted to hold the A-911 in alignment) with the manufactured head on the top side. Tape all the rivets in place and flip the aileron over, so the bottom side is up.

Backrivet the trailing edge rivets, but for now, set the rivets only about halfway. If the rivets are set fully in only one direction it can leave a "hook" in the trailing edge. Put blocks on either side of the back-riveting plate, so the aileron can stay flat as it slides over the plate. Weight the aileron so it remains straight while riveting.

Flip the aileron back over, topside up now. Set the trailing edge rivets to the final size with a mushroom set.

Drill the bolt holes for A-906 and A-907 to full size and install the hinge brackets to complete the aileron. Remember that if they will be painted when the aileron gets painted, they should be scuffed to remove the gloss before installation.

FLAPS

Flap construction also uses a flat work surface. It is possible to build in an unacceptable twist, so be careful to keep the flap flush to the table surface with weights. Refer to DWG 14.

PREPARATIONS

Adjust the flange angles on all the ribs (except for the one used at the most inboard location) to 90°.

Cleco the FL-904 nose ribs, FL-907 hinge brackets, and FL-908 hinge spacers together. See the Exploded and Right Side Views on DWG 14. To help maintain alignment, place a spacer (two 1/16 thick washers will work) between FL-907 hinge brackets and tighten a ¼" bolt in the pivot holes while drilling. Drill and cleco these assemblies to the FL-903 spar.

Fabricate the FL-906A angle. Make the FL-906C spacer and de-burr the FL-906B plate.

Drill these components to the FL-903 spar. The FL-906C spacer is sandwiched between FL-906A angle and FL-903. The vertex (edge) of FL-906A coincides with the inboard edge of the spar. Vertically center the inboard end of FL-906A on the spar. Clamp the FL-906A angle and FL-906C spacer then drill using spar holes as a guide. Leave everything clecoed on to the spar.

DRILLING THE FLAP COMPONENTS

Place the FL-902 Flap Bottom Skin on the table, inside surface up. The holes for the spar should protrude over the edge of the table. Cleco the spar to the skin using the match holes. Insert the clecoes from beneath about every 8".

Move the skin until the sides of the clecoes almost contact the side of the table. Drill the surface of the table through every second FL-905 match hole, starting with the second one back from the spar line. As you go, cleco directly into the table top.

Remove the clecos and remove the skin from the table. Drill 5/8" holes in the table, centered on the holes just drilled through FL-902. These will allow the flap assembly to rest flat on the table later – the clecoes will fit through the holes in the table. The opposite flap will require a new set of holes. The flat table will not be used for anything else so it does not matter that you are filling it with holes.

Drill and cleco the FL-905 Main Ribs to the FL-903 Spar. Note that all the ribs have their flanges facing the same way (outboard). The FL-904 Nose Ribs are still clecoed on. You may have to move some clecoes to make room.

Place the rib/spar assembly on the table, bottom side up (Fig. 7-20.) Cleco and drill the FL-902 Bottom Skin to the FL-905 Ribs (not the FL-903 spar yet). Leave clecoes in every other rib hole starting with the second hole. You will end up with a pattern that fits in the 5/8" diameter holes drilled in the previous step. Flip the assembly over and let the clecos fall into the holes (Fig. 7-21, 7-22.)

Fasten the FL-901C Upper Aft Skin to the ribs with clecoes every other hole. Cleco holes in the spar about 8" apart just to hold everything in alignment. Place a straight 2x2 between the clecos through the top skin halfway back from the spar. Weight the flap and 2x2 down well to hold the skins and ribs flat to the table (essential to building a straight flap) (Fig. 7-23.)

Install the FL-901A Inboard Nose Skin and the FL-901B Outboard Nose Skin with clecoes top and bottom in every other spar hole (Fig. 7-24, 7-25.) The nose skins will install easier if the clecoes are put in the bottom first. Place the FL-909 Trailing Edge into the flap, between the top and bottom skins. Locate it with the trailing edge piece from the other flap as shown in Section C-C', DWG 14.

Drill and cleco the trailing edge directly to the tabletop (Fig. 7-26.) Remember to drill perpendicular to the chordline of the flap, not perpendicular to the top skin (see drill angle guide DWG 5).

Drill all holes in leading edge ribs, spar and upper skin to full size. Use a 12-inch drill bit to reach the holes along the bottom of the spar (Fig.7-24.)

Position the FL-906B Plate by aligning it horizontally and vertically with the inboard face of FL-906A. The FL-906B bend line should coincide with the aft vertical face of the spar. Clamp and drill to FL-905 end rib and FL-906A using the FL-906B as a guide.

Disassemble everything and prepare the parts for riveting by deburring, and countersink all holes as required. Machine countersink the flanges of the flap spars like the aileron spars. Dimple countersink all of the remaining skin related holes. The holes used with blind rivets must be drilled out to 7/64" eventually. Do it later, in assembly.

The FL-906B and the most inboard FL-905 rib need holes drilled to mount the K1000-4 platenut. Use an AN4 bolt to temporarily center the platenut on the hole and drill the rivet holes. Machine countersink the hole in the rib and F-906B plate for the attachment rivets.

Prime all parts

Do not rivet this flap until the other is finished to this stage. The FL-909 Trailing Edge will be needed as a spacer.

ASSEMBLING THE FLAP

Rivet the Nose Rib/Hinge Assemblies together. Use a bolt and spacer to keep the pivot holes in alignment.

Rivet the Nose Rib/Hinge Assemblies to FL-903 Spar. Remember, at the inboard end, the FL-906A Angle and FL-906C Spacer must be included. And at the outboard end, the FL-905 Main Rib must be riveted with the Nose Rib/Hinge Assembly.

Rivet the FL-906B Plate to the inboard FL-905 Rib; install the platenut; and rivet the Rib to the FL-903 Spar. Finally,

rivet the FL-906B Plate to the FL-906A Angle.

Rivet the remaining FL-905 Main Ribs to the FL-903 Spar.

Cleco the FL-901C Top Skin to the FL-905 Ribs. Cleco the FL-901A/B Leading Edge Skins on. Lay the assembly on the table topside up with the FL-902 skin off. The ribs must lie flat on the table. Use enough weight to hold the ribs in this position.

Drill the leading edge skin to all but the most inboard and the most outboard nose ribs, using a 7/64" drill bit to slightly enlarge the dimpled holes. The ribs on each end can be riveted with regular rivets and do not require their holes to be enlarged. Rivet the skin to the nose ribs (but NOT to the spar) with blind rivets, except for the end ribs. These are accessible with a squeezer, so solid rivets are used.

Put the flap in the saddle (Fig. 7-27, 7-28). Rivet the FL-901C top skin, FL-901A&B nose skins, to FL-903 spar and the FL-905 ribs.

Lay the flap top side down on the table. Place weights on the inside of top skin to hold it flat. Holding the flap flat in this next step is very important because when the L.E. section is riveted closed it can lock a twist into the flap

Cleco the FL-902 Bottom Skin under the FL-901A and FL-901B nose skins, to the spar. Rivet the skins to the spar (Not to the Main Ribs.) Lift the bottom skin at trailing edge and reach inside to buck the rivets through the spar (Fig. 7-29.)

Cleco the FL-902 Bottom Skin to the FL-905 Ribs through every other hole. Set the flap topside down on the table with the trailing edge overhanging the table edge. Cleco the FL-909 trailing edge extrusion through every other hole with the clecoes hanging off the edge of the table.

Weight the flap down to the table and drill all the holes that join the FL-902 bottom skin to the interior FL-905 ribs to 7/64". Set the blind rivets. The outboard end ribs are accessible with a squeezer so you can use solid rivets here.

Turn the flap topside up and insert rivets in all the FL-909 trailing edge holes (remove the clecoes when enough rivets are inserted to hold the FL-909 in alignment) with the manufactured head on the top side. Tape all the rivets in place and flip the flap over, so the bottom side is up.

Back rivet the trailing edge rivets, but for now, set the rivets only about halfway. If the rivets are set fully in only one direction it can leave a "hook" in the trailing edge. The flap must be held flat for this step also, so be sure to provide spacers the same thickness as the back riveting plate to hold everything flat.

Flip the flap back over, topside up now. Put blocks on either side of the back-riveting plate, so the flap can stay flat as it slides over the plate. Weight the flap so it remains straight. Set the trailing edge rivets to the final size with a mushroom set.

ATTACHING AILERONS TO THE WING

Completely finish the flaps and ailerons before mounting them to the wing.

Set the wing, with the leading edge and the top main skins riveted on, on a workbench, topside down.

Assemble the W-917 and W-918 pushrods as shown in DWG 9. Prime both pushrods inside and out. Cover the inside by pouring a small quantity of primer inside the rod and slowly swirling it around. Rivet the VA-4908P or VA-169 rod ends to the pushrod and thread the rod-end bearings and jam nuts on. Temporarily tape the pushrod where it passes through the rear spar, so when aileron is removed the primer won't be scraped away.

Install the WD-421 bellcrank as shown on DWG 9. The bushing in the WD-421 needs to be reamed to final size for the slip fit on the AN4 bolt. The bushing should be slightly longer than the WD-421 aileron bellcrank. It is held firmly between the bellcrank brackets with the bolt. The bellcrank rotates around the bushing, not the bolt. This is the same way that the stick assembly is done also. Lubricate the bushing with your favorite grease when assembling for the final time.

Connect the W-917 and W-918 pushrods to the WD-421 bellcrank. Use the W-930 bellcrank jig provided to set the bellcrank in the correct neutral position. Use the alignment tool you built at the beginning of the wing construction to position the aileron in the neutral position. Clamp the aileron in this position and adjust the rod end bearings on the W-918 push rod until bolts at the bellcrank and A-906 bracket slip in smoothly. Tighten the jam nuts and label the push rod right or left as appropriate. Final adjustments will be made to the W-917 push rod later, when the wing is installed on the fuselage.

FINISHING THE WING

INSTALLING THE PITOT LINE AND WIRES

Install the Pitot line and fittings shown on DWG 9. Install SB437-4 snap bushings in the 7/16'' holes for the Pitot line in W-910 and W-911 (see DWG 9 & 10). Put the low profile face of the bushing on the flange side of the rib, to ease access to the skin rivets later.

Double check that you have done everything else inside the wing that you wish to do such as installing wiring for wing tip lights, installing a wing leveler servo, etc., before closing up the wing. If you have not decided on some of these items, riveting the bottom skins can wait until much later in the project.

RIVETING THE BOTTOM WING SKINS

Riveting the bottom wing skins requires two people.

With the wing laying upside down on a workbench top or saw horses, cleco both of the skins in place.

Rivet the W-905 outboard skins by unclecoing the forward third of the skin, gently lifting the skin and sliding and arm (with a bucking bar) between the skin and the main spar. Begin riveting at the rear spar, in the center of the skin, and work forward and out toward the forward corners. As rivets proceeds forward, you can reach through the larger lightening holes in the ribs. Use the access holes and lightening holes in the ribs to reach the rivets as necessary.

Drill the access panels to the bottom of the wing. Install the platenuts in the wing skin as shown in Detail B, DWG 11.

WING TIP INSTALLATION

Delay wing tip installation until late in the construction process, preferably until the aircraft is nearing final assembly. This prevents the possibility of damage from handling and gives every opportunity for the installation of lights, wing tip antennae, etc.

The tips may be installed with the wing lying down on a table or with a wing positioned in a cradle style storage fixture. See DWG 15.

The aileron control system is used to neutrally position the aileron, which helps to position the wingtip. Use the W-930 Adjustment Fixture to locate the aileron in its neutral position and hold them in place with a bungee cord.

Sand or file the flange on the W-915 Tip so it is an even depth and width all around.

Portions of the aft end of the W-915 Tip must be trimmed away to provide clearance from the aileron and W-914 Aileron Hinge Bracket (DWG 13.)

Slip the W-915 Tip into place. Push it forward so it is tight in the wing leading edge and align the trailing edge with the trailing edge of the aileron. An assistant is helpful.

Drill the W-915 Tip using a #40 drill. Begin at the leading edge and work to the back. Alternate holes from the top to the bottom. If you are unhappy with the placement of the tip, adjust it slightly when the holes are drilled to full size.

Swing the aileron out of the way and slip the W-916 Tip Rib (DWG 15) into place. Mark the location of the rib trailing edge on the tip.

Remove the tip and lay out the rivet lines (top and bottom) 5/16" from the edge. Cut the 2-1/4" hole in the W-916 Tip Rib using the 3/16 hole as a guide. See DWG 15.

Cleco the W-915 Tip back on the wing and slip the W-916 Tip Rib back in place. The flange edge must be flush with the tip edge.

Locate the rib chordwise so it is a fits without distorting the tip.

Drill and cleco the W-916 Tip Rib to the W-915 Tip. Remove the tip and machine countersink it. Rivet the rib in place.

The W-931 Rib is bonded and riveted in place. If the rib were only riveted in place the W-915 Tip would tend to pull and pucker between rivets. By initially bonding it in place the surface of the Tip is much smoother.

Scuff sand the interior surface of the W-915 Tip where the W-931 Rib will be located. Using 80-100 grit sandpaper will provide a good surface for the adhesive to bond.

Flute the W-931 Rib and adjust the flange angles so they match the interior surface of the tip as closely as possible. Do a good job. The smooth, flexible fiberglass surface will highlight any errors.

Place a bright light in the W-915 Wing Tip and position the W-931 Rib. The light will let you mark the location of the rib on the exterior of the tip. Remove the rib, lay out the rivet pattern and drill the tip.

A thick adhesive paste is needed to bond the W-931 Rib to the W-915 Tip. Use a fast curing, structural epoxy resin.

The resin will probably be too runny to do a good job right out of the mixing cup, so you will have to add flox (not microballons) to thicken the resin to a point that it resembles cake frosting.

Spread a 1/16" layer of the mixture on the inside of the W-915 Tip. Slide the W-931 Rib into place from the front. Now leave it alone until the resin has set. You want the Tip to be smooth, if it is squeezed or poked and prodded it may leave waves visible on the surface.

Drill the W-931 Rib using the holes in the W-915 Tip as a guide. Use a sharp bit and do not press so hard that the Rib is pulled free. Machine countersink the W-915 Tip and rivet the W-931 Rib in place.

The W-915 Tip may be riveted or screwed to the wing (DWG 11.) The choice usually depends on what kind of access is necessary to service lights, power supplies, etc.

If you decide to use the rivets the tip must be reinforced with a strip of aluminum to keep the rivets from cracking the fiberglass. Drill (#40) the W-928 Reinforcement Strips to the W-915 Tip using the existing holes.

Scuff the W-928 Reinforcement Strip and W-915 Tip with some 80-100 grit sandpaper. Bond the strip to the tip with resin (polyester or epoxy). Hold the strip in place with clecoes.

Remove the clecoes before the resin is fully hardened. You will look silly flying around with those clecoes sticking out of your wing tips.

When cured, cleco the W-915 Tips back on the wing and drill out to full size. Remove the tips and machine countersink the fiberglass to accept a 1/8" dimple.

Dimple the skins on the wing and blind rivet the W-915 Tip on. This step may be postponed until later to permit easier access.

If you are using screws and platenuts the platenuts may be riveted directly to the fiberglass. You may delete the W-928 Reinforcement strip. Screws and platenuts for this installation are not provided in the kit.

Instructions for installing the lens for the tip position and strobe lights are in with the wing kit. The hardware is in Bag-967.

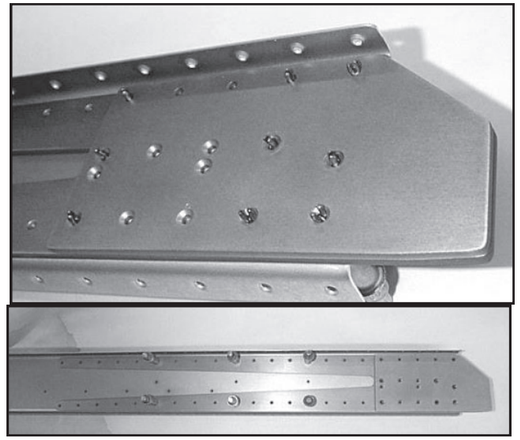


Fig. 7-1. The root end of the rear spar. Note that the flanges are already dimpled...it is hard to get a squeezer on them if the doublers are already installed.

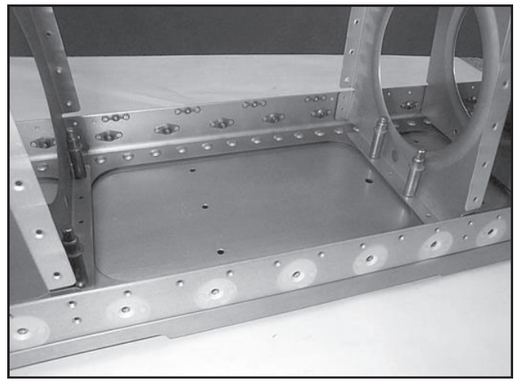


Fig. 7-2. Main ribs are fitted and drilled to the main spar.

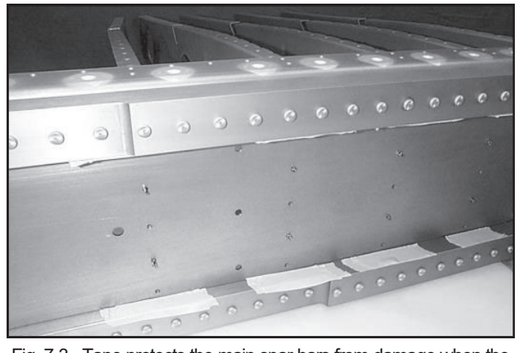


Fig. 7-3. Tape protects the main spar bars from damage when the ribs are riveted.

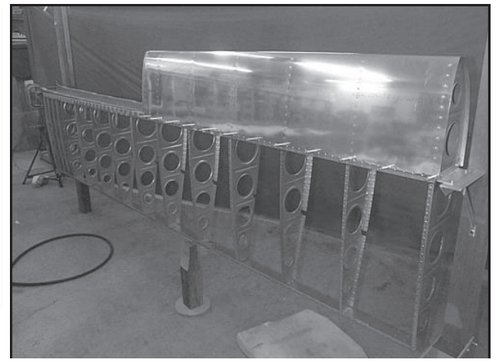


Fig. 7-4. A pair of posts and brackets hold the wing in a convenient position. The posts under the rear spar keep the structure from sagging. Here the leading edge is fitted to the wing skeleton.

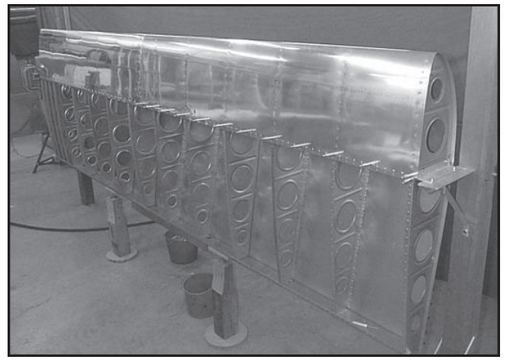


Fig. 7-5: The tank and top main skins are fitted.

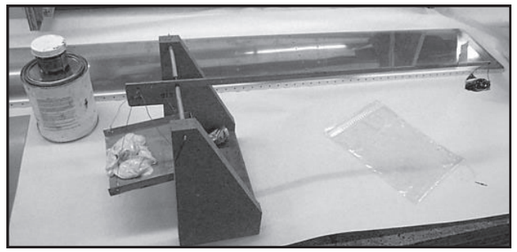


Fig. 7-7. Tank sealant is mixed in a shopbuilt 10:1 balance.

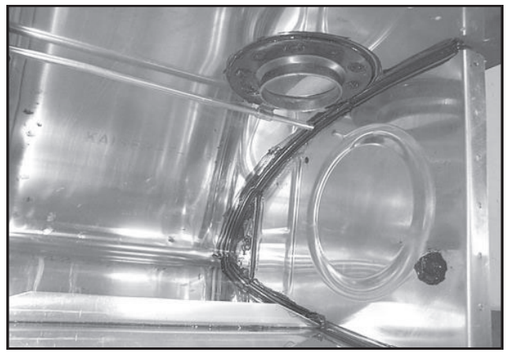


Fig. 7-8. The interior of the tank at the outboard end. The T-410 reinforcement helps seal around the nose. The blob on the rib is a 316" rivet set in the tooling hole and covered with sealant. The filler neck and vent line are also visible.

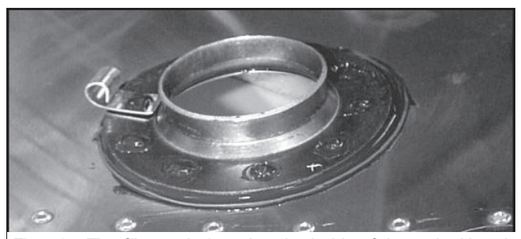


Fig 7-9. The filler neck riveted to the inside of the tank skin. A common rivet holds the T-914 clip to secure the vent line.

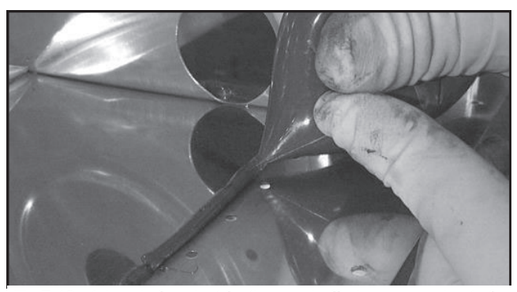


Fig 7-10. A bead of sealant for the rear baffle is squeezed out of a plastic bag.

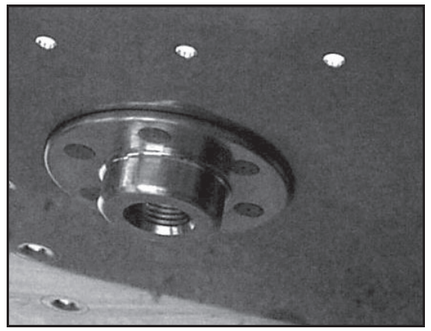


Fig.7-11. The VA-112 drain flange riveted to the outside of the tank skin.

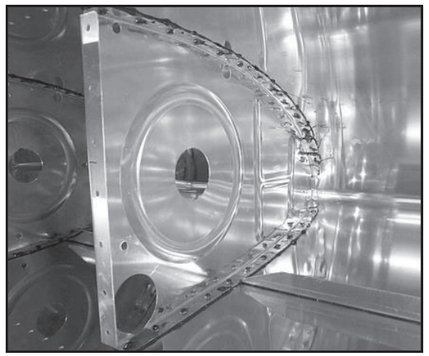
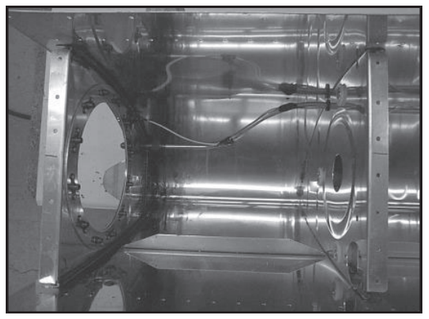
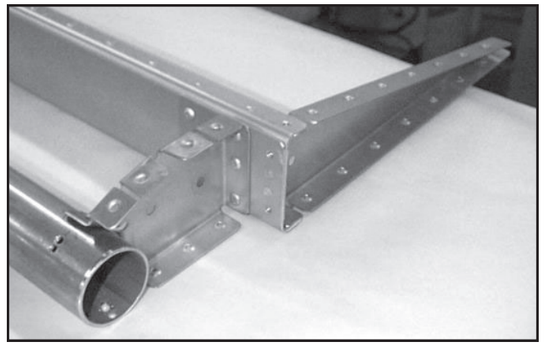


Fig. 7-12. An interior fuel tank rib, riveted and sealed.



Above: Fig 7-13. Details of the inboard bay. The access cover with the fuel sender attached will cover the large hole on the inboard rib. The vent line is looped forward to clear the sender float.



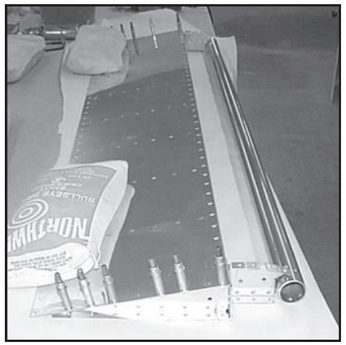


Fig. 7-17. The bottom skin is fitted to the skeleton. Bags of lead shot keep the assembly down tight on the flat worktable.

Fig. 7-14.The inboard end of the aileron skeleton.

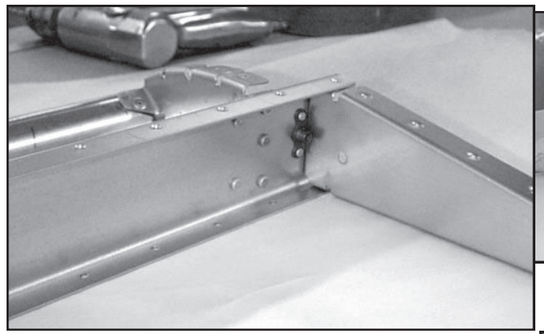


Fig. 7-15. A rear view of the inboard end, showing the platenut riveted to the spar.

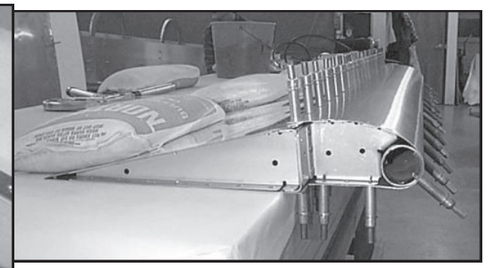


Fig 7-18. The top and nose skins are drilled and clecoed.

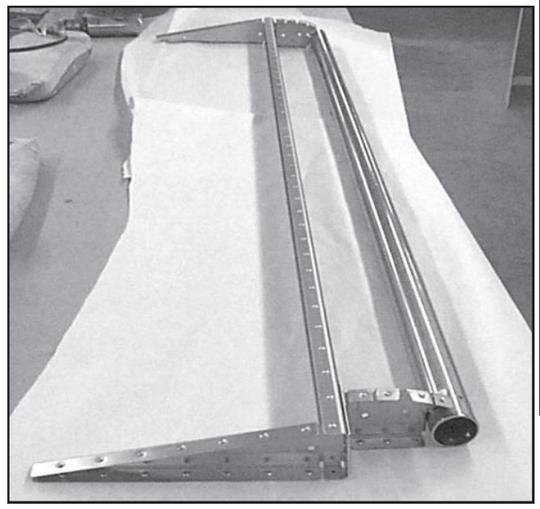


Fig. 7-16. The assembled aileron skeleton with counterbalance tube.

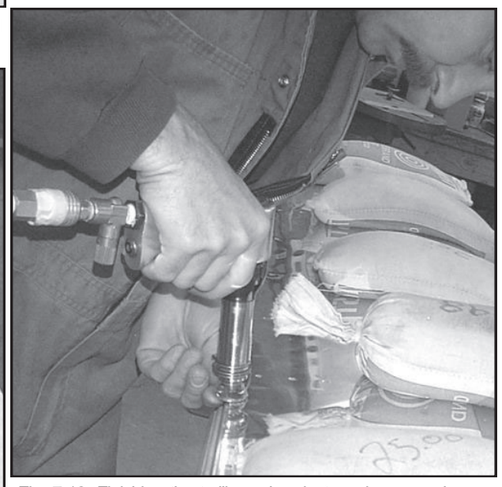


Fig. 7-19. Finishing the trailing edge rivets, using a mushroom set and a back-riveting plate set into the table.

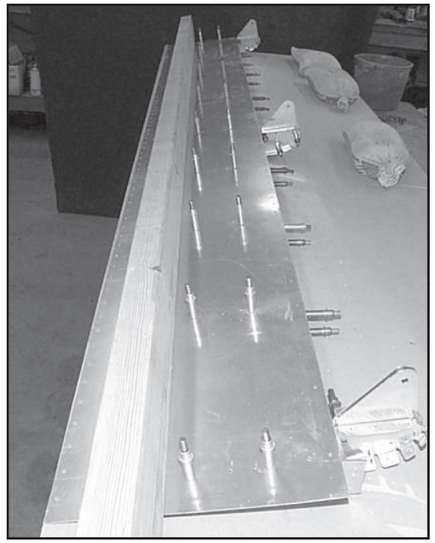


Fig 7-20 . The bottom flap skin is drilled to the rib/spar/ bracket subassembly.

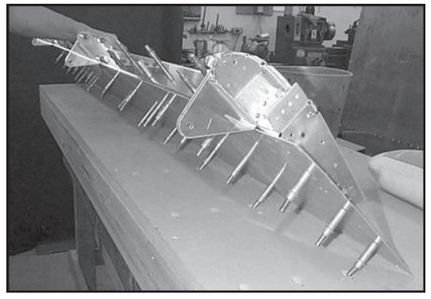


Fig. 7-21. The clecoed assembly is flipped over and the clecoes inserted through holes drilled in the worktable.

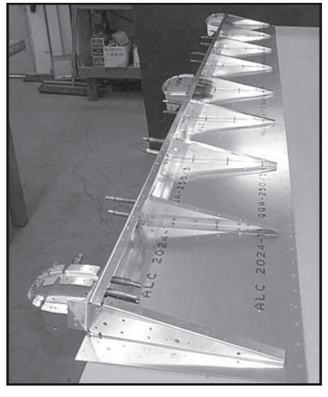
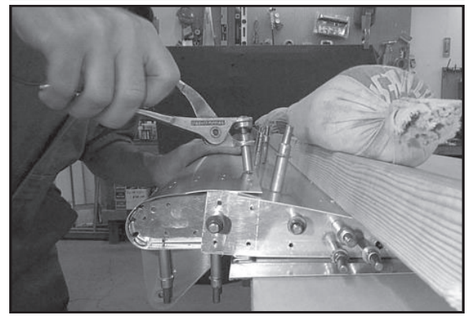


Fig. 7-22. The assembly lies flat on the surface of the table.

Fig. 7-23. The top skin is held down with a board and weights.

Fig. 7-24. The nose skins are drilled onto the flap assembly, starting at the bottom and working around the leading edge.

Fig. 7-25. Clecoing the nose skin to the top of the spar.



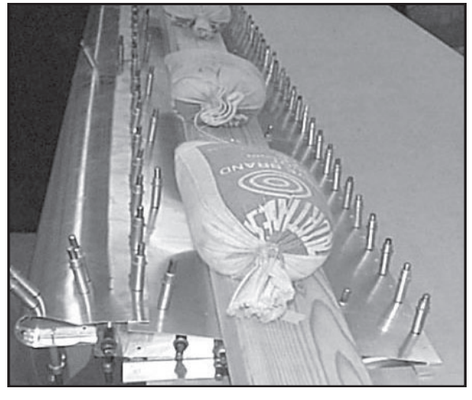


Fig. 7-26. The trailing edge wedge is drilled and clecoed to the table. The other wedge is used as a spacer to establish the correct position.

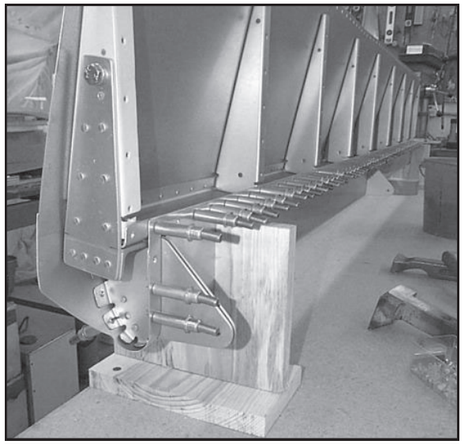


Fig. 7-27. The flap assembly is inserted into the “saddle” fixture for riveting.

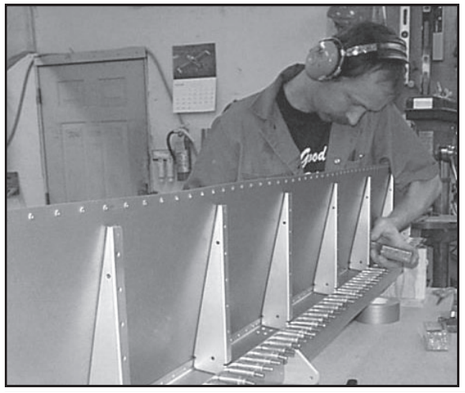


Fig. 7-28. Riveting the aft top skin to the ribs and spar.

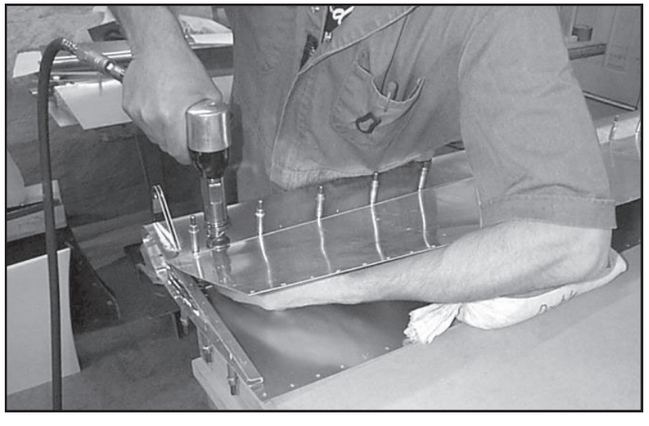


Fig. 7-29. Riveting the aft bottom skin and nose skin to the spar.

NOTES

SECTION 8. BUILDING THE FUSELAGE

INTRODUCTION

The RV-9/9A fuselage is a semi-monocoque structure. The skins carry a majority of the load and they are held in place with a combination of bulkheads and longerons (also called stringers).

All the ribs, bulkheads and skins are pre-punched at Van's factory. No jigs or alignment fixtures are required ... when the holes align, the fuselage must be straight. All that is required is three sturdy sawhorses to support the fuselage as it is assembled and a clean, level table used to assemble the bulkheads.

A NOTE TO QUICKBUILDERS

Obviously, not all the information needed to build the fuselage from the Standard Kit is necessary for a fuselage built from the QuickBuild Kit. However, we still recommend reading the entire chapter to gain the “big picture.” Once you understand the basics of fuselage building, you can extract the relevant information for the QuickBuild Kit.

STRAIGHTENING, FLUTING AND PRIMING

Seam and flute the flanges of the ribs and bulkheads. If you are the kind of person who eats their vegetables first, you can finish all the ribs and bulkheads now. Otherwise, you may finish them as you need them.

Not all flanges are seamed to exactly 90°. The aft end of the fuselage is a cone, so the bulkhead flanges should match the angle of the skin. It is hard to get the perfect angle unless the bulkheads are in place and you can sight down them. For now, get them as close as possible. The perfect adjustment can be applied later when the bulkheads are all in place.

From here on we will assume that you know enough to deburr, dimple/countersink, and prime everything as necessary before assembly. We will only mention these chores if there is a special order or technique that should be used.

PREPARING THE BULKHEADS

ASSEMBLING THE F-601 FIREWALL

The firewall is a stainless steel bulkhead, reinforced by aluminum angle. Steel brackets, fitted on each corner, provide a means of attaching the longerons and supporting the engine mount.

Stainless steel has a couple of nasty qualities. First, edges can be very sharp. Second, it will quickly dull your drills, unibits, and deburring tools. When drilling stainless, use regular twist drills for holes 1/8" or smaller. Use a unibit on all larger holes. Use plenty of lubricant (we like Boelube) with either, and keep the drill speed low. Paying attention to the best drill/feed speeds, combined with Boelube, will allow your cutters to last the life of the project. Without them, you will be buying a new cutter every 5 to 10 holes.

Begin the firewall by making the F-601J angles from AA6-187x2x2 1/2 stock, as shown on DWG 19.

Position and cleco all pre-punched or drilled stiffeners, spacers, gussets and weldments to the matching holes in the F-601A-2 firewall. Drill and cleco the remaining holes, using F-601A-2 as a guide.

Fabricate the F-601P spacers and F-601E stiffener and install them per DWG 19. Note that you need to round some edges of F-601J and the ends of F-601N-L&R to fit the inside radius of the aluminum angle they rest upon. There is no need to make this curve exact -- just remove enough of the corner to allow the edges of the brackets to rest on the flanges of the angle.

Square F-601J-L&R with the F-601N and F-601M stiffeners. Align F-601J-L/R horizontally by nesting their inboard face with the outboard face of F-601N-L/R. Use the dimension given on DWG 19 for vertical alignment. Clamp F-601J-L&R and underlying shims F-601H-1 and F-601G-1 lightly in place and align the pre-punched holes. Then tighten the clamps and back-drill F-601J through the firewall.

The brake lines require an F-6122-1 bracket riveted to the firewall. This bracket holds the fittings that connect the flexible brake hoses from the master cylinders to the solid brake lines leading to the wheels. Drill F-6122-1 to F-601A-2 as shown on DWG 19, Firewall Bulkhead Rear View.

Cleco the firewall recess (necessary to provide room for the oil filter and prop governor) F-601K-1 in the square hole centered in the F-601A-2 bulkhead. Drill all holes to full size.

Fit and drill the F-601Z Fuel Pump Doubler to the lower firewall. Rivet it to the firewall. Note that the nutplates are on the forward side of the firewall and the rivets holding them penetrate both the F-601A-2 stainless firewall and the F-601Z doubler.

Disassemble the firewall, dimple F-601A-2 and F-601K-1, then machine countersink the underlying stiffeners and spacers. The firewall is built using flush head rivets, with the flush heads on the forward side. This gives a smooth surface, making the firewall easy to clean and easy to fit brackets, etc.

Rivet all the components of the firewall together, except the F-601K recess. Leaving the recess out will allow a good access through the firewall and make installing the rudder pedal brace much easier.

Drill the top two engine mount attachment holes using the holes in WD-602-L-1 & -R-1 as guides. Make sure the drill remains perpendicular to the firewall while drilling so that the bit exits centered on the pre-punched hole in the firewall. A block drilled in a drill-press and held flush against the flat on WD-602-L-1 & -R-1 can help maintain perpendicularity.

The firewall keeps fumes and liquids in the engine compartment from entering the cabin. Some of bent corners have unavoidable openings, especially around the firewall recess and the lower corners of the firewall. Seal all openings with fuel tank sealant after skinning the fuselage.

ASSEMBLING THE F-904 BULKHEAD

The F-904 bulkhead is a massive assembly and there's a reason: it is the heart of the fuselage. It transfers most of the loads carried by the airplane. Deburr and prime all of the pieces that need it. The F-904 was drilled in a fixture, in assembly with the wing spars to insure an exact fit. Important pieces are marked so they may be returned to their proper location.

The F-904 bulkhead is shown on DWG 16.

Drill the holes that will receive snap bushings in F-904A/B/C/D to full size.

Attach the F-904C-L&R Center Sections to the F-904A forward bulkhead and the F-904DL&R Center Sections to the F-904B aft bulkhead. Assemble the components with clecos and put a NAS1307 bolt through at least one hole on both top and bottom to align the parts exactly. On the aft F-904B, locate the F-904G shear bars with bolts and clamp them in place. Drill the rivet holes to final size, then disassemble, debur and dimple as necessary. Rivet the F-904C, F-904D and F-904G parts to the center section. Note that the rivets attaching the F-904G bars have flush heads on the forward side.

Fabricate the F-633 Control Column Mounts. Drill the first bolt to hole to the dimensions shown, then bolt the F-633 to the aft F-904. Square it carefully and back-drill the second hole through the pre-punched hole in the bulkhead. After the holes are drilled, you may trim away the area shown (on the bolted leg of the angle, not the leg with the bearing in it!) to save weight.

Now is a good time, while the bulkhead is wide open, to fit the Wd-610 control column and Wd-611/612 control stick bases. These are bolted together as shown on DWG 38. Once the control stick assembly is fitted it may be removed as a unit, leaving the mounts bolted to the bulkhead, and stored.

Countersink all the nutplate rivet holes on the top flanges of F-904A/B. Rivet on all nutplates.

Prepare the F-982B-L&R and F-983B-L&R Cover Support Ribs. Drill them to the bulkhead, then remove them and install the nutplates. Drill the snap bushing holes to full size.

Fabricate the F-904M Web Stiffeners and drill them to the F-904A.

Rivet the Cover Support Ribs and Web Stiffeners to F-904A.

Make the F-904J Center Section Spacers from the rigid aluminum tube provided. The ends are squared by chucking them in a drill press and spinning them gently against a piece of sandpaper or fine file held flat on the drill press table.

Make some spacer blocks from dense wood or particleboard to hold the halves of the center bulkhead assemblies the correct distance apart. The thickness of these spacers must be 1.438” (1 7/16”) to match the thickness of the spar. Drill the blocks (the holes may be oversize) to allow the bolts to run through the spacers.

Bolt the two center bulkhead assemblies together around the spacers for a trial fit. Do not rivet the F-904H side plates on now. They will be riveted to the center section after being riveted to the side skins. It is a strange order but it allows some potentially difficult rivets to be set easily.

When you are assured everything fits correctly, remove the bolts and spacers so the bulkhead is once again two separate halves, fore and aft. Store all the bolts and spacers in a bag and tape the bag to the bulkhead.

ASSEMBLING THE F-705 BULKHEAD

The F-705 bulkhead serves several purposes. It supports the seat backs, strengthens the open cockpit and provides the attachment for the rear wing spar. Details are shown on DWG 20.

Trim the ends of the F-705B Center Section Bar as shown on the upper right of DWG 38. Mark a lengthwise centerline on the rear face of the bar. Locate and clamp the F-705B, the F-605C Bar Doublers and the F-705H Spacers to the F-705A Rear Spar Attach Bulkhead. Drill the assembly using the prepunched holes in the F-705A as a guide.

Drill the F-634 seat belt anchors to the F-705 lower bulkhead assembly. One of each pair of anchors should be

drilled first. Bolt it to the F-705A, then put a 3/16" shim between it and the other anchor and clamp the three pieces together. Clamp the flange of the unbolted anchor to the bulkhead. Drill the anchor using the prepunched hole in the bulkhead as a guide. In some cases, the flange of the seat belt anchor comes close to an adjoining rivet or bolt hole. Grind or file the flange of the seat belt anchor to allow for bolt or rivet heads as necessary. Be careful to preserve a 2 diameter edge allowance from the center of the anchor bolt hole to the edge of the anchor flange.

Disassemble and prepare the F-705A lower bulkhead for riveting. Fabricate the F-705G angles (for the tip -up canopy only) and drill the snap bushing holes to full size.

Drill and rivet the F-705J Angle, the F-705K Plate and the F-705-L seat adjustment supports to the F-705F Channel.

Drill the snap bushing holes and install the nutplates on F-705D. Cleco the F-705A, D and F bulkhead components together.

If you are planning a tip up canopy, cut a slot into the F-705G angle, using the slot in F-705D&F as a guide. These slots provide room for the canopy latch fingers when the canopy is closed.

Before riveting the F-705 bulkhead assembly together, see the NOTES on DWG 20 for the various holes that must be left open so other pieces may be attached later. Cover these holes with tape. Also note the holes that must have flush rivets installed and be sure they are dimpled.

Rivet the F-705 bulkhead together.

Fit and drill the F-661EF flap actuator bearing blocks. You may drill out the bearing blocks with a #10 drill if necessary to fit the bolts. Once the blocks are fitted, remove and store them, they will be bolted on permanently when the flaps are installed.

Bolt the seat belt anchors and F-705H spacer to the lower bulkhead.

ASSEMBLING THE F-706 BULKHEAD AND BELLCRANK SUPPORT RIBS

Bulkhead details are shown on DWG 21. The F-706 ring bulkhead is made of three pieces. The F-729 bellcrank rib, F-728 Bellcrank Channel, F-730 Plate and F-729C Angle all attach to the aft side of the F-706B Bulkhead Bottom (see DWG 26.)

Use a unibit to enlarge the rudder cable holes on all these bulkheads..

Make the F-729C angle shown on DWG 26.

Drill and rivet the F-729A bellcrank Rib and F-729B angle together. Be sure to drill the 1/4" hole for the bellcrank pivot bolt.

Drill the F-728A Bellcrank Channel to the F-728B angle, but do not rivet them together yet. Be sure to drill the ¼" hole for the bellcrank pivot bolt.

Begin assembling the bulkhead by drilling the F-730 plate, F-728, F-729C and F-729 rib to the F-706B Bulkhead Bottom. After deburring, rivet the assembly shown in Detail A of DWG 26 together, except for the F-728 channel. Leave that clecoed for now.

Fit and rivet the F-706A-L&R bulkhead halves to the F-706B bulkhead bottom. Leave the top joined with clecos. Drill and cleco the F-728 channel to the pre-punched location hole on the top of the F-706A bulkhead.

ASSEMBLING THE F-707, F-708, 709, and 710 BULKHEADS

See DWG 21. The F-707 and 708 bulkheads are simple two piece bulkheads. Align the tooling holes and rivet them together.

F-711 BULKHEAD

The F-711 is a double bulkhead. The front half is F-711A and the back half is F-711B.

The protruding F-711C bars will attach to the horizontal stabilizer. Mark the centerline of the F-711C bars. Cleco the F-711A&B bulkheads together, using the holes that are not common with the bars. Clamp the bars against the F-711A forward bulkhead, with the lines showing in all the pre-punched holes, then drill using the prepunched holes as a guide.

Both F-711 Bulkheads must have the upper portions trimmed away to allow the elevator pushrod to pass through. Trim to the marks on the bulkheads.

After the usual preparation, rivet the bulkheads and bars together to form the finished F-711 Bulkhead.

F-712 BULKHEAD

The F-712 is also a double bulkhead and again F-712A is the front and F-712B is the rear. They must be riveted together before the fuselage is assembled. Note that flush rivets are used with the flush side aft. The aft surface must be smooth so the vertical stabilizer spar will fit. For RV-9A builders, the aft tiedown will be fitted later, in assembly with the vertical stabilizer .

BENDING THE LONGERONS

This section will require more of an artist's touch and a little finesse. The F-718 longerons (see DWG 18) must curve, bend, and twist to form the necessary shape of the fuselage. Aluminum angle can do maddening things when you try to bend it. If you bend it in one dimension, it will also move in another. You must persevere. Correctly bent longerons are fundamental to an accurate fuselage.

Begin by finding the AA6-125 longeron angles (shipped in your wing spar box). Measure and trim them to the correct length - see Note 2, DWG 18. Triple check before you cut! Trim the horizontal face on the aft end of the angle as shown on Detail C, DWG 18.

You will obviously be bending a left and right version of the F-718 longeron. It is easy to get confused and bend one incorrectly, so mark the longerons plainly for front, rear, top and side.

Lay the longerons side-by-side on the floor with the ends matching. Mark the starting and ending point of the shallow curve, looking down. This bend follows a line 0.032” inside the outside edge of the F-721B Aft Canopy Deck. Mark the location of the sharp downward bend, in side view. This bend occurs at the front end of the F-721 B.

BENDING THE SHALLOW CURVE

Bend the F-718 longeron angle in a sturdy vise mounted to a solid, stationary table. Pad the jaws to protect the longerons from gouges and scratches.

The general idea is to hold the angle in the vise, pull on the free end and establish a small "pre-load" on the angle and then give it a small-to-medium whack with a rubber hammer to produce the bend. Several small, progressive bends will form the curve.

Cut the template from DWG 17 and glue it to a piece of stiff cardboard or aluminum. This serves as your guide while bending the longeron. Make both sides useable so it will work on both a left and a right longeron.

Clamp the angle in the vise so the end of the jaw is one inch aft of the aft mark. Start bending at the mark. Push the forward end of the longeron in the correct direction, hold it there, and hit it right at the end of the vise jaw with the rubber mallet until it bends a few degrees. Move it an inch and repeat the process until you get to the other mark. Check it often against the template to prevent overbending.

Keep coaxing the angle until it matches the curve of the template. You can clamp the angle in a six-inch vise without removing any of the bend, so it is easy to add more bend.

Remember to check that the angle has not bent out of plane (up or down) as you were applying the sideways load - it is quite common to get vertical bow while you're bending a horizontal curve. If this happens, rotate the longeron 90°, clamp it in the vise and bend it back straight with your hands. You can call it a night when the curve of the F-718 longeron matches the curve on the template within a 1/16" all around and the angle sits flat on the table within a 1/16".

Tape a piece of 0.032” aluminum to the outboard surface of the longeron and fit the F-721B aft deck to the top of the longeron. Carefully establish the fore/aft position. The shim will simulate the F-970 side skin. When the outside edge of the side rail matches the outboard surface of the shim, drill the F-721B to the longeron. Leave it clecoed for now.

MAKING THE SHARP DOWNWARD BEND

The front of the F-718 longeron needs the sharp bend and twist applied. The bend is done using the same method as the curve; you just don't move the longeron. The angle will really want to curve off axis on this bend. Check this bend by using the F-970 forward side skin as a template. The angle should match the upper portion of the skin within about a quarter of an inch.

TWISTING THE FORWARD END OF THE LONGERON

The twist is applied with a big crescent wrench. Clamp the longeron in the vise, with the point of the downward bend at the end of the vice jaw. Grab the end of the angle and give it a twist. Keep going until you have the twist shown on View A-A', DWG 18.

FINISHING THE J-CHANNEL

Cut the F-786A, B, & C J-channel to length and prepare the ends as shown on DWG 18. A cutting disk in a die grinder works well here too.

AFT FUSELAGE ASSEMBLY

Now for the fun part: putting some of the big assemblies together.

Set up three sawhorses so they are all at the same height and level.

Begin the assembly by clecoing the F-779 Tailcone Skin to the F-711 and F-712 bulkheads.

If you are building an RV-9, the WD-409 tail spring mount must be fitted between F-711 and F-712. Also, the F-779 skin must be relieved to allow the tail spring mount tube to protrude aft and down. See drawing 27 for WD-409

installation details. The “mouse-hole” in the bottom of F-712 may be enlarged as necessary to allow the tube and weld fillet of WD-409 to fit.

The WD-409 forward plate upper edge should be used to square the tail spring mount with the F-711 bulkhead assembly. Drill through F-711 and WD-409 for the AN4 bolts using the pre-punched holes in F-711 as drill guides. Drill through F-712 and WD-409 for the two “keeper” rivets only; the three bolt holes will be match-drilled later while attaching the vertical stabilizer. If there are any gaps between WD-409 and the two bulkheads, a shim should be installed between F-711 and WD-409. After fitting and match-drilling WD-409 to F-711 and F-712, remove WD-409.

Now that WD-409 has been fitted between the two aft fuselage bulkheads and removed, it is now time to match-drill the tail spring to the tail spring mount. The pivot axis of the tail wheel assembly must be perpendicular to the upper edge of the WD-409 tail spring mount forward plate. Match-drill the tail spring mount and tail spring and set aside until later.

Lay the F-778 Aft Bottom Skin across two of the sawhorses, with the outside surface down. Reach underneath and cleco the F-707 and F-708 bulkheads to the inside of the skin.

Mark the outside face of the lower 4 J-channels with a lengthwise centerline. Slide the lower 4 J-channels into the slots in the bulkheads, leaving them loose for now.

Slide the assembly to the edge of the sawhorses and cleco the F-773 side skins to the bulkheads.

Cleco the F-706 bulkhead to the assembly.

Cleco the F-729A bellcrank rib to the bottom skin.

Now add the F-711/F-712/F-779 assembly and cleco in the F-710 bulkhead.

With all the skins in place check to make sure there is no twist in the fuselage by hanging a plumb bob on bulkheads on each end. The tooling holes are on center, so if the plumb line falls past the center of the top and bottom holes, on both bulkheads, the fuselage is straight. Check before you drill!

Double check the J channels for proper position and drill them to the skins. It works best to drill every fourth or fifth hole and cleco. Work from one end to the other. When the J-channel is located, drill the remaining holes.

Drill all of the remaining holes (except the ones for the F-706 bulkhead and the F-718 longerons) to final size.

NOTE: see DWG 27A for the position of the F-792 rudder stop One hole must be left open to match with the drilled hole in the rudder stop. Mark this hole or tape over it so that it will not be riveted or dimpled.

When drilling is complete, remove the skins. Debur the structure and skins, dimple as required, and cleco the rear fuselage back together.

Rivet F-712 bulkhead to F-779.

RV-9 Only: Attach WD-409 to the F-712 assembly using keeper rivets previously drilled.

Rivet the F-711 bulkhead assembly to F-779 and bolt WD-409 (RV-9 Only) to the F-711 assembly.

Rivet the F-779 and F-778 bottom skins to the bulkheads and J-channel.

Rivet the F-773 skins to the bulkheads up to the upper J-channel, and to the J-channel itself, but no higher. The top of the skins must be able to bend away from the upper sections of the bulkheads so the main longerons can be inserted later.

PREPARING THE CENTER FUSELAGE

The center fuselage is shown on DWG 22. Skins are shown on DWG 28.

Make four F-916C spacers from aluminum plate as shown on DWG 22.

Modify one F-916-L and one F-916R Seat Rib by adding the F-716B Seat Rib Access Plate and cutting the rib. The top of the ribs must be removable to install the control system.

Modify one F-916R and F-916-L Seat Access Rib by enlarging the lightening hole in the forward portion as shown. The extra space is needed to allow the controls to move.

Install the nutplates on all the seat ribs. Screws generally fit quite tight in nutplates, and because there isn’t much room for a screwdriver on the outboard edges of the floor skins, it is acceptable to run an 8-32 tap through the nutplates. This will make it easier to install the screws. Be careful and use a lubricant on the tap.

Attach the rear half of F-904 center section bulkhead to the F-916 and F-915 seat ribs. Be sure you have the modified ribs in the proper place. F-916 ribs may be clecoed, but the F-915 seat ribs are not drilled to the center section until later, so hold them in place with clamps for now.

If you are going to install the optional step(s) cut the F-725 baggage ribs with a 1 5/8" hole saw using the prepunched hole as a guide.

Cleco the F-725, 726, and 727 baggage ribs to the F-705 rear spar bulkhead.

Cleco the F-705 bulkhead and ribs to the aft ends of the F-915/916 seat ribs. Insert the F-916C spacers at the

necessary stations.

Cleco the F-976 center bottom skin to the center fuselage assembly. The skin holds the F-915 and F-916 seat ribs in correct alignment.

Drill everything to final size except for the aft two rows (spanwise) on the F-976 center bottom skin. Fit and drill the F-623 corner ribs. Flute the F-623 as necessary to fit the skins, and if you are installing steps, trim the flange to clear the step tube. Make the F-623A forward and aft attach straps.

Once again, fit the front half of the F-904 bulkhead to the rear half. Use the pre-fit bolts and spacers you made earlier to hold the bulkhead together.

Now, drill the holes on the forward edge of F-976 to size.

NOTE. See DWG 28. Rivets at the intersection of the spanwise row across the forward F-904 bulkhead and the fore-and-aft lines along the stiffener are shown as AN426AD3-6. Machine countersink these holes through the F-976 skin and into the bulkhead. Rivets through these holes will later attach the floor stiffeners and a smooth inside surface will help fit the stiffeners property.

Once the bottom skin is clecoed on, fit and drill the F-904H side doublers to the center section.

Remove the clecos and prepare the parts for riveting. Do not dimple the holes in the aft edge of the F-976 bottom center skin. They will match up with the F-706 bulkhead and F-778 bottom aft skin later when the two fuselage halves are brought together.

Dimple the holes (in the skin and the ribs) that will later match up with the lower aft tabs on the F-725, 726, and 727 baggage ribs.

ASSEMBLING THE CENTER FUSELAGE

After all the preparation, it's time to rivet and bolt the skeleton of center fuselage together. Details are shown on DWG 25.

Draw a centerline on the bottom flange of the F-915 ribs.

Start at the aft face of the F-904 bulkhead and install the F-916-L&R ribs. Use bolts and rivets as shown on DWG 22.

Turn the center fuselage upside down and rivet on the F-976 center bottom skin on the skeleton. Remember to leave the holes for rivets common to the F-672 Forward Bottom Skin open.

Do not rivet the F-623 corner ribs on yet.

Turn the assembly upright and cleco in the F-742-L&R, F-747-L&R, F-939, and F-940 baggage and seat skins. See DWGs 25 and 29. Drill all of the holes, except for those through the F-915 outer seat rib, to final size.

Drill the F-915 outer seat rib to the F-904 bulkhead. Position the top of the rib so the distance between the outside of the web and the outer edge of the seat skin is 0.032” (use a bit of scrap for a spacer.) This means a thin strip of flange will be visible past the edge of the seat skin when viewed from the top.

The seat and baggage skins should be left clecoed in place to help keep the fuselage stiff and straight during the assembly.

JOINING THE REAR AND CENTER FUSELAGE ASSEMBLIES

It's time to join the aft and center sections of the fuselage. Place the tailcone assembly upside down on a couple of sawhorses. Add another sawhorse on the forward side of the tailcone assembly approximately where the F-904 bulkhead will rest.

Set the F-718 longeron assemblies on either side of the aft fuselage. Remove just enough clecoes from the F-773 side skins to allow the longeron to be slipped into the notches in the bulkheads. Align the vertical leg of aft end of the longeron with the aft end of the flange of F-712.

The longerons must be notched to fit around the F-711C bars as shown on DWG 18.

NOTE: *NOTCH THE LONGERONS, NOT THE F-711C BARS!*

With the longerons in place re-cleco the side skins to the bulkheads. Add a few clamps to keep the longerons aligned with the top of the side skin.

Place the center fuselage in position. Place the top of the F-904Cs so they rest on the third sawhorse. Slip the F-725, 726, and 727 baggage ribs and the F-976 center bottom skin into place over the F-706 bulkhead and F-778 aft bottom skin.

Cleco the F-725, 726, and 727 baggage ribs to the F-706 bulkhead from the rear. Cleco the F-976 center bottom skin to the F-706 and the F-778 aft bottom skin.

The F-970 forward side skins are fitted next. (If you are going to install a step, use the holesaw to drill the F-970 where the tube of the step will pass though. Pilot holes show the location. If you are not installing a step, dimple

these holes and fill them with 'rivets to nowhere'). Cleco the F-970 forward side skins to the F-904, F-705, and F-706 bulkheads, and the F-773 aft side skins. It may be necessary to raise or lower the tailcone slightly to align the holes.

Use a straight edge to mark the flanges of the F-623 corner ribs where the step comes through. Use the F-970 forward side skin and F-725 baggage rib as a guide. Remove the ribs and trim them on the table.

Check the forward ends of the main longerons. The longerons should follow the top edge of the F-970 side skin. If they do not, adjust the bend/twist in the longeron until they do.

Fit and drill the F-920 armrests. You may flute lightly between the holes in the armrest to make it match the holes in the fuselage side skin. After drilling, remove and store the armrests. They are installed after the side skins are riveted on and the seat floors are installed. Do not install the LP4-3 blind rivet until the F-704Ks are installed.

Remove the F-970 forward side skins.

The conical bend at the lower aft end of the F-970 skin must to be rolled to fit the aft fuselage. Clamp the F-970 to the table with a couple of C-clamps and a length of angle. Arrange the skin so the bend line rests between the edge of the angle and the edge of the table.

Drill a piece of scrap AA6-125 angle to match the lower edge of the skin and cleco it to the skin, using clecoes in every hole. The bend of the skin is very tight -a sharp 90° bend - on the forward end, and opens to a gentle curve at the aft end. Clamp visegrips to the aft end of the angle and use a twisting, rolling motion to start the curve. At the same time, use a strong push with the thumb of the other hand to form the tight bend at the forward end. It may take several tries and trial fits to form a bend that makes a smooth transition to the rear fuselage. Be patient and take the work in small steps.

Make and install the F-623A Rib Attach Strips that fasten F-623 to F-705. See View C-C', DWG 22.

Cleco the F-970 skins back on the fuselage.

At this point all the skins below the main longerons and aft of F-904 should be clecoed to the fuselage skeleton. Clamp the skins aft of F-904 to the longerons, being sure to that the corner of the longeron is flush with the edge of the skins. Begin drilling all the holes through the skins and the longerons, starting at the tail and working forward.

NOTE on the F-773 side skins that there is a "rivet between rivets" several places along the main longerons. These rivets are used to fasten the skin and longeron during construction. The rest of the holes are left open and used when the top fuselage skins are installed.

ADDING THE FORWARD FUSELAGE

At F-904, clamp the longerons even with the upper edge of the F-970 skin. Now check the forward edge of the F-970 ... the skins should extend 3/4" past the forward edge of the longerons. If the longerons are slightly short, there is no problem, but if they are closer than 3/4", trim them back with a die grinder and cutting disc.

Drill the remaining holes connecting the longerons to the F-970 skin.

Make the four F-904-L straps shown in Detail D, DWG 23.

Remove the forward six or seven clecos from the longerons and set the firewall in place. The rear facing "fingers" of the WD-602 brackets rest on the inside of the longeron angles. Clamp the firewall to the longeron.

Draw a centerline on the flange of the aluminum firewall angle. Cleco the F-972 Forward Bottom Skin to the F-904 bulkhead. Clamp the skin to the firewall with the line centered in the 2nd row from the front edge. Drill a hole on each side of the fuselage, through the skin and angle. This will set the distance between the firewall and the F-904 bulkhead.

Slip some AN470AD4 rivets into all the holes in the skin and longeron between the firewall and the aft end of the WD-602. At this point, these holes have not been drilled through the steel brackets and the firewall is heavy enough to cause some sag in the longerons and make the holes mis-align.

Now, take a break for a few minutes. When you return recheck that:

1. The forward face of the firewall is 5/8" aft of the forward edge of the F-970 skin.

2. The webs of the longeron -angles are clamped tightly to the Wd-602 brackets.

3. The 1/8" holes in the F-970 skin and longerons are still aligned -in other words, 1/8' rivets slip easily into the holes.

When all these things have come to pass, drill the F-970 skin to the flanges of the firewall, starting at the top longeron and working toward the bottom.

Add another clamp or two to the longeron/bracket assembly and continue the holes already in the longeron and skin through the steel brackets. Put a cleco in each hole as you drill it.

Drill the F-972 skin to the flange of the firewall and the aluminum firewall angle. Cleco in place the FF-00098 Cowl Attach Plate and FF-00099 Cowl Attach Shims and drill through the skin and into these parts to “clean-up” the

holes. The location and orientation of the attach shims and plates are found on DWG 28, BOTTOM VIEW, SECTION A-A, and F-972 FWD BOTTOM SKIN.

If you are building an RV-9A, remove the F-972 lower skin and use the template shown on DWG 34A to locate the holes for the landing gear sockets and brake lines. Enlarge these holes as shown. Some of the forward flange of the F-904 must also be removed for gear leg socket clearance.

INSTALLING THE AUXILARY LONGERONS AND FORWARD BULKHEADS

Draw lengthwise centerlines on Auxiliary Longerons F-713 R&L. Trial fit the longerons between the firewall brackets and the F-904 bulkhead. To fit properly, the longeron must be twisted slightly and the aft end must be filed at an angle to butt against the F-904.

Clamp the forward end of the F-713 and wiggle the aft end until the centerline appears in the pre-punched holes in the F-970 side skin. Drill and cleco.

Make the two F-719B Angle Clips shown on DWG 23. Use them to help fit the F-719R&L Forward Skin Stiffeners to the skin in the same manner as the F-713 longerons. Note that the joggled end of the F-719 goes aft and laps over the edge of the F-904 bulkhead as shown in Sect H-H'.

Make the F-917-R&L Lower Longerons. These are simply lengths of AA6-125 x 1 x 1¼ angle. The aft end is cut at an angle to butt against the vertical side of F-904, and 4 1/8” of one leg of the angle is removed as shown on the plans. This is for clearance of the F-7114 gusset (RV-9) or the WD-921 landing gear mount (RV-9A). See DWG 34 or 34A. To mate with the curving forward fuselage, this longeron must have a bit of twist. Clamp the longeron in a sturdy vise with the forward 3-7/8" captured between the jaws

Use a large padded crescent wrench on the vertical leg of the angle to twist it inboard. Work in small steps and fit the longeron to the fuselage until it "nests" well with the Wd-603 bracket (see Section K-K') and butts against the forward edge of the F-904 bulkhead (see Section N-N'.) The vertex of the longeron should parallel the lower edge of the F-970 side skin. About 1/8” of the longeron will be visible, extending below the edge of the skin.

When the longeron fits in Wd-603, clamp the assembly and drill the four vertical bolts shown in Detail L, Detail A and the Side View of DWG 23.

Clamp the aft end of the longeron to the F-904 bulkhead for now.

Before drilling holes for the rivets that join the lower longerons and auxiliary longerons to the Wd-603 brackets, the F-684 gussets must be fitted. These require some careful edge filing to fit really well, but this is an important juncture, so make sure all the parts fit before riveting. The forward edge of F-684 should be 1/8” aft of the firewall bulkhead and the lower edge should align with the lower edge of the F-713 Aux. Longeron. Adjust the bend angle if necessary to make the gusset lie flat inside the Wd-603 bracket and the vertical firewall angle. See Section K-K', DWG 23.

Clamp the assembly, drill as shown on Detail A, and cleco. The holes in the skin will act as guides.

INSTALLING THE FORWARD BULKHEADS

Adjust the flanges of the F-902-L&R Forward Bulkheads until the web is perpendicular to the aircraft centerline. Check by using a straightedge between the two bulkhead webs to see that they are parallel. Straighten the bulkheads as necessary with flutes between the rivet holes. Open the hole for the rudder cable to 5/8”.

Rivet the nutplates to the aft side of the F-902 bulkhead. These will later hold clamps securing the fuel vent line.

Cleco the F-9101 Gear Attach Web to the F-904 bulkhead. This should rest the web of the F-902 against the forward flange of the F-9101. Make any small adjustments necessary, then drill and cleco the F-902 to the F-9101 and the skin.

Adjust the top and bottom tabs of F-902 as necessary to fit the longerons, drill and cleco.

Make the F-996B Spacer shown on DWG 38. Drill the top 3/16” hole in F-996B at the dimensions shown, but leave the other holes undrilled for now.

Make the F-996C reinforcement angle (DWG 38) and drill all the holes except the bottom one. Drill the 3/16” holes to #30 for now.

Put a centerline on the outboard face of the F-996C angle and cleco it on the inside of the longerons and F-9101 web, using the upper pilot hole drilled in the angle. When the centerline is visible in the lower hole, drill and cleco it to the fuselage.

Remove the F-9101 and F-996C. Cleco them together and drill all the holes in F-996C through F-9101.

Draw a centerline on the inboard face of F-996B. Cleco it through pre-drilled hole to F-9101 and F-996C. When the centerline appears in the holes, drill F-996B for the bolt and keeper rivet holes.

After deburring and countersinking, rivet F-9101, F-996B and F-996C together with the keeper rivets. Be sure that the flush heads are on the outboard face of F-996B.

Cleco the assembly back in the fuselage.

INSTALLING THE RUDDER AND BRAKE PEDALS

DWG 37 shows details of installing the rudder and brake pedal assemblies. This is best done while access is still available.

Assemble the F-6117-L&R Brake Pedals.

The Wd-655R&L Rudder Pedal Assemblies are assembled with the brake and master cylinders bolted on as shown on the Exploded View of DWG 37. The F-6116 Side Bearing Blocks are slipped over the end of the rudder pedal tubes and the assemblies are dropped into the fuselage from above. Note that the right side pedal assembly is forward of the left side.

The exact fore-and-aft location of the F-6116 bearing blocks is left to the builder. We recommend drilling several attachment hole patterns so the location can be changed easily if it becomes necessary. Remember to maintain at least two hole diameters between the edges of the holes.

Bolt the rudder pedal assemblies to the longerons with bolts through the side bearing blocks. Trim the F-6118 Rudder Pedal Brace as shown. The extra length of the notch in the bottom flange will accommodate the F601K Firewall Recess. Fit the F-6115 Center Bearing Block around the Wd-655 rudder pedal tubes and bolt it to the brace. Clamp the brace against F-601 upright firewall stiffener and drill. You may find it easier to drill from the inboard face of the F-601, reaching through the open hole for the F-601K recess. Plan your holes so the rivets don't interfere with rivets that attach the recess coming through the other leg of F-601N.

Remove and store the rudder pedal/brake pedal assemblies.

INSTALLING THE FLOOR STIFFENERS

The floor stiffeners are shown on DWG 23.

Cleco the F-972 forward bottom skin back on the fuselage.

Draw centerlines on the back of the F-972B-R&L Floor Stiffeners. These must be fitted to the inside surface of the F-972 skin, so it helps to have a helper to shift the stiffeners while you watch for the centerlines through the holes in the skin.

When the floor stiffeners are located, drill them to the skin, firewall, and center section bulkhead.

The center floor stiffeners are also drilled to the bottom of the F-983-L&R Cover Support Ribs and F-601J angles on the firewall. Make sure the stiffener is firmly against the floor and bulkheads before using an angle drill to make these holes.

THE CABIN

FRAMING THE BAGGAGE AREA

See DWGs 25 and 29. The inside of the baggage area sidewall is partially covered with two panels. The aft is permanent, but the forward panel must be removable to give access to the flap mechanism. These panels are supported by two ribs, one vertical, one horizontal.

Fit the F-724 vertical rib by clecoing it to the F-970 side skin.

Install the nutplates on the F-722 horizontal ribs then drill and cleco them to the side skins.

Cleco the F-750 aft baggage side covers to the F-722 and F-724 ribs.

Adjust the top and bottom flanges of F-724 to the longeron and the F-623 rib, and drill them.

RIVETING THE FORWARD SIDE SKINS

Before the F-970 forward side skins can be riveted to the fuselage framework, there is a laundry list of small tasks that must be completed. You may have done some already. If not, complete them now.

Remove the skin.

Rivet the F-684 Gussets to the vertical firewall angles as shown on DWG 23, Detail A.

Rivet the F-9101 Gear Attach Web to the F-902 bulkhead (DWG 23, Sect G-G'.)

Rivet the F-719 and F-719B Stiffener and Angle Clip to the vertical angle of the firewall.(DWG 23, Detail C)

'Pre-rivet' the F-904H Center Section Side Plate (DWG 16) to the F-970 skin. A few key rivets are set at this time, because they will be very difficult to reach when the skin is installed on the fuselage. These rivets are right next to the spar entry cut-out. Set the upper five rivets forward of the spar cut-out, leaving the lowest one open ... it will be riveted when the skin goes on. Set the six rivets aft of the spar cut-out.

Complete the necessary dimpling or countersinking on the F-970 skin and underlying structure. (See Section 5E and Figure 5-4.) NOTE that the outboard five rivets holding the F-972 and F-976 Bottom Skins to the F-904A Forward Bulkhead must be "double flush". See drawing 28. The flush heads rest on the inside of the F-904 flange are necessary to provide clearance for the RV-9A main gear leg mounts that will be bolted into this location later. It

is recommended that RV-9 builders install rivets the same way to retain the possibility of taildragger to tri-gear conversion.

When preparations are complete, rivet the F-970 side skins to the fuselage. We recommend starting at the F-904 bulkhead and working fore and aft. Finish riveting the F-972 skins. Don't forget to include the hinges and the FF-00098 Attach Plate and FF-00099 Attach Shim (see DWGs 28 and 45) when riveting the skins to the firewall.

Complete any riveting on the aft fuselage that has not been finished yet. Remember to rivet the skins to the main longerons with only the rivets specified! The rest of the holes must be left open to attach the top skins.

ROLLING OVER THE 'CANOE'

After the all the skins are riveted on, roll the fuselage right side up and set it at a convenient working height on a pair of sawhorses. Level the fuselage at the center section, both lengthwise, along the longerons, and sideways, across the longerons. Secure the fuselage so that it stays that way.

See DWG 26. Clamp the F-714 aft deck to the longerons, using clamps through the forward lightening holes and rear rectangular opening. Place a level across the rear deck, near F-710. It should read level ... if it doesn't, loosen the clamps and twist the fuselage slightly until it does. Take your time with this step. Once the aft deck is riveted to the longerons, the fuselage is torsionally rigid, and any twist built into it will be there forever.

When the fuselage is straight, re-clamp the aft deck and drill it to the longerons.

After deburring, etc., rivet aft deck to the fuselage.

FINISHING THE FORWARD FUSELAGE AND LONGERON DETAILS

INSTALLING THE SIDE RAILS and GUSSETS.

See DWG 25. The F-721B side rails have already been drilled to the longerons. Trim the F-757 gussets to the shape required by your canopy and try them for fit by sliding them into the slot in F-721B. File and radius the outside edge until the pre-punched holes in the F-757 match the holes in the F-705 bulkhead. Remove as little metal as possible.

Drill and cleco the pre-punched holes to fix the F-757 in position, then drill the holes through the longeron and the outboard portion of F-757.

Rivet both side rails, canopy decks and gussets to the longerons. Carefully file the decks and rails to fit the contour of the side skin.

INSTALLING THE F-695 FORWARD FUSELAGE GUSSETS

The F-695 gussets attach the main longerons to the angle frame of the firewall. They are shown on DWG 23.

Drill the holes in the gussets, then clamp the gussets to the longeron and horizontal angle of the firewall. Drill the gusset to the firewall and the longeron.

After final preparations, rivet the gussets to the fuselage.

INSTALLING THE SHOULDER HARNESS ANCHORS

RV-9/9A shoulder harnesses are secured to the aft fuselage longerons by a stainless steel cable. This provides a direct load path. Fit and drill the F-636 shoulder harness anchors as shown on DWG 26, Detail D. Do not bolt them in just yet, because they will interfere with riveting the top fuselage skins to the longerons.

FINISHING THE BELLCRANK SUPPORT

See DWG 26. Drill the F-728A vertical channel to the F-706 bulkhead, then remove the channel. Fit, drill and rivet the F-728B angle to the channel, then re-install the channel permanently in the fuselage. It will require a narrow or notched bucking bar to set the rivets attaching it to the top of the bulkhead. If you don't have one that will work, you may use blind rivets as shown.

Fabricate the F-635 Bellcrank by riveting the components around the VA-146 flange bearing. Make the tubular F-635C spacers and fit the bellcrank in the fuselage. Square the ends of the spacers and fit them precisely between the area washers on each side of the bellcrank and the support ribs on either side. The bellcrank should be centered between the ribs and rotate smoothly, with no side-to-side play.

Remove the bellcrank, washers and spacers and store.

FITTING THE TOP FUSELAGE SKINS

FITTING THE AFT TOP SKIN

The aft fuselage is shown on DWG 26. Adjust and check the flanges of the bulkheads to an angle that will lie smoothly against the skin. You can simulate the skin with a straightedge or tight thread.

Make the two F-786A Top Fuselage J-Stringers. Draw a centerline on the upper faces and tape them to the F-706, 707 and 708 bulkheads.

Cleco the F-775 Rear Top Skin to the F-707 and F-708 bulkheads and to the main longerons. The longeron holes were drilled already, when the lower side skins were installed.

INSTALLING THE GUSSET PLATES

The F-656-L&R gusset plates tie the F-706 and F-707 bulkheads to the main longerons. See DWG 26. Clamp the gussets to the longeron. Cleco the gussets to the bulkhead and use the pre-punched holes to drill them to both the bulkhead and the longeron.

Rivet them any time.

FITTING THE FORWARD TOP SKIN

Draw a fore/aft centerline on the top of the F-688 Gusset and trim it to final size (see DWG 26.)

Cleco the F-787 Stiffener Rib between the F-706 and F-707 Bulkheads.

Cleco the F-774 Forward Top Skin (tip-up canopy) or the F-7112 Forward Top Skin (sliding canopy) to the F-707 and F-706 bulkheads. As you move to the forward part of the skin, slip F-688 between the skin and the bulkhead and rib and adjust it until the centerline is centered in the skin holes.

Drill the skin to the bulkheads, F-787/688 and J-stringers.

Now that both skins are on and clecoed to both bulkheads and longerons, fit the F-709 Bulkhead. Insert the bulkhead underneath the aft top skin and press it firmly against the inside of the skin. Cleco it to the F-714 aft deck, then drill it to the skin.

Remove the clecoes on the right side of the F-774 (7112) and F-775 skins and lift them up to expose the F-787 stiffener rib. Fabricate the F-707B clip shown on DWG 26. Clamp it to the F-707 bulkhead and F-787 rib. Drill it to the F-707 bulkhead using the pre-punched holes as a guide. When it is clecoed to the bulkhead, drill it to the rib. You may rivet F-707B to F-787, but do not rivet F-707 until the aft top skins are riveted – F-787/F-707B blocks access to one of the skin rivets.

Rivet the F-787 to the F-707B clip, but not to the F-707 bulkhead.

FITTING THE F-6111 RIBS (SLIDER ONLY)

Cleco the F-7112 skin in place. Trim the F-6111 ribs to length. The ribs are not attached to the longeron at the bottom and have one rivet common to the F-705 bulkhead at the top. The rib must be twisted and possibly fluted to achieve the proper shape. See DWG 41.

FINISHING THE INSIDE OF THE CABIN.

THE BAGGAGE COMPARTMENT

See DWG 29. Drill and rivet the F-750-L&R Aft Baggage Side Covers to the inside of the fuselage.

Now is the time to install the steps if you are building a –9A. See the separate instructions shipped with the steps.

If the F-747 baggage floors have been removed, cleco them back in. After drilling, deburring, and dimpling for the inboard nutplates, rivet them in place. Don't forget to rivet the nutplates as well. Leave the forward row of rivets out for now, as these are common to the F-742 Aft Seat Floors which will be installed shortly.

While the top skins are still clecoed to the fuselage, fit and drill the F-751 and F-652 corrugated baggage bulkheads to the F-706 bulkhead. The lower F-751 bulkhead has pre-punched holes across the bottom that can be used as guides, but the holes up the sides must be located and drilled in assembly. The upper F-652 bulkhead must be trimmed as shown on DWG 29 and drilled in assembly with F-706.

Remove the baggage bulkheads and install the nutplates on F-706.

Notch F-652 and install the F-6114B&C cable wear blocks.

Temporarily install the baggage bulkheads on F-706. If any of the screws are particularly difficult to get into the nutplates, especially along the bottom where they are a bit difficult to reach, you can run an 8/32 tap through the nutplate.

Fit the F-748 Baggage Tunnel Cover.

Fit the F-749 Forward Baggage Side Covers. This will require twisting it into position with the horizontal flange under the baggage floor. (Yes, it can be done.) This cover must be removable to allow access to the flap links, so it is held to the fuselage frame with screws. We find the optional tie-down ring holders shown in Detail D, DWG 29, to be useful.

Adjust the flanges until F-749 fits correctly, match drill the necessary holes and rivet on the nutplates. Remove the aft top skins for deburring and dimpling. There is no particular rush to rivet these skins on ... in fact, having them off simplifies several operations in the rear fuselage, so store them carefully away.

AFT SEAT FLOORS

See DWG 30. The seats attach to the aft seat floors with piano hinges. The seat back position is changed by simply pulling the pin and repositioning the back in another hinge segment.

Prepare the F-742-L&R Aft Seat Floors by drilling them to the floor ribs and fitting the F-637E hinges as shown in DWG 30. Note that the F-637E hinges have eyelets on both ends and two eyelets trimmed away in the middle. The aft edge of F-742 may go on top of the baggage floor, or between the baggage floor and the F-705 bulkhead.

Rivet the aft seat floor assemblies to the floor ribs.

FORWARD SEAT FLOORS and CONTROL ROD TUNNEL

See DWGS 25 and 30. Fit and drill the F-939 and F-940 Forward Seat Floors to the seat ribs. These floors must be removable to gain access to the control system, so they attach to the ribs with screws. The left floor (F-940) goes on first, with the wider right floor (F-939) on top.

Make the F-741A-L&R Tunnel support covers and the F-741B from material as shown on DWG 30. Drill holes in the lower flanges of the support only. These holes must match the holes in the floors, so measure carefully.

Cleco the supports securely to the floor and clamp the F-741B Tunnel Cover to the top flanges of the supports. Slide the cover forward until it contacts the slanted floor. Drill and cleco the single forward hole to the floor. Check to see that the edges of the cover and the support flanges are even, then drill the holes connecting the cover to the supports.

Rivet the tunnel cover to the supports.

Remove the tunnel cover and forward seat floors. Install the nutplates in the seat ribs and around the stick cut-outs in the floors. Don't forget the nutplate for the tunnel cover.

Run a tap through the outboard nutplates.

Re-install the floors with enough screws to hold them securely.

SEAT BACKS

The seat backs are made as shown on DWG 30. The upright angle supports are made from 0.125 angle material (not 0.063!). The seat backs are very simple, but once the hinges are mounted on the bottom, they become "right" and "left." Be sure to make one of each.

The F-638 Seat Back Braces are trimmed on the ends and the optional lightening holes cut on the drill press with a hole saw or flycutter.

FORWARD COVERS

Several covers are installed in the forward fuselage to protect fuel lines, cover the electric fuel boost pump and direct cabin heat. See drawing 34. These are removable for maintenance.

Fit the F-982E Access Plate and F-982 Heat Baffle to the F-982C Center Cabin Cover. Rivet the baffle and necessary nutplates to F-982C.

Insert the F-982C between the center floor reinforcement angles and the F-601N vertical angles on the firewall. Check to see that an even amount of the horizontal section of F-982C is exposed above the floor angles. Don't force it down too far…the flanges will be forced inboard by the radius of the angles and a poor fit will result. You may wish to put a simple wood spacer between the cabin floor and the center cabin cover to ensure that this won't happen.

Rivet the nutplates to the F-983A Fuel Valve Plate and screw it to the F-904 bulkhead. Slide the F-983C Fuel Valve Cover underneath the plate and fasten it to the F-983B cover support ribs and the fuel valve plate.

Adjust the F-982C fore/aft until it mates with the bottom of the F-983C Fuel Valve Cover. Cleco the two parts together.

Fit the forward section of the F-982C to the firewall and F-601K-1 firewall recess. Recheck the height of the F-982C and drill it too the floor stiffener angles. Finish drilling it to the firewall as well.

Remove the fuel valve cover and center cabin cover components and install the necessary nutplates. If you are installing electric elevator trim the triangular flange on top of the F-983A may be trimmed away. Leave it if you are installing manual trim…it will be needed to hold the trim cable.

THE ELECTRIC FLAPS

Electric flap actuation is standard on the RV-9A. The power comes from a sealed motor/gear drive assembly between the seat backs, driving the flaps through a welded steel actuator and pushrods connected to the inboard end of the flaps. The flap mechanism is shown on DWG 33.

Begin by drilling the holes in the clevis ends of WD-613-EF flap actuator to ¼".

Drill the holes in the F-680 block and saw it in half.

Drill the safety wire hole shown in Detail E. Install the rod end bearing and jam nut on the end of the ES-85615-157 flap motor shaft.

Install the flap actuator in the baggage compartment using bearing blocks F-661-EF on the F-705 uprights and F-680 in the center. The forward corner of the F-748 cover must be notched to clear the F-680 block, so it can be removed without removing the block. Use the holes in the F-680 block as a template to drill the floor.

Make the F-766C plate, but drill only the indicated index hole in it for now.

Make the F-766B angle, the F-785B attach angle, the F-766D Spacer and F-767 Attach Plate. Pre-drill the angles, but don't drill the attach plate.

Fit and rivet the F-758 bracket to the bottom end of the F-766A channel and install the nutplates along the sides.

Note: The F-758 and F-767 brackets replace the EF-603 and EF-604 brackets that are contained in the electric flap kit parts bag for the RV-9/9A.

Centerline the F-766C plate and match drill it to the F-766A channel. Rivet the pieces together and drill the bolt hole full size.

Fit and rivet the F-785B attach angle to the bottom of the F-785A backrest brace.

Temporarily screw the F-758/766A assembly to the floor and clamp the F-767 attach plate to the top of the channel. Clamp the attach plate to the crosspiece of the F-705 bulkhead and adjust it until it aligns with the pre-punched holes in the bulkhead. Drill the F-767 to both the F-766A and the bulkhead.

Remove the channel and finish F-767 by fitting the nutplates and riveting it to the top of F-766A.

Install the F-766 assembly in the fuselage.

Slide a bolt through the F-766B angle, the flap motor, the washer and the F-766D spacer. See Section B-B'. Use a 12v battery to run the motor until the shaft is half way between its travel stops. Reversing the leads to the terminals will make the motor run the other way.

When the shaft is stopped at half travel, bolt the motor to the Wd-613-EF actuator arm, using the washers shown to center it in the clevis. Safety wire as shown in Detail E. Rotate the arm and bracket until it rests against the inside of the F-766A channel. Bolt the assembly to the channel. Clamp the F-766B bracket to the channel and drill it, using the holes in the channel as guides.

Remove the bracket from the motor and rivet it to the channel. Re-install the motor, using the spacer, etc. on top as shown in Section A-A'. Don't forget the cotter pin!

Install the F-785 backrest brace and begin fitting the F-760 Flap Actuator Covers. Match the holes with nutplates in the F-766 channel, cleco, and drill the rear row of holes. You can enlarge the hole around the bolt head with a unibit if necessary. Drill the backrest, using the side cover as a guide. Remove the backrest, install the nutplates and re-install it in the fuselage.

The final details of wiring and adjusting the F-959 pushrods are left until the wings and fuselage are joined.

INSTALLING THE LANDING GEAR MOUNTS (RV-9A ONLY)

The main landing gear mount installation is shown on DWG 34A.

Before fitting and bolting the mount to the fuselage, the upper gear leg alignment bolt hole must be completed. Make sure that the inside of the mount tube and the knob on upper end of the gear leg are clean and have no burrs around the holes.

Slide the gear leg into the mount and align the hole. Match drill the leg to the mount using a .311" reamer.

Remove the leg and clean up any burrs.

Bolt the gear mount to the F-904 bulkhead and fuselage side.

WING/FUSELAGE ASSEMBLY

During this phase of construction it is necessary to assemble the wings to the fuselage for a number of reasons including drilling the rear spar/center section attach, finishing the aileron and flap control mechanisms, installing the wing tank/fuselage attach brackets, fabricating and fitting fuel & vent lines, and installing the wing root fairings. If you are working in a small shop it is acceptable to install, then remove, one wing at a time.

Before installing the wing, mark screw locations at each unused rivet space on the bottom flange of the W-710 root rib on the outside of the W-704 bottom wing skin. Then mark a straight line from the hole location toward the wing tip and make a measured mark 3" outboard from the intended screw location. This will allow you to measure back to the same point on the overlapping F-976 fuselage skin.

If your wing tips have been permanently attached to the wings and/or your shop dimensions are such that the aileron pushrods cannot be inserted from the tips of the wings, the W-917 pushrods must be loosely placed in the wing lightening holes from the root before the wing panels are "plugged-in" to the fuselage.

Installing the wing panels should be very simple, as the spars have been fitted and drilled at the factory. It is helpful to file a slight bevel on the root ends of the spar to assist getting it started sliding through the slot in the fuselage bulkhead, and to prevent it from scratching and galling the bulkhead bars as it slides through. Support the inboard ends of the wings when inserting to prevent the bottom of the spar from dragging along the inside of the fuselage bottom skin. As the wings are pushed in near center, be sure that the F-976 fuselage center bottom skin (which overhangs the fuselage) doesn't catch on the wing skin.

When bringing the wing panel into its exact position and lining up the bolt holes in the bulkhead and spar, it is often helpful to use drift pins. These are usually a disposable hardware store bolt with the end rounded or tapered on a grinder. Gently driving this lubricated pin into a nearly aligned hole will center the bulkhead/spar hole so that the bolts can be installed without excessive force. Once the holes are aligned, use 7/16" and ¼" hardware store bolts for test fitting to prevent damage to the holes and NAS bolts. For fitting purposes, it is only necessary to install four 7/16" bolts, one top and one bottom, on each wing panel. Of course, when permanently installing the wings all the bolts called-out on DWG 16 must be installed.

NOTE: When installing the wing for the last time, lubricate the NAS bolts with LPS #1,2 or 3 (available in a spray can). In lieu of that a light coat of ordinary motor oil will do. Do not lubricate the threaded portion of the bolt as this will influence the torque wrench reading.

SETTING THE WING INCIDENCE

With the main spar bolted in place, the next step is to attach the rear spars. Level the fuselage, both laterally and longitudinally, using the top surface of the longerons as a datum surface as shown on DWG 38 Then square the wing with the fuselage by measuring from corresponding points on the wing tips to a common centerline point on the aft fuselage. The dimensions should be equal. At the same time check that the wings have no forward or aft sweep by dropping 4 plumb lines from the wing leading edges (2 on each wing at inboard and outboard points). They should all fall in a straight line. When the wing is squared, mark the position with a vertical line on both rear spar and center section at the rear spar attach.

Now the very important incidence angle must be measured and set. Use a level and spacer blocks as shown in DWG 38. Verify that the fuselage is level. Rest one end of a level on the forward spar just forward of the skin butt joint and the other end on a spacer placed directly over the rear spar web. Shift the rear of the wing up or down to center the level. The spacer size has been calculated to provide the desired incidence angle. Check several points along the span of the wing to verify the level reading. Clamp the root in place and check the other wing in the same manner.

It is extremely important that there is at least 5/8" from fastener center to the edge of the part, in both the rear spar and F-705. If unable to maintain proper edge distance, call Van's Aircraft for assistance before proceeding further.

See DWG 38, Section G-G. After checking and re-checking, drill the 5/16" hole for the attach bolt. Initially drill an undersize hole starting with no more than a 1/4" drill. Then progressively enlarge the hole to 5/16" to provide a close fit for an AN5 bolt. A long stiff drill bit is a good idea because it can be held straighter for a truer hole.

The overlapping portions of the F-976 bottom skin are screwed to the bottom of the wing when the wings are installed to stay. Holes for these screws must be drilled now. Use the reference lines to locate the hole positions. When the wing is removed, these holes are countersunk for #8 screws and K1100-08 platenuts attached.

Install the ailerons, W-918 pushrods, and flaps.

FITTING THE FORWARD ATTACH BRACKETS

Make the F-996A Fuel Tank Attach Brackets shown on DWG 38. Bend the web of the bracket so it fits to the fuselage side and to the T-905 angle bracket on the fuel tank. Clamp the F-996A angle firmly to the T-905 bracket on the fuel tank. Check to see that it rests firmly against the fuselage and drill the bolt holes from inside the fuselage.

After the F-996A is bolted, at least temporarily, to the fuselage, the clamp can be removed. Locate the center of the 1/4" hole on the flange of the angle. Double check to be sure you have sufficient edge distance on both T-905 and F-996A. Drill the 1/4" hole through T-905.

Finish the bracket installation after the wings are removed by installing the nutplate on T-905 as shown in DWG 38 Section E-E. Note the orientation of the platenut. It is important.

THE FLAP ASSEMBLY

Assemble VA-256 flap pushrods as shown on DWG 33. Bolt the VA-256 to both the flaps and the Wd-605EF flap control weldment. Rob a battery from your car or lawn tractor and connect it to the flap motor. Run the motor up and down while checking for any possible interference in the flap linkage. The hole in the fuselage skins (side and bottom) may be enlarged as necessary to avoid interfering with the pushrod.

WING ROOT FAIRINGS

Wing root fairings are supplied in the finish kit.

INSTALLING THE CONTROL SYSTEM

Install the WD-610 control column, WD-611/WD-612 control sticks, and F-665 control column pushrod as shown on DWG 38. Use the W-930 bellcrank jig to hold the WD-421 bellcrank in its neutral position as shown on DWG 9. Install and adjust the W-918 aileron-to-bellcrank pushrod such that the aileron is in the neutral position (see DWG 15) when the bellcrank is held in its neutral position. Install and adjust the W-917 bellcrank-to-stick pushrod such that the sticks are vertical when the bellcrank is held in its neutral position.

INSTALLING CABIN SYSTEMS

Installing the brake, fuel tank vent, and fuel systems inside the cabin is much easier when the forward fuselage is still open. The brake and rudder pedals have already been fitted, but the brake lines and hoses must still be finished and installed. The fuel lines are made from aluminum tubing, flared on the ends to mate with AN fittings. Details of these systems are shown on DWG 36/36A.

- The routings and fitting details are so well depicted on DWG 36/36A that step-by-step instructions would be redundant. Here are a few general hints, however:
- Install the fuel and fuel vent lines before putting the rudder/brake system in to stay.
- Study the Standard Aircraft Handbook or a similar publication to learn the correct method of cutting and flaring the ends of aluminum tube. A tubing cutter and flaring tool will be necessary. Flares on aircraft fittings are typically 37°. Do NOT use automotive 45° flaring tools or fittings!
- A lever type tubing bender makes neat bends without collapsing the tube. It takes a little practice to learn the bend allowances and techniques, but the results are better than trying to hand-bend tight corners.
- Remember to put the sleeves and nuts on the aluminum tube before you flare the ends. The sleeves particularly will not go around any but the gentlest curves. If you forget, you will usually have to cut the flared end off to get the fittings on.
- A drop of oil on the flaring and bending tools makes the operation much smoother and easier.
- Use Fuel Lube (a sealing paste available in supply catalogs) when installing AN fittings with pipe threads. Do not use Teflon tape!

FITTING THE EMPENNAGE

DRILLING THE ELEVATOR HORNS

The elevators were fitted to the horizontal stabilizer during construction, but the lower bolt hole in the elevator horns (to which the pushrod attaches) has not been drilled yet. These holes are best drilled with the elevators mounted to the stabilizer. This hole must be exactly perpendicular to the horns. If it isn't, when the bolt installing the pushrod is tightened, one horn will be pulled forward and the other aft, mis-aligning the counterbalance arms.

Clamp the horizontal stabilizer to the bench with the hinges hanging over the edge. Mount the elevators on the stabilizer. Align the elevator counterweight arms to the stabilizer tips and clamp them so they will not move. Measure the distance between the inside faces of the elevator horns.

The horns are individually welded and seldom does one side match the other exactly. Usually the mis-match is slight. Determine which horn is aft, then remove that elevator and drill a #30 pilot hole in the horn at the dimensions shown on DWG 27A, Side View.

Make an aluminum or hard wood block that fits exactly between inside faces of the horns. The exact size of the block is unimportant, but the two outside faces must be parallel. Use a drill press to make a #30 hole perpendicular to the faces of the block.

Remount the elevator and fix the counterweight arm to the stabilizer. Clamp the block between the horns and align the hole in the block with the hole in the one horn. Use the block as a guide to drill the other horn. Once pilot holes have been drilled in both horns, enlarge them to full size. This can be done one horn at a time.

INSTALLING THE TAILCONE STIFFENERS (RV-9 ONLY)

Position a F-00773A Tailcone Stiffener as a drill template on the outside of the F-773-L Aft Side Skin in the same position as the stiffener will be installed. See Detail B on DWG 27.

Match-Drill #40 all the holes in the stiffener into the side skin. Deburr and dimple the holes in the side skin then rivet the stiffener to the inside of the side skin using the rivet callouts on DWG 28. Repeat this procedure on the right side of the aircraft to install the remaining stiffener.

FITTING THE HORIZONTAL STABILIZER

Clamp the horizontal stabilizer to the aft fuselage. The stabilizer must be perpendicular to the longitudinal centerline of the fuselage. Pre-position the inboard edges of the skins parallel to the longerons. Check by running a tape measure from the outboard end of the stab to the corner of the firewall. Use similar points on both sides of the airplane and adjust the stabilizer until the measurements are equal.

Once the stabilizer is located, it is time to drill the holes though the HS-908 attach angles on the forward spar.

The outboard holes must got through the fuselage longerons, the F-710C spacer and F-710B angle (see Detail B, DWG 27). These parts are underneath the F-714 deck and invisible. Take careful measurements and locate these bolts as accurately as possible. Remember: the vertical leg of the longeron is 1/8" thick and the bolt must center in the available 5/8” of the horizontal leg.

When both HS-908 angles have been drilled, make the F-798 shims, slip them between the deck and the angle and use the holes as guides to drill the shims.

Temporarily bolt the forward spar and shims to the fuselage. Dig out an 11/32" drill bit (bet you haven't used that lately) and slide it between the rear spar of the stabilizer and the aft deck. This will set the spacing necessary to obtain the desired 0° incidence. Check this by measuring from the deck to the tooling holes in the inboard stabilizer ribs. The measurements should be the same, fore and aft.

When the stabilizer is located, drill the bolt holes though the F-711C bars and the rear spar of the stabilizer.

INSTALLING THE PUSHROD AND SETTING THE ELEVATOR TRAVEL STOPS

While the stabilizer is still bolted to the fuselage, pin the elevators in place and clamp the counterbalance arms to the stabilizer.

Install the F-635 Bellcrank and spacer assembly between the F-728 and F-729 ribs (DWG 26).

Make the F-790 Pushrod as shown on DWG 38. Because the pushrod effectively becomes an enclosed unit with no practical possibility of internal inspection, we recommend priming the inside of the tube. Pour liquid primer into one end and swirl it toward the other, coating the entire inside of the tube. An alternative method is to spray primer into one end of the tube, then turn the tube around and spray into the other end. Let the primer cure thoroughly, then rivet the primed VA-101 pushrod ends in the tube with the MSP-42 high strength blind rivets. The primer must be dry before installing the rod end bearings. We have seen wet primer migrate into the rod end bearing and freeze the bearing. You can make a simple pattern out of a strip of stiff paper. Wrap it around the outside of the tube, trim it until the ends just meet, then flatten it out and mark the pattern of 8 evenly spaced holes. Wrap it around the tube again and transfer the spacing to the tube.

Thread the jam nuts onto the rod-end bearing shanks, then thread the rod-end bearings into both ends of the pushrod.

Temporarily bolt the pushrod to the F-635 bellcrank and the elevator horns. Put the F-635 bellcrank in the neutral position, i.e., with the bolt holes for the pushrods vertical. You can come very close by inserting a 3/8" socket through the hole in the F-728 rib and fitting it over the head of the lower bolt, but because socket wall thicknesses are not standardized, there may still be some error, so double check.

With the F-635 in its neutral position and the elevator in trail, the length of F-790 should allow some adjustment both ways in the rod ends.

NOTE: In the final installation, both rod-ends must have over half the thread engaged, making it impossible for a bearing to back off the push-rod if both ends are pinned.

Adjust the pushrod length and tighten the jam nuts against the pushrod ends. Remove the pushrod and store.

MANUAL TRIM CABLE INSTALLATION

The RV manual trim control is a functional, though unconventional, vernier control. A vernier is a control cable that rotates for fine adjustment, but has a button that “unlocks” the threads and allows rapid push-pull movement. Most of us have encountered verniers in other airplanes where they are commonly used as throttle, prop, or mixture controls. Because the trim is very effective, it is conceivable that rapid trim application while the airplane is traveling at high speed could produce high G loads, possibly even destructive loads. Because of this remote possibility, the rapid push-pull action of the cable should be disabled, leaving the rotational vernier action as the only way to move the trim tab.

Pry up the rubber button with a small screwdriver. Work carefully because the button is held with and adhesive and it is possible to damage the handle. When the rubber button is out, remove the plunger shaft. Without this shaft, the vernier control cannot be released and all action will be limited to the twist screw function.

Replace the rubber button with a 1” chrome snap-in hole plug from the local hardware store.

The trim cable is installed from the cabin end, starting through the center console and then routing it aft through the fairlead holes in the bulkheads. See DWG 32 or 32A.

NOTE: If you are planning on a fuel injected engine, order the longer 191” length cable for clearance around the high pressure fuel pump and filter. (7/7A F.I. PUMP INSTAL KIT)

Snap-in bushings of 7/16 I.D. are used as fairleads in all of the bulkheads and webs through which the trim cable passes, except at the root rib and rear spar of the horizontal stabilizer. The hole through the root rib is at an acute angle not suited for a bushing, and the holes through the rear spar must be of minimum size, not large enough for a bushing. Use RTV Silicone Rubber to form a protective gasket around the trim cable in these passages.

Feed the cable through the fuselage and horizontal stabilizer and then through the elevator spar and out through the opening in the elevator bottom skin.

Drill the Wd-415 to the E-616PP cover plate. When the cable is completely in with its aft end hanging free under the elevator, the Wd-415 Anchor Nut is threaded onto the cable. With this anchor clecoed in place, the clevis end is threaded onto the shaft (just over half depth) and trim tab travel can be tested. Desired down travel of the tab (nose up trim) is 35 degrees, and up travel is 25 degrees.

The two inch travel of the control cable is sufficient for this total travel, but it may be necessary to adjust the position of the cable by threading the Wd-415 anchor in or out before it is finally riveted on. Even then, a little adjustment is available in the clevis end fitting.

ELECTRIC TRIM INSTALLATION

The installation of the Electric Elevator Trim (option ordered on the Empennage Kit) and Electric Aileron Trim (option ordered on the Fuselage Kit) systems are covered in those specific subkit instructions.

FITTING THE VERTICAL STABILIZER

Temporarily bolt the F-981 attach plate to the forward spar of the horizontal stabilizer.

Trim the VS-702 front spar as shown on DWG 27A.

Clamp the rear spar of the vertical stabilizer to the back of the F-912 bulkhead, centering it in the bulkhead. Set the height using the dimension shown between the longeron and the hinge bracket.

Take measurements from the tip of the vertical stabilizer to both tips of the horizontal. Adjust the vertical stabilizer until the measurements are equal and the stabilizer is truly vertical.

Drill the bolt holes through the stabilizer and the F-912D Up Elevator Stop. Install bolts temporarily.

Place a straight edge along the back of the vertical stabilizer hinge brackets. The hingeline must remain straight, so hold the straight edge there and double check while clamping the front vertical stabilizer spar to the F-981 attach plate. If the rear spar bends aft at the top when the front spar is clamped, the vertical spar may be mounted on the rear of the F-981 plate. If necessary, you can make a shim to put between the F-981 and the vertical stabilizer spar. If the rear spar bends forward, make a shim to go between the F-981 and the front spar of the vertical stabilizer. Note that the F-981 has a joggle built into it that will offset the front of the vertical stabilizer slightly to the left of the fuselage centerline.

When the vertical stabilizer is properly aligned, drill the front spar to the F-981, using the pre-punched holes as guides.

NOTE that because the stabilizer is offset, the rear spar no longer fits flush against the F-912D angle. Use a single washer, superglued to the forward face of the spar, as a spacer. See View A-A', DWG 27.

Drill the bottom of the rear spar to the F-712 bulkhead. See DWG 27 For RV-9, DWG 27A for RV-9A. For now, drill #30.

RV-9A only: Make the F-712E Tie-down bar shown on DWG 21.

Remove the vertical stabilizer.

RV9A only: Drill the tiedown hole in the F-779 skin to 5/8". Mark and drill the rivets that will attach the F-712E Tie-down bar to the bulkhead.

Draw centerlines on the aft surface of the F-712E tie-down bar and insert the tiedown into the fuselage. Adjust the centerlines until they fall in the center of the holes drilled in the bulkhead. Clamp and drill the tie-down bar, using the drilled holes as guides.

Countersink the rear bulkhead and rivet the tiedown to the bulkhead.

Re-install the vertical stabilizer and drill the bolt holes to full size.

Temporarily bolt the vertical stabilizer to the horizontal stabilizer and rear bulkhead.

FITTING THE RUDDER

The rudder must swing freely. The gap between the counterbalance arm and the top of the vertical stabilizer should be even. If the rod end bearings were not installed and adjusted during empennage construction, do it now.

Thread the rod end bearings and jam nuts into the rudder spar. Measure from the center of the pivot bolt hole to the forward face of the spar. As a starting point you may use the measurements shown on DWG 7.

Adjust these measurements as necessary to make the rudder swing without binding.

Make the F-792 L&R rudder stops shown on DWG 27. Align the drilled hole with the pre-punched hole in the fuselage skin that was left open when the rear fuselage was riveted. Once the stop is clecoed and clamped, the rest of the holes may be drilled in assembly.

Measure the rudder deflection. The proper 35° degree swing is attained when the distance between the outboard trailing edge of the elevator skin and rudder skin trailing edge is 46 1/8". File the rudder stops if necessary to achieve this dimension.

Rivet the rudder stops to the fuselage.

Now that the vertical stabilizer, horizontal stabilizer, elevators, and rudder have been installed now is a good time to install the empennage fairing. See drawing 44 for the empennage fairing installation details. See Section 5.18.

FINISHING THE FORWARD FUSELAGE

SOME THINGS TO THINK ABOUT

At this point, the cabin area is open to the sky. Except for the cross bar of the F-705 bulkhead, no permanently installed part crosses the cabin area. Before you begin upper fuselage construction, consider how the interior will be finished. All Van's demonstrator airplanes are simply painted with a high quality semi-gloss paint on the floor and sides. The only upholstered surfaces are the seat cushions. This rather spartan approach may not be for you. If you plan carpets and sidewall upholstery, now is the time to make and store patterns. It will be much easier than crawling around under the canopy and between the rudder pedals.

If you intend to paint the interior, it is still the time. Remove all the removable covers and panels and paint them separately. Mask and paint the interior as desired. Paint adds weight of course, so carefully consider what surfaces will be visible…do the seatbacks need to be painted, for instance, if they are always covered with cushions?

CONSTRUCTING THE CABIN FRAME (TIP-UP CANOPY ONLY)

The cabin frame serves as a join between the movable canopy and fixed windows over the baggage compartment. More importantly, it provides roll-over protection to the occupants. It is built from thick aluminum channels, formed in curves and riveted into a bow. The cabin frame is shown on DWG 39.

Cut the access holes in the aft F-631A channels, using a hole saw or fly-cutter in a drill press.

Make the various mounting angles shown on DWG 39. Remember to make lefts and rights when required!

Make the F-631E Plates.

Carefully study the cross section drawing, Section A-A'. Clamp the two aft F-631 channels (the ones with the big holes) to a flat surface and check both the width and height dimensions. Double check the width by measuring the fuselage…remember to allow for the thickness of the F-631C brackets. The forward edge of the frame assembly, including these brackets, should match the width of the fuselage as shown in View C-C', DWG 40. The butt ends of the channels can separate slightly to achieve the correct width.

Center F-631E on the center joint and drill the plate to the channels.

While the rear channels are clecoed and clamped to the bench, prepare, fit and clamp the lower F-631B inner strap to the lower flange of the channels. Begin drilling from the center and work toward both ends. The strap will try to rise out of position as it goes around the curve, so check often to see that it is still held firmly against the web of the channel.

Repeat the process with the upper F-631B strap.

Clamp the other pair of F-631 channels to the assembly on the bench and drill the holes through the straps. When the entire bow is clecoed together, drill the second F-631E plate at the joint. Although this will be installed inside the channel, it can be drilled from the outside.

Stand the bow on a table and measure the height at the center as shown on DWG 39, Rear View. File the ends of the bow if necessary.

Disassemble the frame for deburring, and while it is apart, fit and drill the F-732D Angle to the rear half.

Rivet the frame together, including the F-732D angle.

INSTALLING THE CABIN FRAME

Place the cabin frame flat on the table, with the large holes up.

Clamp the F-631C angles to the outside surface of the frame.

Clamp the F-631D angles inside the frame.

Clamp the two sets of angles together and drill the keeper rivet holes, using the holes drilled when F-631D was made as guides. Remove the angles, deburr and rivet them together to form channels with a offset bottoms.

Locate the F-631C/D channels on the fuselage at the F-705 bulkhead as shown in the Side View of DWG 40. Drill and bolt the channels to the fuselage, through F-705F and F-705G. This will leave the aft end of F-631C protruding outside the contour of the fuselage. Trim and file the projecting part of the bracket away as shown in View C-C', DWG 40. The skin must fit smoothly on the outside face of the bracket.

If it isn't already, cleco the F-774 skin to the fuselage.

Clamp the cabin frame assembly to the brackets on the fuselage. Cleco the F-732A Channel and F-732F spacer between the frame and the F-706 bulkhead as a brace. Match-drill #30 and cleco through the F-774 skin, F-788 gusset, F-706 bulkhead, F-732F spacer and F-732A channel.

Match-drill #30 through the two tabs on the F-732A into the F-706 Bulkhead. Match-drill the forward end of F-732A to the F-732D angles.

Use the two pre-punched holes in the forward "tongue" of the F-774 skin to locate the forward screw holes that join the F-774 skin, the F-631C bracket and the cabin frame. See Note 1 on DWG 40 for the sequence of drilling these holes. Leave them at #30 for now, so that clecos will hold.

Peel back the skin, cleco the bracket to the frame through the holes you just drilled, then drill the aft screw holes, using the holes in F-631C as guides. In the finished airplane, the forward holes will be visible from the outside, but the skin will hide the aft screws.

Remove the skin and finish drilling the screw and bolt holes at the base of the cabin frame. Tap the frame as shown and temporarily install the screws and bolts attaching the frame to the fuselage.

Because it is easier to work on many things in the cabin and fuselage if the rear skins and cabin frame are not in the way, once these components are fitted and ready to install, they may be removed and stored.

INSTALLING THE FRONT DECK (TIP-UP CANOPY ONLY)

The structure between the instrument panel and the firewall, above the main longerons, differs, depending on which canopy has been chosen. Be sure you are reading the directions for the canopy on your airplane.

Details of the upper forward fuselage for the tip-up canopy are shown on DWG 24A and 47.

Begin by making the F-721C, F-743B, F-768C and F-703C angle brackets. Be careful to make left and right pairs when necessary.

Make the F-703B Angle and fit it, along with the F-703C angles, to the F-703 instrument panel. You can either rivet the angles to the panel now, or leave it until later…. the decision may rest on exactly how you plan to cut the holes for the instruments. If you are sending the panel out for custom work, perhaps involving machine or laser cutting, it will probably be better to leave the angle clecoed, so the flat panel is available to the cutting machine.

Assemble the components of the center F-768 subpanel. Locate and drill the hat-section F-697 Channel to the aft face of the F-768A Center Subpanel. Pre-punched holes in the subpanel serve as guides. The upper two rivets on the right hand flange also hold the F-643-1 Forward Fuselage Channel, so fit that as well.

Drill the F-644R&L stub ribs to the flanges of the F-768A.

Drill the F-746 engine cable control bracket to the bottom of the F-768A.

Drill the F-768C seal support to the F-768A. Note that the flange of the seal support is lower than the flange of the subpanel (see Detail D) to allow for the thickness of the seal.

Prepare and rivet the stub ribs, channel and hat-section together. Note that flush head rivets are used (flush heads outboard) to join the F-644 stub ribs to the F-768A subpanel. Leave the F-746 engine control bracket clecoed for now…you may want to vary the spacing between the clamps holding the engine control cables, and it is much easier to install these nutplates out on the bench. See Note 1, DWG 24A.

Install the platenuts on the aft flange of the F-745-L&R Forward Fuselage Ribs.

Fit and rivet the F-768D Seal Support Angles to the F-768-L&R Outboard Subpanels.

Drill each F-768B outboard subpanel to the appropriate F-745 rib. Note that the two upper rivets are flush, with the flush heads inboard. Dimple the subpanel and rib and rivet them together with the flush rivets only. This will form two rather floppy subassemblies.

Insert the outboard subassemblies into the fuselage, with the notch in F-768 fitting around the longeron. Cleco the outboard subpanels to the forward flange of the F-721A deck and the F-902 bulkhead. Slip the center subassembly between them and cleco the structure together. Cleco the ribs to the firewall.

Fit and drill the F-743B bracket (connecting the F-643-1 to the firewall) to the channel only.

Fit and drill the F-771 Forward Top Skin (DWG 28) to the firewall, ribs and subpanel. When the F-643-1 is clecoed to the skin, drill the F-743B angle through the firewall. Also fit the F-721A Forward Canopy Decks to the longerons. These will require some gently hand twisting to fit well. Cleco them to the subpanels and align them with the longerons. The aft ends must be filed to fit the F-721B canopy decks. When the F-721A is removed for de-burring, bend the flange on the leading edge of the F-721B inboard to rest against the inside of the F-721A. Drill these components together.

Fit and drill the F-721C and F-721D attach angles to the panel and the F-721A deck. Rivet the nutplates to the angles and then remove the panel and install the angles to the deck.

Temporarily screw the instrument panel to the aft flanges of the ribs.

Mark centerlines on the F-643-1 and firewall flange.

Fit and drill the F-793-L&R Vent Brackets to the fuselage, and fit the SV-2 Adapter and SV-5 Ventilator to the panel.

Depending on which task you intend to do next, you may either leave the structure clecoed in place or remove it all. You will probably want to at least "rough-in" avionic and instrument installations before riveting the entire upper forward fuselage assembly permanently.

INSTALLING THE FRONT DECK (SLIDING CANOPY ONLY)

The structure between the instrument panel and the firewall, above the main longerons, differs, depending on which canopy has been chosen. Be sure you are reading the directions for the canopy on your airplane.

Details of the upper forward fuselage for the sliding canopy are shown on DWG 24.

Make the F-7103B-L&R and the F-7103C-L&R Attach Angles that go on the back of the F-7103 Instrument Panel. See View B-B, DWG 24. Leave the angles clecoed to the panel.

Make the F-7109 Plate, the F-7108B Angle, F-7108C and F-721D Attach Angle.

Drill and rivet the F-7109 plate and F-7108B angle to the F-7108A Center Forward Fuselage Rib.

Drill the F-746 engine control bracket to the F-7105A subpanel, but leave it clecoed for now…you may want to vary the spacing between the clamps holding the engine control cables, and it is much easier to install these nutplates out on the bench. See Note 1, DWG 24.

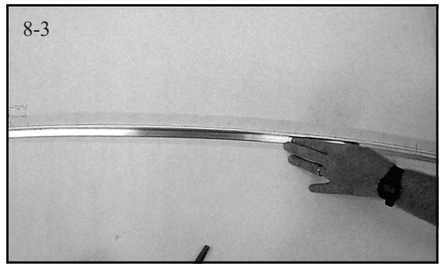
Twist the F-7105A subpanel and fit the F-7108 rib through the center of it…the guy who designed it swears it is possible. Cleco the rib to the firewall.

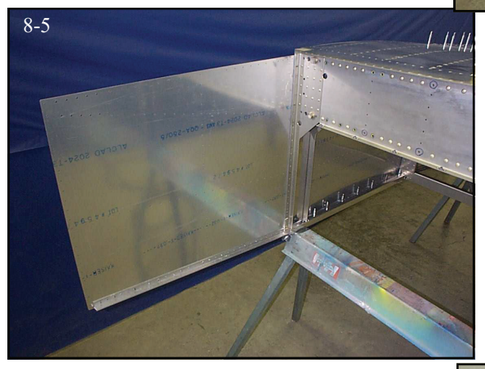
Cleco the F-7107-L&R Ribs to the firewall and F-7105. Add the F-7105B Outboard Subpanels and the instrument panel, so the entire structure between the panel and firewall is clecoed in place.

Fit and drill the F-7106 Forward Top Skin to the forward fuselage. Also fit the F-721A Forward Canopy Decks to the longerons. These will require some gently hand twisting to fit well. Cleco them to the subpanels and align them with the longerons. The aft ends must be filed to fit the F-721B canopy decks. When the F-721A is removed for de-burring, bend the flange on the leading edge of the F-721B inboard to rest against the inside of the F-721A. Drill these components together.

Fit and drill the F-721C and F-721D attach angles to the panel and the F-721A deck. Rivet the nutplates to the angles and then remove the panel and install the angles to the deck.

Fit and drill the F-793-L&R Vent Brackets to the fuselage, and, if you have them, fit the SV-2 Adapter and SV-5 Ventilator to the panel.





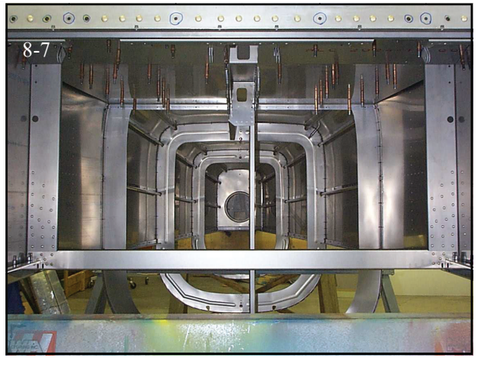
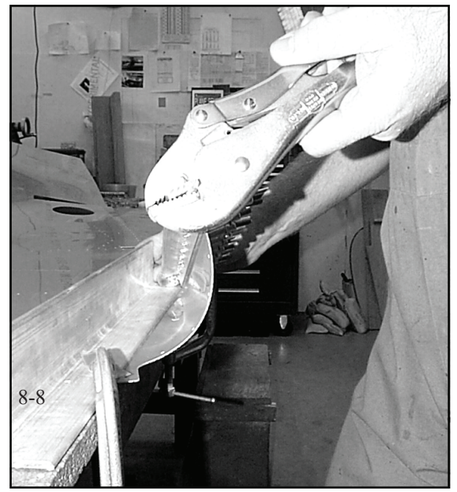
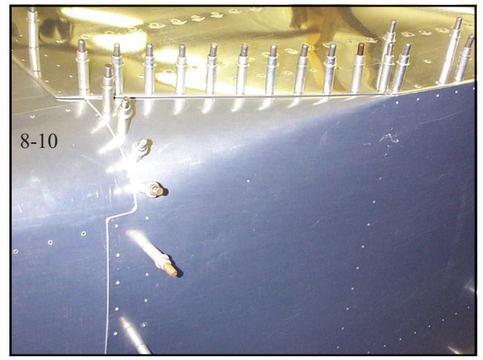
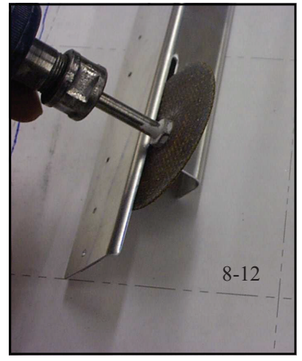


Fig 8-1. Bending the longeron in a vise.
Fig 8-2. Twisting the longeron.
Fig 8-3. Checking the longeron against the template.
Fig 8-4. The aft fuselage bulkheads and skins riveted together.
Fig 8-5. The forward side skin attached to the forward fuselage.
Fig 8-6. The longerons inserted.
Fig 8-7. Interior of the tailcone with floor ribs clecoed in place.





Figs 8-8-11: Various stages of the conical bend on the F-970 side skin. The forward end is bent almost to a sharp corner, but be cautious...if you try to do to much it will crack.



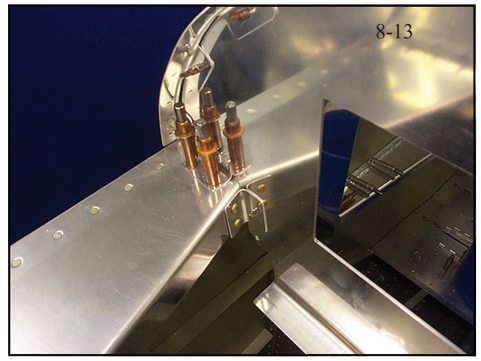
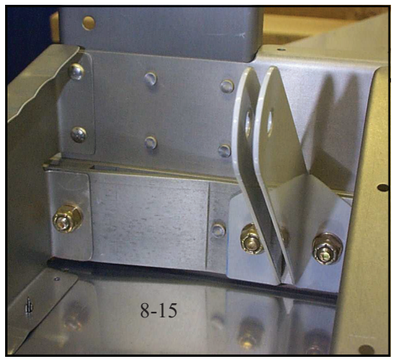
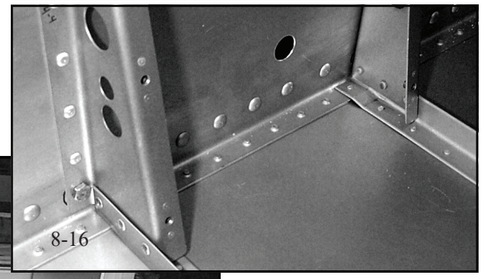
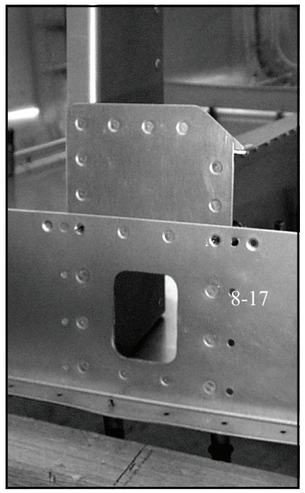


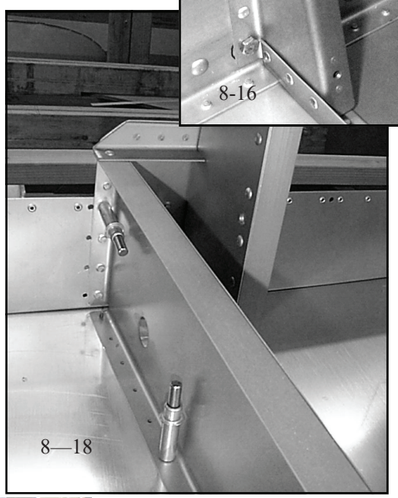
Fig 8-12. Slotting the aft end of the F-721B canopy deck.
Fig 8-13. The forward end of F-721B butted against F-721A


8-14


8-15


8-16


8-17


8—18


8—19

Fig 8-14. The F-656 gusset.
Fig 8-15. The F-634 seat belt anchor.
Fig 8-16. The F-838B cover support rib.
Fig 8-17/18. Details of the F-729/730/705 junction.
Fig 8-19. The modified F-916 floor rib

NOTES

SECTION 9: FITTING THE CANOPY

OVERVIEW

The RV-9/9A has been designed to accept either a forward hinged, tip-up canopy bubble or a sliding canopy with a fixed windshield. The fuselage structure differs slightly between the two styles. Be sure you are following the directions for the proper canopy.

Fitting the canopy is one of the most demanding construction jobs in building an airplane -- any airplane. The big plexiglass bubble is fragile and difficult to handle. The geometry is not always obvious. The fit must be correct to prevent aggravating air and water leaks.

Take your time and work with patience and persistence.

PLEXIGLASS TIPS

The plexiglass canopy bubble is one of the most expensive and fragile components in the kit. Mis-handling and cracking it is one of the most disappointing, gumption-robbing experiences a homebuilder can have. Here are a few plexiglass tips.

Plexiglass is dramatically less brittle when it is warm. Do not try and work on the canopy in a cold shop. Cutting or drilling Plexiglass in temperatures under 60º F is asking for trouble. Heat the shop to 75-80º -- it may be uncomfortable to you, but your canopy loves it. Many builders will put a small space heater under the canopy when trimming, just as insurance.

Regular twist drills have tips that tend to fracture Plexiglass. Special Plexiglass drills are available from tool suppliers. We have also found that a small Unibit makes excellent holes in warm Plexi. Using a regular twist drill to enlarge a pre-drilled hole is almost guaranteed to crack a canopy.

Do NOT try and use a saw of any kind. You might get away with it once or twice, but eventually you will crack the bubble. Cutting discs, supplied with the kit, do an excellent job when used in a high-speed die grinder. They will also cut fingers without a second thought, so support your work well and use two hands to guide the grinder. Die grinders turn at very high rpm and can throw chips and dust at un-dodgable velocities. Eye, ear, and respiratory protection is essential!

TIP-UP CANOPY INSTALLATION (Slider instructions start on page 8)

INSTALLING THE FORWARD FUSELAGE RIBS & CANOPY RELEASE MECHANISM

DRILLING THE CANOPY HINGE BLOCKS TO THE RIBS

Making the canopy fit the fuselage precisely is easier if the canopy frame is fitted before the rotation points are drilled in curved hinges. The rotation points are located on the fuselage first, then transferred to the hinges themselves. To locate the hinge points on the fuselage, the spacers and bearing blocks that will receive the canopy hinges must be fitted and drilled in place.

Make the C-617, C-618, and C-619 spacers as shown on DWG 47.

Temporarily remove the F-644 ribs. Clamp the C-617 block to the F-745 rib with the aft surface of the block flush to the aft edge of the rib and the top surface of the block just low enough to clear the skin when it is installed. Drill two shallow #12 pilot holes into the block using the two pre-punched 3/16” holes in F-745 as a guide. Drill only about 1/16" deep into the block.

Remove the block and finish drilling the holes in a drill press using a #10 drill. (Be sure the drill press table is level and square). UHMW plastic tends to expand when drilling and then shrink back after the drill is removed. A #10 bit will produce a hole that will be a slip fit for an AN3 bolt.

Clamp the C-617 and C-618 blocks together, with the forward and top edges flush. Use the holes in C-617 to drill C-618.

While the two blocks are joined, carefully measure the location of the ¼” hole for the canopy hinge pivot bolt and drill it through both blocks.

Repeat the procedure with the other C-617/C-618 blocks.

Reinstall the C-617 blocks on the F-745 ribs with temporary bolts.

Drill the ¼” holes in the F-745 ribs, using the holes in the C-617 as a guide.

Pull a .251" reamer backwards through the block and rib a few times to get a nice slip fit on the modified AN43B pins.

Drill the upper hole in the C-619 spacer to the measurements shown on DWG 47. Be sure to maintain the bolt hole edge distance because this spacer will be used later as a guide/stop for positioning the canopy frame. Clamp the C-619 spacer to the C-617 block, insert a bolt through the hole and drill the second bolt hole.

The F-644 ribs were drilled but not riveted to the F-768 bulkhead during fuselage construction. Now they must be match drilled to the block assembly. Cleco the F-644 ribs to the F-768 bulkhead. Insert the C-617/618/619 assembly between F-644 and F-745 and slide bolts through the holes until they contact the face of F-644. Clamp the ribs and blocks together, using just enough pressure to hold the clamp in place.

Cleco the F-771 front top skin in place to maintain the proper position of the F-644 ribs. Do not cleco the portion of skin that is outboard of the F-745 ribs so the skin may be lifted to provide access for drilling.

If the holes in F-771 skin and F-644 ribs don’t align, insert thin aluminum shims between the inboard face of C-617 and F-644 until they do. When the assembly comes apart later, you can make a full size shim of the correct thickness.

When the F-771 is clecoed to the F-644 rib, tighten the clamp. Peel up the outboard portion of the skin, remove one bolt from the assembly and drill F-644 through the hole. Reinsert the bolt, all the way through F-644 this time, and continue until all the holes are drilled.

INSTALLING THE CANOPY RELEASE

Make the C-620 bearing block shown on DWG 47. Drill the bolt holes to the dimensions shown.

Fabricate and/or install the canopy release mechanism components C-620, C-621, C-622, Wd-618, Wd-619, Wd-620, and the modified AN43B-16 bolts. See DWG 47. The entire pushrod/bellcrank assembly can be pre-assembled on the bench, with all its clevis pins, thin washers, and cotter pins. This will allow you to install it in one piece without having to lie on your back installing cotter pins, etc. Experiment with installing the assembly with the top skin removed so it will be familiar when it is time to install it after the skin is riveted on.

When drilling the Wd-618 to the Wd-619 be sure the arm on the Wd-619 is “clocked” to the correct position (with the ears on the Wd-619 pointed outboard) and that the elevation is correct. It must center vertically as it swings through the pre-punched cutout in the F-768 bulkhead.

Fit the mechanism to the forward fuselage and align the C-620 bearing block on the F-697 channel. The horizontal position is determined by the side-to-side pushrods. The vertical position is determined by the fore-and-aft pushrod. Clamp the block to the channel and work the mechanism. Adjust the block position if necessary to align the pushrods and eliminate any binding. When the block position is correct, drill the C-620 to the F-697 using the holes pre-drilled in the block as guides.

Note: If you intend to have in-flight canopy jettison capability you must notch a portion of the F-771 skin above each hinge slot to allow the canopy frame to be pushed up and away from the fuselage. See DWG 28, Detail F. These notches can then be covered with a sacrificial cover plate bonded in place lightly enough that it will not exceed your (probably adrenaline-enhanced) ability to break the bond should you ever have to push it open.

RIVETING THE UPPER FORWARD FUSELAGE

Once the above work is completed the upper forward fuselage structure can be riveted at any time, though we recommend that you delay it as long as possible. This will provide much better access to the cockpit area for all of the systems installation, wiring, instrument panel work, etc.

When you are ready to assemble the forward fuselage structure, first rivet the F-768C seal strips to the F-768A and F-768B sub-panel (leave open any rivet holes that share other parts). Rivet the plate nuts to the F-697 and then rivet the F-697 and the F-643-1 to the F-768A.

Rivet the F-745 ribs to each F-768B sub-panel (only at the 2 top holes requiring AN426 rivets). An F-768B with its associated F-745 rib (your choice, left or right) can now be riveted to the F-768A. Now before riveting the other F-768B you must fit the whole assembly into the fuselage and cleco it in place. See DWG 24A. You can now finish all of the other riveting in any order you choose, though it is easier to rivet the F-721C & D attach angles to the F-721A before it is riveted to the fuselage. If you are using the optional map box kit, now is a good time to complete the installation.

INSTALLING THE PRIMARY CANOPY LATCH

INSTALLING THE SIDE HANDLE

Use the Tip-Up Canopy Latch Hole Pattern template on DWG 48, Detail D to locate and drill holes in the forward

side skin for the latch handle. Use a small file to slot between the holes…this will be visible, so work carefully.

Use a straight edge and check the C-607 Latch Handle for straightness. The 1/8" thick material often distorts slightly in the punching process. Clamp it in a vise and lightly tap in the appropriate locations to get it as straight as possible.

File/deburr the edges of C-607 and C-609. Finish the interior of the hooks with a small jeweler's file.

Fabricate the lower C-712 angle as shown on DWG 48. Use particular care to accurately locate the two 3/16" diameter holes in C-712.

Temporarily bolt C-607 and C-609 to the lower C-712 angle. The aft outboard portion of C-607 has two straight, parallel edges offset .032 from each other. C-607 should mate to the lower C-712 so one of the edges is flush with the outboard face of C-712 and the other edge is protruding by .032. C-609 should mate to the C-712 angle so it rotates enough to disengage before interfering with the forward surface of C-607.

Fabricate the upper C-712 angle. Clamp the angles together and ensure that the outer faces of the two angles are flush before drilling the 3/16" diameter holes.

Temporarily bolt the C-607 and C-609 between the two C-712 angles. We use UHMW tape applied to the upper/ lower faces of the C-712 angles to prevent C-607 & C-609 from scraping the angles as they rotate. Use an .016 spacer and a piece of heavy paper (to allow for the of UHMW tape) between the inside faces of angles and C-607 and C-609. This will provide some clearance and prevent binding.

Position and drill the C-712/C-607/C-609 sub-assembly to the forward side skin. Use the C-607 to align the sub-assembly with the slots in the skin.

Machine countersink the C-712 rivet holes, dimple the forward fuselage skin and rivet the angles to the skin.

Follow the instructions supplied with the VA-104 knob and install it on the C-607.

Bolt the C-607 to the C-712 angles. Drill a hole in C-609 and in the main spar bulkhead for C-616 wire core.

Install the C-607/C-609 latch handle, then insert the C-616 wire core into the C-615 spring and hook it into the holes on the fuselage and latch.

INSTALLING THE AFT CANOPY LATCH

The Wd-617 Canopy Latch spans the cockpit behind the seats and operates canopy latch fingers on each side of the canopy frame. It is shown on DWGs 48 and 49.

Bend the latch hooks (if necessary) until they fit through the oval holes in the F-705 bulkhead.

Mark lines on each C-611 block for the vertical position of the bolt holes. Fit a C-611 block to each end of the Wd-617 and install it into the fuselage. Fit the hooks in the F-705 oval holes and clamp the blocks in position so that the bolt position lines are visible through the pre-punched holes in F-705 (see DWG 20).

Using the holes in the bulkhead as guides, drill holes in the C-611 blocks about 1/16" deep with a #30 drill to mark its location. Remove the blocks and finish drilling the holes in a drill press. Then enlarge the holes in the blocks with a #10 drill bit. Enlarge the bolt holes in the F-705 bulkhead with a #12 drill. Bolt the Wd-617 and the two C-611 blocks into the fuselage.

Install the two VS-411 brackets to the F-705 bulkhead.

Install the C-605 and the two C-606 links. The links will require a slight twist and small bends on the ends to make them align with the angular difference between the arm on the Wd-617 and the C-605.

This all sounds complicated but it should be readily apparent when you begin bolting the parts together.

Finally make the C-710 push rod assembly as shown in DWG 48. Drill the ends of the tube with a #3 drill and tap them with 1/4 - 28 threads at each end to accept the rod ends.

FITTING THE CANOPY FRAME TO THE FUSELAGE

PREPARING THE FRAME AND FITTING THE CANOPY SKIN

If the instrument panel and avionics are installed, remove them for safekeeping while the frame is fitted.

Install the C-617, C-618, & C-619 blocks.

Draw a black pen center line on the aft tube of the Wd-716 fwd canopy frame weldment.

Use a ¼" to ½"wide strip of UHMW tape along the inner surface of the forward edge of the C-702 skin to prevent it and the F-768 sub-panel flanges from rubbing on each other when opening and closing. The tape should be attached flush with the forward edge of the skin before beginning the installation process.

When the forward ribs of the Wd-716 canopy frame assembly are manufactured, the flanges do not form to the necessary 90 degrees. Use a file or belt sander to remove some material on the aft edge of the upper flange so it is 90º when checked with a square. Only the portion from the center to about 3" outboard of each hinge bracket should be modified. Outboard of that, the fuselage widens and the flange should be a little under-bent.

Cleco the C-702 forward top skin to the Wd-716 fwd canopy frame weldment. Verify that you can see the pen line on the Wd-716 aft tube through the aft row of holes, then begin drilling and clecoing from the center out to each side with a #40 bit (they will be opened up to #30 later on).

Double check that there are no bumps around the notches in the F-768A or F-768B flanges that would prevent the skin from smoothly laying down. File as necessary to make the skin fit smoothly.

Fit the forward canopy frame/canopy skin assembly on the fuselage (you might want to protect the fuselage side rails with paper/tape from now on if they are already painted) and check the fit. The frame width at the aft tube may need to be adjusted slightly to match the fuselage width. This can be done by adding more curve to the aft tube at the ends (bend it around something round) or straightening them slightly (push it against a table top).

Tape the canopy frame/canopy skin assembly back on the fuselage, pulling it down tight on the fuselage. Put the forward edge of the C-702 canopy skin up to the aft edge of the F-771 forward fuselage top skin. When the canopy frame is in the correct position, the two skin edges will have a .032 gap across the full width of the fuselage.

Pre-drill the hole pattern into the C-614 center splice plate using #40 holes. See DWG 47. Fit C-614 to the Wd-716 canopy frame and drill the holes to the two frame ribs (only use a # 40 bit at this time to allow for slight adjustments later if required).

Drill two rows of #40 holes through Wd-716 that run aft from each hinge point using the pre-punched holes in the C-702 skin as a guide.

Remove all chips from between canopy skin and canopy frame and re-cleco.

Now drill #30 through the pre-punched holes in the tabs on each hinge bracket into the fwd canopy frame ribs. Remove the frame. Remove the skin.

Deburr all holes. Re-cleco the skin to the frame and put it back on the fuselage.

Retape with duct tape to pull everything back down tight.

Double check that you are happy with the fit and if so drill the holes in the C-614 splice plate to #30.

Disassemble deburr and rivet the 1/8" rivets in the frame splice plate and hinge angles. Note that some of the rivets are AN426 flush on the fwd side. See DWG 47, View D-D.

Re-cleco the canopy skin to the frame and fit the frame back to the fuselage.

DRILLING THE HINGE BRACKETS

Be sure you have installed the second of two AN3 bolts through F-745, C-617, C-618, C-619, and F-644 after riveting on the F-771 skin. Use a ¼" drill bit in an angle drill to back drill through the C-617 block and into the Wd-716 hinge brackets to mark the hinge pin location. You do not have to drill all the way through the Wd-716 hinge brackets. Drill just deep enough to make the full diameter of the drill bit. Remove the frame from the fuselage and finish drilling the ¼" holes all the way through the brackets as straight as you can.

With the hole finished to 1/4 " enlarge it for the bushing. This is most accurately done by carefully drilling the hole to 23/64" and then reaming to .375 with a straight reamer. A sharp new 3/8 drill bit can also be used to take the hole to final size if a reamer isn't available. Deburr the holes and then press in the bushings using flush set in a rivet squeezer.

Reinstall the previously made release mechanism in the fuselage.

Attach the Wd-620 handle temporarily to make it easier to engage the pins when installing and removing the frame the 100 or so times you will do it while fitting the canopy.

FITTING THE CANOPY FRAME TO THE FUSELAGE AND CABIN FRAME

Reinstall the canopy frame on the fuselage (without the canopy skin clecoed on) and engage the release pins.

The canopy installation is designed with a very tight clearance between the Wd-716 frame and the F-768C seal support angle. See DWG 24A. Trim the seal support angle just enough to allow the frame to pivot without scraping.

Cleco the C-702 canopy skin to the Wd-716 canopy frame using clecos in all the holes.

Make four spacers 7/8" thick and four 1/8" thick. They can be made of what ever material you like (we used aluminum bar for the thin ones and blocks of wood cut on the band saw for the thick ones) but they should be accurate for thickness. The 1/8" spacers should be approx. 1" X 2", and the 7/8" spacers should be approx. 2" X 4".

The 1/8" spacers will be used under the Wd-725 canopy side rails, and the 7/8" spacers will be used between the F-631A ribs and the F-631 roll bar.

The F-631A ribs must have the flange angles re-adjusted to about 92.5 degrees (as formed they are only about 88 degrees) and then fluted to make them straight. Adjust the flute spacing to allow for the eventual screw pattern that will attach the canopy.

Fit and drill the C-704 splice plate (DWG 49) to one (just one) of the F-631As.

Lay the Wd-725 canopy side rails in place on the fuselage to check the fit. The goal is to have the curve of Wd-725 exactly match the longitudinal curve of the fuselage and align vertically with the fuselage side when checked with a straight edge. As supplied, the curve is usually very close along the bottom but more curve will probably be required along the joggle at the top. This is improved by lightly bending the rail across any heavy round object.

The fwd ends of the Wd-725 canopy side rails may need to be adjusted/modified where they mate to the Wd-716. Squeeze the upper bend with flush sets in a rivet squeezer and then finish the adjustment with a hand seamer. The goal is to get a smooth transition from the Wd-725, rolling inboard to the Wd-716.

Lay out and pre-drill the rivet pattern in the C-613 splice plates using a #40 drill. See DWG 48.

Layout and pre-drill the rivet pattern in the angle bracket welded to the aft end of each Wd-725, using a #40 drill.

Tape the 7/8" spacers to the aft side of the F-631A ribs. Clamp the ribs to the forward side of the F-631 cabin frame.

Clamp each Wd-725 to the fuselage sides using the 1/8” spacers between the bottom of Wd-725 and the F-721 aft canopy deck. The aft surface of Wd-725 mates to the forward surface of the F-631A ribs. Use a piece of .032 scrap to simulate the C-603 canopy skirt thickness. The correct position of the Wd-725 is with the C-603 skin flush with the side of the fuselage (see DWG 48, Sect B-B and C-C). Drill the welded angle to the F-631A ribs.

Clamp the C-613 splice plates to the Wd-716 and the Wd-725 with the bottom flanges of Wd-716 and Wd-725 aligned (see DWG 48.) The lower flange on the C-613 nests tightly to the lower flange of the Wd-725. The forward portion of the flange that angles away from the Wd-716 will be later filled with a wedge shaped spacer.

FINISHING THE FRAME

When you are happy with the alignment of the frame sides to the fuselage, drill the holes from the C-613 through the Wd-725 and the Wd-716. Do not drill the two holes through the Wd-725 upper flange and Wd-716 aft tab at this time. Drill the holes only through Wd-725/Wd-716 and C-613. While drilling, be sure to peel back the C-702 skin slightly where it overlaps the splice plate holes so you don't drill into it.

Remove the C-613s and Wd-725s from the Wd-716 and remove the Wd-716 from the fuselage.

Un-cleco the C-702 skin from Wd-716.

Re-cleco the C-613’s to the Wd-725's and the Wd-716.

Make the C-723 spacer wedges. See DWG 48.

Clamp a piece of scrap angle along the bottom edge of the side of the frame to make sure it is straight and then drill the 2 holes through the Wd-716, C-613, and the C-723 wedge.

Disassemble, deburr, and machine countersink for the AN426 rivets.

Re-cleco and reclamp with the angle to be sure it is straight, and rivet the canopy frame together, except at the joint of the F-631As. This will be final drilled and riveted a little later.

Reinstall the frame on the fuselage and cleco on the C-702 skin.

FITTING THE PLEXIGLASS CANOPY

It is now time to start cutting the canopy. Put away the prayer beads…this isn’t as bad as you may have feared.

Keep the vinyl plastic on the canopy for as long as possible to protect it from any accumulation of dirt and grit that can cause scratches during installation. It is very difficult to remove this without causing scratches. If you get to a point where you have to remove the vinyl, replace it with some stretch-on plastic wrap from the kitchen. This will help keep it protected until the airplane is ready to fly.

Before doing any cutting, mark a centerline on the vinyl down the middle of the canopy from front to back. This will aid in aligning to the fuselage and keeping the two parts aligned with each other once the canopy is cut.

The initial trim removes just the excess flange around the front, and the clamping areas along the sides and the back. Use this cutting on unused portions of the canopy as an opportunity to practice making clean straight lines. Go ahead and mark lines with a straight edge and practice following them as well as you can.

Before the canopy is moved/handled you must finish on the edges at least to the point of removing any nicks and rounding the sharp edges. These are all stress risers that can be the origin of a crack.

Put some masking tape on the roll bar and the F-631 rib flanges to prevent scratching the canopy. Mark a center line around the circumference of the cabin frame. This will be the eventual split line between the front and back portions of the canopy.

Set the canopy in place on the fuselage to check the fit. The canopy will eventually go behind the “ears” on the C-702 skin but for now, put some tape on the ears to prevent scratching and let them rest inside the canopy.

You now should be able to see what the frame shape has to be at the fwd end of the Wd-725 side rails where they intersect the Wd-716. The joggled flange on the Wd-725 and the tab on the Wd-716 need to begin rolling inboard to allow for the shape of the canopy at this point. Remove the canopy and adjust as necessary, then refit the canopy.

The initial trimming should work towards a flush fit of the windscreen portion at the front to the C-702 skin. WHEN CHECKING THE FIT OF THE CANOPY TO THE FRAME, THE CANOPY MUST BE (AS MUCH AS POSSIBLE) CLAMPED/HELD WHERE IT WILL BE IN WHEN IT IS FINALLY SCREWED ON TO THE FRAME.

Pull the canopy sides in to the frame when checking the overall fit. The goal is to get the canopy to fit nicely to the C-702 skin while it is pulled in to the Wd-725 side channels, is touching around the sides of the roll bar, and contacts the F-632A approx. 1.5 " forward of the F-606 bulkhead. In final position the base of the windscreen will be approximately 1.75" aft of the forward edge of C-702.

Do not attempt to do any trimming to final size, other than around the base of the windscreen, until after you have split it the canopy at the roll bar. The molded shape of the canopy results in a slight duck tail upturn at the very back (trimmed off later) and a curve in the top where it goes over the roll bar. This will prevent it from laying down flush on the top of the cabin frame and canopy frame until it is separated into two pieces.

When you have gotten the fit to be somewhat close (it doesn't need to be perfect: it actually becomes much easier to deal with once the canopy is split) it is time to mark the split line. The split point goes right down the middle of the F-631 roll bar. Don’t forget to pull the canopy in tight on the sides when marking the line.

At this time you should also temporarily cleco on the F-774 aft top skin and mark the window cutout on the canopy. Immediately mark "do not cut at this line". The line is useful for repositioning the canopy, but you must remember to leave an extra flange for attaching the window to the skin. Mark a line about 1.25" outside of the “do not cut” line for doing a rough cut to final size.

Remove the canopy from the fuselage. Attach (nail, screw, etc.) blocks to the table top or edges to hold the canopy and keep it from spreading as it rests on the table. By restraining its sides in this manner will hold its shape and you can be work on it safely.

It is a very good idea to have a helper with this step to help manage the progressively floppier canopy.

Cut the canopy into the front and back pieces. You may begin cutting at any point comfortable for you. However, if the cut begins on the bottom edge, we suggest that before the cut progresses more than a foot, the edge be taped or clamped back together in order to hold the shape as well as possible while continuing the cut. Similarly, the top center should either be the last portion cut, or should be taped together before completing the side cuts. The object here is to prevent the rear of the canopy from sagging down and damaging the last part of the cut. Finish these edges before moving/handling the pieces.

Put the fwd portion back on the fuselage and mark for the final trimming. Because it is more flexible now it should lay down flush all around the roll bar. It will probably not match up exactly to the center split line on the roll bar but don't worry, this will be taken care of with a little bit of final trim adjustment. You can also double-check the fit once more at the fwd end of the Wd-725. Remove the canopy, make any other adjustments necessary, then drill and rivet the tabs on the Wd-716 to the Wd-725s.

DRILLING THE CANOPY TO THE CANOPY FRAME

Reinstall the canopy on the frame.

With the canopy at its final position, lightly clamp it to the roll bar. Now unclamp the F-631 frame ribs and move them so that they make contact with the interior of the canopy and then re-clamp them to the roll bar.

Using a helper, carefully remove the canopy so as not to disturb the position of the F-631 ribs.

Carefully drill the remaining holes through the F-631 rib and the C-704 splice plate.

Using the .032 shim to simulate the C-603 canopy skirt and a piece of angle to hold the Wd-725 side rail square (see photo), drill the aft angle of the side rail to the F-631 frame rib with a #40 drill.

With everything clecoed, refit the canopy, tape it with duct tape at the front, clamp or tape it to the roll bar at the back. Mark the final trim along the Wd-725 joggle, and note any small adjustments that you want to make where the base of the windscreen mates with the C-702 skin.

Remove the canopy and do the final trim along the sides and front. Once again, finish the edges before handling or moving.

Locate and mark all the screw hole locations on the canopy frame. When drilling the canopy you can pre-drill all of the holes in the frame #40 and then drill through the canopy to them with a plexi bit. The canopy is transparent of course, and it is relatively easy to hit the holes already in the frame. Alternatively, you can drill the hole in the canopy (using a special 1/8" plexiglass bit) until the tip of the bit makes a mark on the frame. The holes in the frame will be drilled with a regular bit when the plexiglass is removed.

Either way, it is very important that you have the canopy pulled down tight when you drill the first few holes, at least on the side you are drilling. These holes will "lock in" the canopy position, so you must have the canopy where in the correct position.

With the canopy taped at the front and clamped or taped at the back, begin by drilling 3 or 4 holes at the top center of the F-631 rib bow to help lock-in the position. Now with a helper pulling the canopy tight on one entire side drill some holes 6 - 8 " apart around the rear bow and the sides to lock it down. Do the same on the other side. Finish drilling all remaining holes.

Mark the aft edge of the canopy for final trimming to match the split line on the roll bar. Remove the canopy and frame as an assembly from the fuselage.

Do the final trimming on the back edge of the canopy. Note: more may be required later to provide clearance from the aft portion, and to allow for it to swing opened and closed.

FITTING THE REAR WINDOW

Trim the aft canopy window portion to the line previously marked and finish the edge.

Mark all of the screw holes on the aft top skin and the roll bar. Be sure that you make the screw pattern fit within the rivet pattern already in the roll bar.

The aft window should be now put in place and positioned so that it reaches the split line on the roll bar (be sure that you are pushing it fully tight to the aft top skin (remember the shape change). You will probably have excess on the roll bar over the top but that will be trimmed/adjusted later.

Lightly clamp the window to the cabin frame. Make sure that it is pushed tightly to the inside of the aft top skin.

Begin drilling at the top middle of the aft top skin and the top middle of the roll bar. Alternating back and forth, clecoing as you go to pull the window tight to the roll bar and skin as you work your way down.

Repeat on the other side.

Mark the window along the split line on the roll bar for final trimming.

Remove the window, trim the forward edge along the split line, and finish the edge.

The holes in the roll bar should be enlarged with a #35 drill and tapped for a 6-32 screw.

Remove the aft top skin. Lay it flat on some scrap .025 material and trace the window shape to cutout the backing strip for the screws.

The window screw holes in the aft top skin should be enlarged with a #27 drill and dimpled for a #6 screw.

Because of the expansion rate of plexiglass, it is good practice to make fastener holes in plexiglass canopy slightly larger than the diameter of the fasteners themselves. Remove the canopy from the frame and machine countersink all the holes for either #6 screw heads or a #6 dimple (Use a piece of .032 or .025 aluminum, as appropriate, dimpled for 6-32 screw to test the fit.) Check the drawing and mark the holes for the correct countersinking depth before you start cutting. After countersinking, enlarge all the holes in the plexi with a 5/32" plexi drill or the 5/32" step on a Unibit. Countersinking before enlarging the holes permits you to use a standard countersinking bit with a #30 pilot. Immediately debur all holes to prevent cracks.

Enlarge all screw holes in the frame with a #27 drill and then debur.

All holes in the aft window that screw to the roll bar should be machine countersunk for a 6-32 screw head, then enlarged as described for the canopy. All holes in the aft window that match with holes in the aft top skin should be machine countersunk, using piece of .025 dimpled for 6-32 screw to test the fit, then enlarged.

FITTING THE SIDE SKIRTS

It is time to fit and drill the C-603 canopy side skirts. Replace the frame on the fuselage, tape it down and attach the canopy bubble with three screws evenly spaced along each side of the frame. The screws are installed through the canopy bubble and Wd-725 only. This allows the final canopy bubble and frame shape to be held without clecos interfering with the side skirts.

The bottom edge of the C-603 side skirts butts to the top of the fuselage side skin and the top edge is trimmed even with the top edge of Wd-725. The front edge butts up to the aft edge of the C-702 canopy skin, and the aft edge fits to the forward edge of F-774 with an approximately 1/16" gap.

Lay out the hole pattern for the AN426AD3 rivets that attach C-603 and Wd-725. Drill and cleco C-603 to the canopy frame. Remove the canopy and frame from the fuselage, and back-drill the row of screw holes through the canopy frame, canopy, and into the C-603 side skirt. See DWG 48, Section C-C.

Remove the C-603 side skirts, remove the screws holding the canopy to the frame, remove the canopy, and remove the C-702 canopy skin.

Debur, dimple/machine countersink all holes, and rivet the skins to the frame. Now is a good time to paint the canopy frame with whatever interior finish paint you have chosen.

Place the canopy bubble on the frame assembly and install all screws, washers, and nuts.

FITTING THE LATCH FINGERS AND SAFETY LATCH TO THE FRAME

Now that the canopy has been fitted and attached to the canopy frame, it is time to complete the canopy latch mechanism by attaching the Wd-622 canopy lugs to the bottom of the aft surface of the frame.

Re-install the canopy/frame assembly on the fuselage.

You will need to work from inside the cabin. Clamp the Wd-622 canopy lug to the aft end of the canopy frame as shown in DWG 48, Sect. E-E. Lower the canopy and engage the lug with the latch fingers by moving the canopy latch mechanism to the closed and latched position. The lug is held in position inside the "hook" portion of Wd-617 from the bottom. Mart its position using the holes that pre-drilled in the aft ends of the Wd-725 canopy side rails. The Wd-622 canopy lugs should be clecoed to the frame initially using #30 holes, and the canopy latch functionality checked before enlarging the holes to 3/16 and installing bolts, washers, and nuts. The Wd-622 lug placement can be "cheated" up when the holes are enlarged if the canopy did not latch as tightly as desired. The "hooks" of the Wd-617 can be deepened slightly, or the lugs can be "cheated" down if the canopy latches too tightly. You should be able to feel the latch engage the lug when you work the latch handle, but you should not have to force the handle closed.

The Wd-621 Aft Canopy Handle is installed next. Insert the shaft of the canopy handle into mount block C-608. Position the handle/block assembly on the forward face of the C-631A frame as shown in DWG 49, View A-A. Mark, drill, and countersink the four holes as shown. Bolt the block to frame C-631A with AN509 flush head bolts. Install the 3/8" washer and cotter pin to hold the handle in the block.

The canopy handle serves several purposes. The primary one is as a convenient handle for raising and lowering the canopy. It also functions as a safety hold-down latch, and to hold the canopy partially open in a "Taxi" position. To function as a safety latch, the handle is turned fore and aft as shown on DWG 51. If the pilot forgets to latch the canopy before take-off, this handle will restrain the canopy from lifting open, at least at low flying speeds. When the canopy is opened about 3 1/2 inches, and the handle rotated fore-and-aft with the tip end aft, this tip will rest on top of the F-631 cabin frame, thus holding the canopy slightly open and providing cabin ventilation while taxiing.

INSTALLING THE SLIDING CANOPY

After the empennage, the sliding canopy probably raises more questions than any other installation. Fitting a structure of welded steel spaghetti to a hand-built fuselage is an exercise in patience and perseverance. Given the inevitable variations between individual frames, roll-bars and fuselages, it is not possible to give dimensions that will work every time. Instead, we caution builders to slow down and work carefully from "first principles." The amount of effort and time you spend on preliminary positioning and alignment, adjusting both the canopy frame and the canopy skirts, makes a big difference to the quality of the final fit of the canopy.

The RV-9/9A Sliding Canopy Assembly consists of two main components; the Windscreen/roll bar assembly which is fixed to the fuselage, and the Sliding Canopy Frame/Plexiglass canopy which moves fore and aft.

The windshield frame also serves as an overturn structure or "roll bar". It consists of a formed steel tube weldment with a flanged base which is bolted to the fuselage upper longerons and cockpit rails. The roll bar also includes a center brace which attaches to the upper forward fuselage. The windscreen is screwed to the roll bar and bonded to the top fuselage skin with an epoxy/fiberglass base molding.

The sliding canopy frame of is made of welded steel tubing and moves on nylon rollers and a slide block. The canopy is trimmed and attached to the steel tube frame with blind rivets and machine screws. Aluminum skirts are used to fair the bottom and rear of the canopy to the fuselage.

The canopy has three contact points with the fuselage; two rollers at the lower forward corners of the canopy frame, and one slider block at the rear top of the canopy frame. The rollers move in extruded aluminum tracks and the rear slider block moves on a builder-fabricated guide track.

The sliding canopy is held closed with an over-center spring-loaded hook latch operated by an internal/external handle. This handle is also used for sliding the canopy open or closed. There are two pins at the rear base of the canopy just aft of the canopy tracks which engage nylon blocks mounted on the fuselage. The front of the sliding canopy is held down by a molded fiberglass lip on the windscreen. The pins and lip serve as passive hold-downs, so operating the sliding canopy requires just one latch and one hand.

INSTALLING THE ROLL BAR

Lay out and drill #40 pilot holes for the 3/16" and ¼" bolts through the F-721B Aft Canopy Decks shown on DWG 42, Detail A. Drill the aft pilot hole through both the upper surface of F-721B and the lower flange of F-721B.

The C-668 spacers are needed to provide a flat surface for the nuts and bolts that attach the roll bar to the longerons. See DWG 42, Section D-D. Modify the C-668 spacers provided in the kit as shown on DWG 42, C-668 Detail Views. When done, you should have a forward left, forward right, aft left, and aft right spacer. Mark centerlines on the upper surface of each spacer. Hold the spacers, one at a time, in place against the bottom surface of F-721B and nested tightly against the inboard edge of the longeron with the fastener centerline mark visible through the #40 pilot holes drilled earlier. Drill #40 through the pilot holes just enough (about 3/32" deep) to make a good center point for finish drilling the holes through the spacers off of the fuselage. Remove the spacers. Use a drill press to drill the #40 holes all the way through the spacers. Then finish-drill the holes to final size. Make sure you put the correct size hole in the correct spacer! #12 for the forward two spacers, ¼" for the aft two spacers.

Place the Wd-641 Roll Bar on the fuselage in the position shown on DWG 42, View C-C. The roll bar should have 7/32" gap between the fuselage sides and the outer edges of the bar. If the gap is within 1/16" of desired, you can push or pull it into position, otherwise you should bend it slightly to make it fit within 1/16". It can be adjusted quite easily by hooking one end behind something and pulling (to make it wider) or by putting one end on the floor and leaning on the other (to make it narrower). Go slooooowly. It is easy to do too much.

Once you have the width close, clamp the roll bar in the proper position of the fuselage (vise grips work well) and using a #40 bit, back-drill the 4 bolt holes up from the bottom using the pre-drilled pilot holes in F-721B as guides. The aft two holes are back-drilled using the holes in the F-721B flanges as well as the holes through the upper surfaces.

Remove the roll bar. Drill the holes up to final size in both the roll bar and in the aft canopy decks. Remember, #12 for the forward holes, ¼" for the aft holes. Use a unibit for the F-721B holes to keep the holes from wandering. De-burr all holes.

Install bolts/nuts/washers to hold the roll bar in place for further fitting. With the nuts tightened, double-check that the roll bar is square to the fuselage longerons. See DWG 42, View C-C. Use shims if/as required.

Insert the forward end of the Wd-643-SS Roll Bar Brace through the pre-punched slot in the F-7106 forward top skin. The tab of the roll bar brace fits between the F-7108A Rib and the F-7108B Angle. Carefully use a screwdriver to pry the rib and angle apart when inserting the tab. See DWG 24.

Trim the upper/aft end of Wd-643-SS as required to mate with the receptacle in Wd-641. Clamp the tube in place and drill a 1/4" hole through its upper end joining the roll bar. See DWG 43, Detail B. Using the pre-punched holes in the F-7108 rib as guides, drill two 3/16" holes through the plate in the Wd-643-SS lower end. Remove Wd-643-SS, de-burr holes, and trim the bottom of the roll bar brace to leave 3/8" edge distance. See DWG 42, View E-E. Install bolts/nuts/washers to hold the roll bar brace in place for further fitting.

FITTING THE SLIDER FRAME

Assemble the Wd-644/C-658 roller assemblies (see DWG 41, Detail A) and insert them into the tubes of the Wd-640 Canopy Frame. Light clamping pressure with a small C-clamp will hold them in -- do not drill them to the frame until all canopy fitting adjustment have been made.

Cut the C-657 Canopy Tracks to length as shown on DWG 41. Lay-out and pre-drill screw holes using a #40 bit. See DWG 42, Sliding Canopy Top View for screw hole spacing. Clamp the C-657 canopy tracks onto the F-721B Aft Canopy Decks.

Drill the hole through C-661 per DWG 43, C-661 Detail View. Position the C-661 rear slider block under the receptacle on the rear center of the canopy frame weldment. Drill through C-661 and the canopy frame and insert the bolt. See DWG 43, Detail J. Remove C-661 and de-burr holes.

Check the shape of the C-763 Slide Spacer against the full-scale template on DWG 41. The part supplied in your kit may vary slightly, so carefully adjust your C-763 to match the template. Complete the rear slider track assembly by positioning, drilling, and riveting the C-762 and C-763 parts together per DWG 43, Section H-H. Make sure that you are not changing the shape of C-763 as you are attaching C-762 to it. Lay the track assembly in place approximately centered on the rear fuselage top skin. Bend the tab in the F-7112 skin down to allow the track assembly to rest on the skin. See DWG 43, Detail J. Slide the C-661 block onto the track. For the time being, hold the track in place on the fuselage with duct tape.

Install the Wd-640 Canopy frame on the fuselage by inserting the rollers in the tracks through their open aft ends and inserting the bolt through the C-661. Slide the frame forward until it meets the roll bar. The flanges of the Wd-644 roller brackets will be the first part of the frame assembly to touch the roll bar.

Additional notes on adjusting the canopy frame:

Some of these instructions may be repeated in other areas, but they are worth reading twice.

The welded steel sliding frame and rollover bar will vary dimensionally, despite the best efforts of the manufacturers and welders. The long tubing runs, combined with local heating/cooling at the welds, insure that no two will be exactly the same. The builder will have to make some adjustments to get a perfect fit.

These adjustments can be frustrating to say the least. Making a slight bend in one place often causes a change in a totally different location. You need to understand why this happens and then learn to make it work for you. If you get carried away with bending in one spot or you add or subtract bend in the wrong place you can very quickly make the fit worse that it was when you started. Move slowly and patiently.

The frame is made of tough 4130 steel tubing. Making a bend in a small localized area takes a lot of force. Making a bend over a wide area takes less force but requires more displacement because there is a lot of spring back. You can make small localized bends by cutting a curve into sturdy wood block (like a length of 2x4), then clamping the block to the tube and squeezing the tube into the block with a couple large c-clamps or a big bench vice (this technique usually requires a helper). You can remove bend the same way, using blocks with less curvature than the tube being adjusted.

You can also make a bend by bridging the tube between two wood blocks (closely spaced for a localized bend, more widely spaced for a larger area bend) then put pressure (weight) on the tube. It takes more weight than you might think…use your heel while you pull with your hands just outside of the blocks.

Bend can be removed by placing the center point of the arc where you want to reduce the bend directly on the floor and stepping on the tube with your heels on each side. Depending on how weight-challenged you are it may require a little bouncing to get any results. Once again, the wider the area you need to change, the wider your feet should be, but remember that less force will be required because of the increase in leverage on the tube.

Bend just a little at a time and check the width measurements before and after attempting any bend. This is the only way to tell when you have actually caused a change (other than putting the frame back on the fuselage). If you can detect a change while you are using your hands and feet, you probably did way too much.

The first thing to check is the profile of the lower side tubes (these may have a round or a square cross-section, depending on the era of your kit. The more recent ones are square). Viewed from above, they should very closely match the shape of the longerons. You can check by setting the frame on the fuselage and putting a 24" straightedge vertical against the side of the fuselage every 3". Add or subtract bend to make them match as closely as possible.

Once the side tubes match the fuselage shape running for and aft, and you have done the initial work of fitting the roller tracks and rear slide, you can begin checking the front and rear bows.

Before you begin making any bend adjustments, determine what the ideal width of the frame is at the bottom of the forward bow (where the roller brackets insert) and at the base of the rear bow. Measure the distance between the tubes on the top of the roller brackets with the rollers centered in the tracks. Subtract 1/2" to compensate for the spreading of the frame caused by attaching the Plexiglas canopy. This will be the inside dimension at the base of the forward bow that you will try to maintain when making adjustments.

Measure the fuselage width at the very aft end of the frame side tubes. Subtract 3/8" to allow for the inset required for the side skirt thicknesses, and the approx. 1/4" spreading that occurs when the canopy is attached. Write the front and back dimensions on some tape and stick them on the frame so that you can refer to them when making adjustments.

With the frame in place on the fuselage, you are ready to begin checking the shape of the slider frame. Be sure that the top center of the frame at the rear is 1/16-1/8" below the F-7112 aft top skin (to allow for the canopy thickness), and that the front top of the frame is about 1/8 - 3/16" higher than the roll bar.

Study the diagrams and note how making a bend change in one area of the bow will cause a change in position down lower on the bow. Very often a change in width can be made by causing a very small bend up higher on the bow. Conversely, if you are making a bend up high on the bow, but you do not need to change the width, you will have to make another bend at another location to return the width to the correct dimension. This is why taking measurements before and after is very important.

Begin checking the rear bows using a straight edge aligned along the extension line of the conical shape. You should work from the top center down around the sides.

Do the same on the front canopy frame bow, but you need to check visually by standing in front of the firewall and looking aft. You should try to get the frame bow to be approximately 1/8-3/16" bigger than the roll bar, all the way around. The point on the roll bar that has the most curve (10 o'clock and 2 o'clock) should be a little larger (a full 3/16") than on the top or the sides.

Use a minimal number of #40 holes (such as one at each end only) when positioning the roller and slide block

tracks during initial drilling. This will allow repositioning later, when you drill on the Plexiglass canopy. After you are sure of the position you can drill the remaining holes and then drill all of them to final size for the mounting screws.

Use an air hose (wear eye protection) to keep the roller tracks as clean of metal drill shavings as possible. They get packed in the roller tracks and into the rollers, which prevents the canopy from sliding smoothly.

When drilling any holes in the canopy to the frame, the canopy must be clamped tightly to the frame *along the entire perimeter.* When you pull the canopy in tight to the frame the canopy changes shape and shifts its position on the frame. If the canopy is not in its final position on the frame when drilling all holes, you will have holes that mis-align later when it is pulled tight during final assembly.

When you drill the holes for attaching the rear slide block to the frame, be sure the block is not tilted to one side. Also, make sure the width of the track allows the block to slide freely the full length of the track (narrow it with a file if necessary). Countersink the rivets and screws in slide track slightly below the surface so that they don't catch on the block.

Before fitting the skirts to the frame/canopy, double check the fit of the frame to the fuselage. With the Plexiglass canopy clecoed onto the frame, the tubes along the sides should still be about 1/16" inside of the fuselage profile and the extended line of the aft top skin should be. The canopy surface should be slightly (1/16") above the profile of the turtle deck but it cannot be inside or below it. It is important, when checking the aft top skin to canopy relationship, to lay a straightedge on the skin paralleling the cone shape, not the centerline of the airplane.

FITTING THE SLIDER FRAME (CONTINUED)

Check the following points to insure the proper fit of the canopy frame to the fuselage:

The canopy frame side bows match the shape of the fuselage, but are inset 1/16". See DWG 43, Section F-F. The vertical distance from the canopy frame side bows to the F-721B canopy deck should vary by no more than 1/8" from front to back.

The rear bows of the canopy frame closely match the contour of the F-7112 skin but are inset about 1/16". (when the plexiglass is fitted, it will bring the level up above the contour of the skin.)

When viewed from the front, the roll bar should look centered on, and symmetrical to the canopy frame forward bow with the canopy frame top center bow centered on the latch pin on the roll bar. The canopy frame forward bow should be slightly higher at the center than the roll bar, see DWG 43, Detail B.

The canopy frame forward bow is slightly wider at the sides than the roll bar. The roll bar to canopy frame width difference is a fall-out of having the canopy frame side bows at the proper inset from the fuselage sides and is necessary because the fuselage widens going aft from the roll bar.

Make any adjustments to the frame shape that may be necessary to achieve these parameters. Use large, heavy objects of similar radius to add more curvature. Use your feet to push it against the floor on areas to reduce the curvature. Because the canopy bubble must be pulled down from its natural shape to conform to the canopy frame, the canopy frame will expand as much as ½" in width when the plexiglass canopy is attached. This will be compensated for during later stages of canopy fitting.

With the canopy frame moved fully forward, re-adjust and re-clamp the tracks so that the canopy frame side bows are inset 1/16" from both fuselage sides when the rollers are centered laterally in the tracks. This should position the tracks approximately 40 13/16" apart when measuring between roller track inboard vertical surfaces. When you are happy with the track positions, drill #40 through the forward most screw hole in each track into the fuselage and cleco. Align the two tracks and measure to be sure that they are exactly parallel. Clamp the tracks firmly in place, drill the remaining holes #40, and cleco to the fuselage.

The C-762/C-763 Rear Track assembly is still free to move both side-to-side and fore-and-aft. Moving the rear track fore and aft raises and lowers the rear of the canopy frame. Use this feature to achieve the proper relationship between the canopy rear bows and the F-7112 aft top skin. A straight edge placed on the F-7112 skin is used to extend the contour forward enough to check the measurement to the canopy frame rear bow. When you have adjusted the rear track position so that the rear canopy bow/skin relationship is correct, match-drill the rear track to the fuselage using a #40 drill at two locations, one aft and one forward. These holes must center on the upper flange of the F-787 channel as shown on DWG 43, Section H-H. The remaining holes are drilled later. This allows for readjustment if required.

Install the C-664 threaded rod brace under the forward end of the rear track as shown on DWG 42, Detail H and DWG 43, Detail J. This brace is adjustable in length and serves to stabilize the overhanging end of the track. Leave the brace full length during fitting. It can be removed and shortened later, after the canopy has been positioned.

Do not worry at this point about the vertical relationship between the canopy frame forward bow and the roll bar. This will be adjusted when the canopy bubble is being fitted to the frame.

Now that you have all the canopy frame shape initial checks and adjustments complete, it is now time to start cutting the canopy.

CAUTION: You now have the canopy frame formed to the proper shape. Do not try to bend or reshape it after the Plexiglass is drilled to the frame, the frame will break at one of the attach holes.

TRIMMING THE PLEXIGLASS CANOPY

Lay the "as-delivered" canopy on a work table. The first step is to mark a fore/aft centerline on the outside of the canopy. This is done by measuring side-to-side along the outer surface of the canopy from bottom molding flange to bottom molding flange then dividing the distance by two (or simply running a string across and folding it in half.) Do this at two locations on the canopy, one forward and one aft. Finally, use a straight edge or snap line to connect the forward and aft center locations and draw the centerline.

Lay the canopy upside down on a padded work table.

Cut the bottom molding flange off of the canopy using a cutting disk in a die grinder. Use these early trim cuts to build your canopy cutting skills by marking straight lines on the canopy and cutting as close to the lines as possible. Whenever you trim plexiglass, take the time to sand and finish the edges to a rounded smooth surface before handling or flexing the canopy. Save the scraps for some practice drilling.

Stick a couple of layers of tape over the top of the canopy frame latch handle tube to keep from scratching the inside of the canopy while the frame is being fitted to the bubble.

Lay the canopy frame inside the canopy bubble. Move the frame fore and aft to find the point of best fit between the shape of the canopy frame center tube and the shape of the canopy bubble. You must pull the canopy sides in tight to the frame while checking because this changes the shape slightly.

Mark the fore and aft position of the canopy latch handle tube on the inside of the canopy at the previously marked centerline. Remove the frame from the canopy.

Use a unibit to drill a 5/8" diameter hole in the canopy bubble for the latch handle tube. Immediately de-burr the hole and sand the edges of the hole smooth initially with 220 grit, then 400 grit sandpaper.

Lay the canopy frame back into the canopy bubble. The latch handle hole in the canopy can be elongated fore and aft if necessary to fine-tune the frame to canopy fit. A cover strip will hide the elongated hole in the canopy.

Use the frame as a guide to mark the canopy for trimming on the bottom sides and rear. Initially, trim the canopy even with the bottom of the canopy frame side bows, so the plexi can be clamped to the frame. Trim conservatively as you might later want to shift the canopy around slightly to enhance the fit.

Place the canopy frame back into the canopy bubble and use spring clamps to tightly clamp the frame to the canopy along both sides and the rear. Clamp the frame into the canopy so its center is indeed on the centerline of the canopy and so the forward bow of the canopy frame fits the inside of the canopy with as few gaps as possible.

Mark the canopy split line dividing the bubble into the sliding canopy and the fixed windscreen. The ideal canopy split location is 1/16" to 3/32" forward of the most forward surface of the forward bow of the frame. See DWG 43, Detail B. Also mark the trim line just above the canopy frame side bows as shown on DWG 43, Section F-F.

Remove the frame from the canopy and make the cuts. The canopy is VERY floppy now and must be well supported when it is set down. One method of providing support is to run a strip of duct tape from side-to-side across the bottom of the canopy at two locations. Another, perhaps more dangerous method of keeping stress off the canopy to minimum is to carefully set the canopy down on its forward edge. The extra flexibility, however, will allow the canopy to fit the steel frame with little stress.

Clean the edges of the well supported plexi, sanding them smooth.

Place the canopy frame back onto the fuselage and slide it all the way closed.

Place the canopy bubble onto the canopy frame.

FITTING THE PLEXIGLASS CANOPY

FITTING THE CANOPY TO THE SLIDING FRAME

NOTE: Before drilling any holes in the forward or aft frame bows you must have both sides of the canopy clamped into final position or you will have misalignment later at final assembly.

Secure the canopy to the canopy frame with duct tape and clamps. Initially drill #40 holes through the canopy into the sliding canopy frame at 2 inch intervals. Plan the rivet spacing at the top rear of the frame to work with the installation of the C-792 Doghouse fairing. See drawing 42. (The holes will later be enlarged to 5/32" with a Unibit or special Plexi drill --remember, don't use a twist drill to enlarge holes in plexiglass!) Start at the top center and work aft and outward alternating from right to left. Be very careful when locating the holes so that they are directly centered on the canopy frame tubes. One good procedure for determining the center is to just lightly put a strip of masking tape on the bow, don't press it down. When the plexiglass is pushed against it, the contact line will show in

the tape, indicating the exact center of the tube. After drilling a hole, cleco the plexiglass in place as drilling progresses.

When the canopy has been drilled and clecoed to the canopy frame, re-check the fit of the canopy and frame to the fuselage. The fitting of the canopy to the frame has probably pulled the frame so that it is a bit wider than is ideal. Note the amount of adjustment required and remove the canopy from the frame.

Take the opportunity to install C-653 Cover Strip while the canopy is off of the frame by placing the cover strip on the canopy and back-drilling from the canopy into the cover strip. See DWG 43, Section D-D.

Before you do anything else, determine and mark which holes will receive rivets directly, and which will contact dimpled aluminum…along the side skirts, for instance. Countersink these holes to the proper depth. Use a rivet or a dimpled scrap of .032 or .025 aluminum to test the depth of the countersink.

After countersinking and deburring the plexiglass, enlarge the holes to 5/32" using a plexiglass bit or small Unibit. By countersinking before enlarging the holes, you can use a countersinking bit with a standard pilot.

Moving back to the canopy frame, enlarge all of the #40 holes to #30. Adjust the frame, re-cleco the canopy to the frame, and re-fit the frame and canopy to the fuselage. Repeat the frame adjustments as necessary to achieve a perfect fit.

FITTING THE WINDSCREEN

Place the windscreen on the roll bar and fuselage. Use duct tape and/or clamps to hold it in place. Trim the front of the windscreen to fit the forward fuselage skin contours. Again, trim conservatively and carefully. The aft edge of the windscreen may also be trimmed slightly if/as required to allow the windscreen to better fit the forward fuselage and to allow the windscreen aft edge to mate nicely with the sliding canopy forward edge. The lower aft edge on each side will likely need trimming on each side. The fit of the windscreen to the fuselage front deck has more leeway than any other part of the canopy, because the molding strip that will be installed here can bridge small gaps.

With the canopy clecoed to the canopy frame and the windscreen taped/clamped to the fuselage and roll bar, it is time to make the final height adjustment of the canopy frame to the roll bar. While shims may be placed under the canopy on either the roll bar or the canopy frame, it is far preferable to place the shims on the roll bar. Shims on the canopy frame will be visible after the canopy installation is complete. Shims on the roll bar are hidden under the fiberglass trim strip and behind a fillet of epoxy and microbaloons or auto body adhesive laid between the aft side of the roll bar and the windscreen.

To ensure that no shims will be needed on the canopy frame, the height of the canopy frame is adjusted at the roller brackets so the windscreen portion of the canopy is even with, or slightly lower than the sliding portion of the canopy. Use a unibit to drill ½" holes in scraps of .063 aluminum to create temporary spacers that are inserted between the bottoms of the sliding canopy forward bow and the Wd-644 roller brackets. If it is necessary to lower the canopy frame, the bottoms of the sliding canopy forward bow may be shortened slightly.

After all height adjustments have been made, match-drill the canopy frame and canopy roller brackets for the AN525 screws. See DWG 41, Detail A. The proper alignment of the Wd-644 roller brackets to the C-657 roller tracks is critical. Verify proper alignment before match-drilling by clamping a straight edge to the inboard flat surface of Wd-644 and aligning the straight edge with the roller track.

Drill the windscreen to the roll bar beginning at the top/center and progress down each side. If it is necessary to place shims between the roll bar and windscreen, be sure to install the shims at each hole location before moving down the roll bar and drilling the next hole. The shims can be neatly cut pieces of aluminum or a stack of AN960-6 washers. An absolutely perfect transition from windscreen to sliding canopy is not essential, any mismatch less than 1/32" is not worth fussing over. A fiberglass trim strip (similar to the windshield base molding) will be laid up over the top of the windscreen. The trim strip will conform to and hide any remaining minor mismatch.

Remove the windscreen, countersink for 6-32 flush head screws, then enlarge the holes in windscreen to 5/32" using a plexi bit or Unibit. Enlarge the holes in the roll bar to #35 and tap 6-32. See DWG 43, Section K-K.

Set the windscreen aside for now.

CANOPY LATCH AND ANCHOR BLOCKS

FITTING THE LATCH

Assemble Wd-642 Canopy Handle, C-667 Bushing, and C-654 Canopy Latch Arm. See DWG 43, Canopy Latch Isometric View and Section C-C. The AN310 nut should be tightened on the AN23 screw lightly so that the latch is free to pivot. The latch arm should fit easily around the C-667 bushing. If not, carefully enlarge the notch in the arm so that it fits freely.

Install the Wd-642 canopy handle sub-assembly through the bushing on the upper front of the Wd-640 canopy frame. Slide the canopy all the way forward to the closed position. While holding the canopy handle sub-assembly up against the bushing, rotate it so that the C-654 latch arm contacts the latch pin on the Wd-641 roll bar. First,

check that the elevation of the latch mechanism aligns the latch hook so it contacts the latch pin. See DWG 43, Detail B. Adjust as necessary by shortening the bottom of the latch bushing on the canopy frame or by adding spacers.

When you have determined the correct level for the hook, fit the C-671 washer and the C-656 outside handle and note the amount which the Wd-642 handle shaft needs to be trimmed to bring the C-656 handle down close to the canopy. Trim the shaft and re-install the outside handle. After final adjustment of the hook, drill and tap for a machine screw as shown on DWG 43.

The C-654 latch arm has been made with excess material so that the exact location of the hook can be varied to accommodate each different canopy installation. See DWG 43, Section C-C. After all other aspects of the canopy installation are complete, the latch arm should be filed and/or trimmed so that it holds the canopy firmly in the closed position, but does not pull so hard that it distorts or mis-positions the canopy and frame assembly.

Remove the canopy and frame from the fuselage.

FITTING THE REAR ANCHOR BLOCKS

Lay-out the hole pattern in the C-677 Rear Pin Mounts as shown on DWG 41. Initially drill holes at #40. Initially drill the holes through the side of the pin mounts only on the outboard side. Make one left pin mount and one right pin mount. Match-drill and mount the C-677 Rear Pin Mounts to the top of the F-718 longerons per DWG 42, Detail B. Also see DWG 41, Detail B.

Place the C-665 Anchor Blocks in position in the C-677 mounts. Slide the canopy almost all the way closed so that the pins on the canopy frame are just touching the anchor blocks. Mark the points of contact and use a #30 or #40 drill bit to make a 1/16" deep mark in each of the blocks. Place the anchor blocks back in position in the mounts and again slide the canopy forward so that the pins are just touching the blocks. Verify the points of pin contact and adjust if/as necessary. Line-up a straight edge with the axis of the pins and project this angle to the sides of the blocks. Slide the canopy fully aft. Line-up a straight edge with the canopy tracks and project this angle to the tops of the blocks. See DWG 41, Detail B, and C-665 detail views. Also see DWG 42, Detail B. Remove the blocks and using a drill press and drill press vise, drill ¼" diameter holes in the blocks at the proper angles for the pins to engage. Check the fit of the blocks to the pins on the canopy frame. The pin holes may need to be enlarged slightly by wiggling the drill bit while drilling. Chamfer the edges of the pin holes as shown on DWG 41, C-665 detail views.

Place the blocks in the rear pin mounts. Slide the canopy all the way closed with the pins engaged in the blocks. Drill through the blocks using the pre-drilled holes in C-677 as drill guides.

Finish-up the mounting of the C-762/C-763 rear slide track by final drilling all holes and installing screws/washers/nuts.

FITTING THE SIDE SKINS

Study Section F-F on DWG 43 and the Exploded View on DWG 41 to understand how all the parts fit together.

The skirts should be preformed so they match the frame and fuselage. Do not use the power of clecos in holes to hold the part in shape. You want to save this positioning power for getting the last little bit of adjustment to get the part to lay tight on the fuselage.

Draw the C-759 inside canopy skirts across your thigh or a table edge to form a gentle curve that matches the curve of the fuselage side. Do the same with the C-660 outside canopy skirt.

Cut lightening holes and notch the lower flange of C-791 as shown on DWG 41. Pre-drill the holes in the upper flange of C-791 using a #40 drill.

While holding the upper flange of C-791 against the inside surface of the canopy frame side bow, match-drill #30 to the canopy frame. See DWG 43, Section F-F. Drill and cleco working from front to rear.

Take measurements on your canopy frame and C-791 braces to be sure that the pattern that you drill on the C-660 will work, then pre-drill the hole patterns in the C-660 Canopy Skirts. See DWG 41.

Fit the canopy skirts to the canopy frame. Start at the front, drilling #40 and clecoing to the frame as you progress aft. Remove the skirts from the canopy frame.

Modify the C-759 Inside Canopy Skirts as shown on DWG 41and pre-curve it to match the curve of the frame side tube.

Lay the C-759 against the inside surface of C-660, lining up the top edges of the two parts. Use C-660 as a drill guide and match-drill four holes evenly spaced from front to back in C-759 using a #40 drill. See DWG 43, detail E.

Cleco C-759 and C-660 to the canopy frame. Hold C-759 and C-660 tightly against the canopy frame as you drill #40 and cleco, working from front to rear.

Pre-drill the screw holes with a #30 drill through the canopy lower edges and into the upper flange of C-759 using

the pre-drilled holes in C-660 as a drill guide. Use a piece of wood to bridge vertically from the fuselage side to the canopy frame side bow to the canopy holding everything in alignment while drilling. Begin in the middle of C-660 and work forward and aft from there.

With one person on the inside of the cabin using a wood block to hold the lower flange of C-791 tightly against the inside surface of C-660 and a second person on the outside, match-drill #40 into C-791 using the pre-drilled holes in C-660 as guides. The person on the outside must hold the canopy skirt in the desired final position relative to the fuselage while drilling and clecoing. After these holes are drilled, the canopy side skirt final shape is essentially locked-in.

Remove all the pieces of the side skirts. Enlarge the holes in C-759 and C-660 for the #6 canopy attach screws and the holes for the MK-319-BS blind rivets. De-burr and dimple all holes as appropriate. Countersink the holes in the canopy, then enlarge them to 5/32” a plexi bit or a Unibit. De-burr the insides of the holes in the canopy.

Re-cleco all the side skirt pieces in place and install #6 screws through the canopy before beginning the aft canopy skirt installation.

FITTING THE REAR SKIRTS

Installing the C-666 aft canopy skirts is perhaps the most demanding detail of the canopy installation. These skirts, right and left, are riveted along with the canopy, to the rear bows of the canopy frame. The trick is in attaching the skirt so that its unsupported rear edge contacts the F-7112 aft top fuselage skin when the canopy is closed. Accomplishing this will depend both upon the fit of the canopy frame to the fuselage, and how well the builder is able to fit and attach these aft skirts.

The C-666 aft skirts are a little more complicated. Don’t cut them out exactly to the lines on the aluminum sheet. These are for reference only. Cut them out as large as possible so you have the maximum to work with. Deburr the skirt edges well so you don't scratch the canopy or the fuselage while positioning them.

Because of the shape of the fuselage the aft skirts require a twist. If you hold the left skirt by the upper end (nearest the center slide block) with it hanging down vertical from your hand, as viewed from above, the lower end needs to twist towards the left side of the airplane, or counter clock wise. The right aft skirt is just the opposite -- it twists clockwise. Most of this twist happens in the bottom two thirds of the skirt (the aft top skin is almost flat on top so the twist starts as the skirt begins wrapping down around the sides)

Form a curve in the rear skirts to match the curve of the turtle deck. As with the twist, they are mostly flat on the top with the curve beginning as they wrap around on to the sides. The curve is accomplished by drawing the skin over your leg or the edge of a table. With a little practice the curve and the twist can be effected at the same time by drawing the skin at an angle.

The primary goal is to adjust the shape of the skirt so, when it is in place on the fuselage, it lays nearly flush everywhere without being held or taped down. This will greatly help in getting a good fit of the aft skirts. The better you make the relaxed fit of the skirt, the better your final fit will be.

Make slight adjustments to make these relationships as closely matched as possible. This may mean repositioning the rear slide or the side tracks to raise or lower the back, or reposition one side or the other. It may also require a slight readjustment of the frame shape even after the bubble has been drilled to the frame. The fit you get at this point is going to dictate how well the skirts finally fit.

With the C-791 side braces drilled and clecoed to the canopy frame, and the frame/canopy in the closed position on the fuselage, take measurements to verify that the fastener pattern shown on DWG 41 will work with your frame and C-791 brace positions. Modify the fastener positions slightly if/as required to match your installation. When pre-drilling the side skirts, do not drill the holes for rivets attaching them to the aft skirts. Drill these from the outside, through the aft skirt.

Leave the side skirt full width until after it has been drilled to the frame. Then cut the bottom edge of the forward portion to fit as close to the top edge of the canopy deck as it will go without rubbing. The aft edge of this cutout falls at the widest portion of the fuselage so that the skirt doesn't spread when the canopy slides.

Fit and drill the side skirts with the canopy in the fully closed position.

Drill the C-791 brace to the side skin. Drill from inside the cockpit while a helper holds the parts tightly together (with a wood block) and the skirt tight to the fuselage side while drilling. Cleco each hole as you go.

When drilling the rear skirts, open the canopy enough to tape some 1/16" spacers between the brackets and the roll bar. This will help the skirts to fit closely when the canopy is fully closed. The holes attaching the Plexiglass to the steel frame are already drilled, and must be matched in the skirt using a hole finder. Use the thinnest hole finder you can find.

Lay the preformed skirt in place and position it so it covers all of the rivet holes in the canopy frame and extends beyond the aft slide track and the side skirt at each end. Tape it in place. Use a straight edge and mark the upper end for a trim that will just clear the slide track. Remove the skirt, trim the upper end, and tape it back in place. Using your hole finder, begin drilling at the upper most hole at the inboard end of the skirt near the slide track.

Continue drilling at each successive hole working your way down around the canopy frame towards the bottom. Hold the skirt down tight and flush, and cleco each hole as you go.

Remove the skirt and trim the forward edge to 1/4 - 5/16" edge distance to all of the holes. The trim line for the forward edge of the skirt area below the holes is made by extending the trim line from the bottom two holes down through the remainder of the skirt (see side view on DWG 43).

Refit the skirt and mark where the forward edge lies on the side skirt. Remove the skirt and mark aft top corner of the side skirt (hidden under the aft skirt) for removal. This important step helps keep the aft skirt from being pushed away from the fuselage.

Trim the trailing edge of the aft skirt for a pleasing shape as shown on DWG 43. Do not trim the bottom end of the skirt until later.

Reinstall the aft skirt but slip it under the side skin.

Mark the edge of the side skin on the aft skin to use as a guide in making sure that all rivet holes drilled will hit the side skin and have proper edge distance.

Mark the aft skirt to side skirt rivet locations on the side skirt (DWG 41) and drill them. Be sure that none of them will fall below the fuselage longeron.

Because the bottom aft corner of the skirt falls over a point on the fuselage where the curve of the turtle deck and the curve of the fuselage side are intersecting, it needs some massaging/shaping to make it lay tight. These curves go in different directions which makes it challenging. The skirt needs a slight curl massaged into it at the bottom aft corner to help it lay down tightly.

It helps if this corner is finished with a large radius instead of a sharp corner (viewed from the side).

When drilling the aft skirt to side skirt, pull the aft skirt forward (towards the front of the fuselage). This will pull the bottom aft corner of the skirt in tight to the fuselage. Drill a couple holes first to get the position. Then mark the bottom edge of the aft skirt and trim it so it matches the bottom of the side skirt.

Reinstall and do more massaging as required to get the skirt to lay down tight.

Drill the remaining holes, repositioning as necessary to improve the fit. The mis-match of the first two holes will not be an issue.

After completing the other aft skirt, trim them at the upper end to fit of the C-792 fairing, and drill it to the aft skirts as shown on DWG 42, Section G-G.

When riveting the skirts, install the screws along the base of the canopy sides last. This will prevent the skirts from being pulled inward and disturbing the fit.

INSTALLING CANOPY BASE MOLDING STRIP

Now that the canopy has been riveted and screwed to the frame, a fairing joining the windshield portion +to the front skin can be fabricated and installed. This may be made of aluminum, or fiberglass, molded in place. Because an aluminum fairing requires some relatively advanced metal working skills, most builders choose one of the fiberglass options. If you choose fiberglass, be certain to use only epoxy resins. Do *not* use the more common polyester or vinyl ester resins. They are not compatible with plexiglass and cause crazing that might (probably will) ruin the canopy. We have had excellent luck with West Systems epoxy, available from boat yards and mail order houses.

The following directions were written by an expert RV builder, known for the beautiful finish around his canopies: They were written during the installation of a sliding canopy, but the techniques work equally well for the strip around the front of the tip-up.

If you choose to mold your own fairing, begin by cleaning the aluminum skin. Several builders have reported markedly better adhesion after they etched the skin with a mild phosphoric acid, but don’t get any of this on the windshield! The molding should continue around the base of the windscreen back to the point where the windscreen is under the aluminum skin. At this point the fiberglass molding is to be faired smoothly into the skin line.

Imagine (or draw on a sheet of paper) a cross section view of the fwd base of the windshield to the top deck of the fuselage. It will be an inside radius. Cut out about a 4" diameter circle in poster board or similar and hold on edge at the base of the windshield. Where the circle touches the windshield and the skin is about where the fiberglass will end on each. Also notice that the space formed by the circle that you want to fill with fiberglass is not the same thickness across the whole section. This is why you can't use cloth all one width (unless you want to do more sanding than any metal airplane builder should have to do).

A couple of general tips -

The closer you get to your finished shape, and the more accurately you lay up the glass/resin, the less finish work (read: sanding) will be involved.

Make sanding tools in the exact shape/radius for the areas you wish to sand. For example: All around the forward base of the windshield, you will be sanding a varying inside radius. Find some type of round tube (thick wall PVC pipe works very well) that you can glue different grits of sandpaper to that has the radius you want the finished shape to be. I use about a 3-4" inch radius and glue sandpaper with spray contract adhesive.

Before doing any glass layups you need to do some prep work.

First, figure out where the edges of your finished glass work will be on the plexi. Use your round circle radius gage to find the contact points around the front of the windshield, and bring it around the sides to match up with the top of the canopy side skirts. I usually match the portion that goes over the top, to the front edge of the roll bar. Mark these edges with a layer of good quality (3M) electrical tape to protect the plexi.

Now carefully sand all of the plexi and aluminum that you intend to bond to with 60 to 80 grit sandpaper. Sand until there is no gloss of the plexi remaining. Do not worry about removing the alclad because it will be sealed in epoxy.

Mix up some resin with microballons to make a small fillet to fill the recess where the windshield mates to the fuselage. Mix it very dry (lots of micro balloons / not much resin) so it will not run. This fillet will prevent the cloth from dropping down into this space.

Cut the cloth strips. On the portion around the front start with about a 1/2 " wide strip and then make each successive strip about 1/4" wider (1/8" to each side) which will give you about 7 or 8 layers if you go up to 2 inches. The last layer you put down should be the width of the finished fairing. These strips do not need to be cut 45 degrees to the weave. If fact, in this case it is easier to cut the strips parallel with the weave. Use at least 2 pieces of fabric for each layer to go around the entire front of the windshield. Because the strip is being pulled on a compound curve the end will not be square as you lay it down. You can just cut it square before laying it down and then butt the next strip up to it. On each successive layer vary the lengths slightly so that the butt joints don't fall on top of each other.

A rotary cloth cutter (available from cloth stores, or get in touch with your friendly local composite airplane builder) and a long straight edge works great for cutting long skinny strips. The more accurate you are cutting (and installing) the strips, the less finish work that will be needed.

Now add another layer of electrical tape to the first one already applied and start laying up the layers.

Center the first ½" strip around the base of the windshield at what will be the center of the fairing. Put on each successive layer centered on the previous ones with the final layer butted up next to the electrical tape but not over lapping onto it. These strips can be laid up all at once – there is no need to let each layer cure before applying the next layer.

Let this begin to set up slightly and then do the portion over the top for the canopy to windshield intersection using a similar procedure. Apply release solution or mylar packaging tape to the top of the sliding canopy so the resin will not bond…gluing your canopy halves together is embarrassing and makes the airplane difficult to enter. The strip over the top of the windshield has an outside radius, and typically needs fewer layers with the layers differing in width by about 1/2" instead of 1/4").

Once everything hardens for a day or so it is time to start sanding…very carefully. Use the shaped tools mentioned previously and start with about 40 to 50 grit paper. This will get you quickly to the general shape --but be careful to not get into the electrical tape. When you get down near the tape switch to about 80 to 100 grit paper and work very carefully until you are just contacting the tape and the skin metal on the edges of the layup. If you sand through the first layer of tape the second one should protect the plexi if you are watching carefully.

Now remove the second layer of tape (leaving just one layer) and sand very, very, very carefully using about 150 grit until you just start to see sanding marks in the tape.

Brush on a heavy coat of epoxy (after getting rid of all sanding dust) overlapping the epoxy onto the tape and the metal at the edges, and let harden.

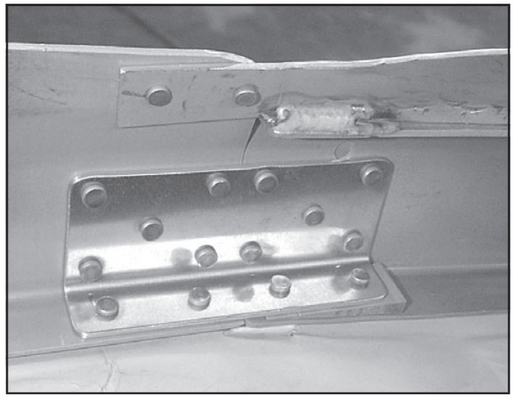
More sanding with 100 and then 150 grit paper.

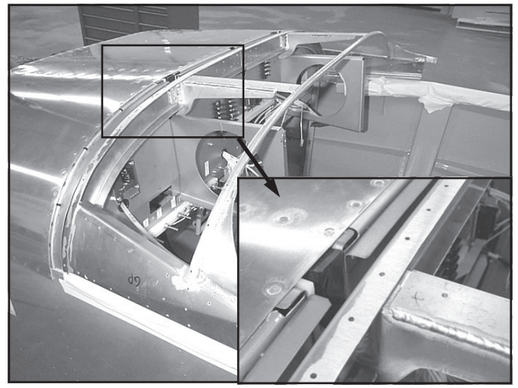
If you have areas that need filling you can fill them now by scuffing with 40 or 50 grit paper and filling with a dry mix of epoxy and microballoons.

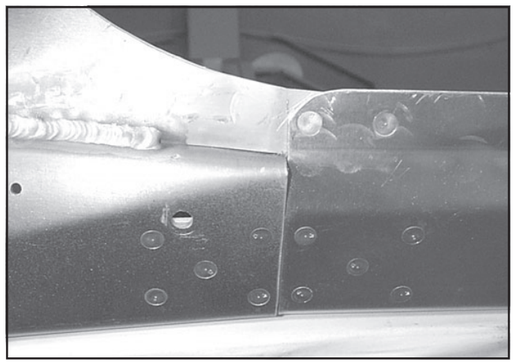
The goal is to have a layup with the outer surface being a buildup of 2 or 3 coats of epoxy that has been finish sanded to final shape with the epoxy blending onto the plexi being the thickness of the electrical tape or less, and the epoxy on the metal skin blending out to nothing.

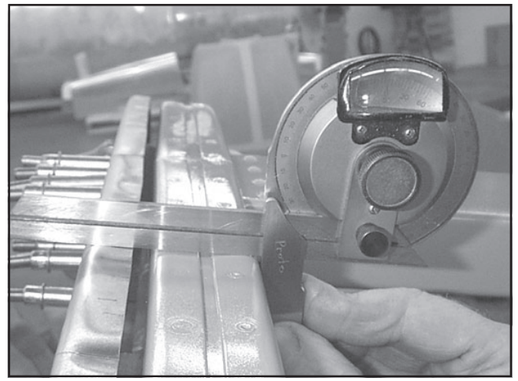
The final blending into the metal may require a couple of wet sanded applications of a filler primer to blend it out entirely.

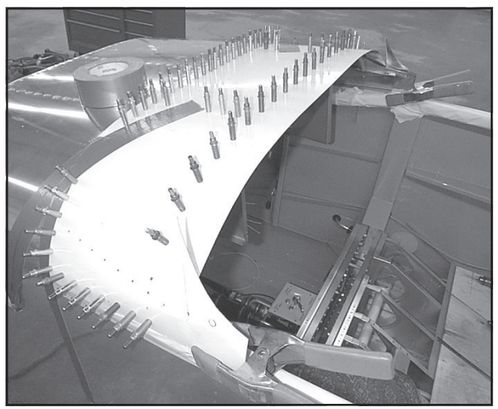
If you do it properly it will give you a very nice looking low drag intersection and it will make all the "Fast Glass" builders wonder how a rivet pounder could get a windshield/canopy finish that looks so good.

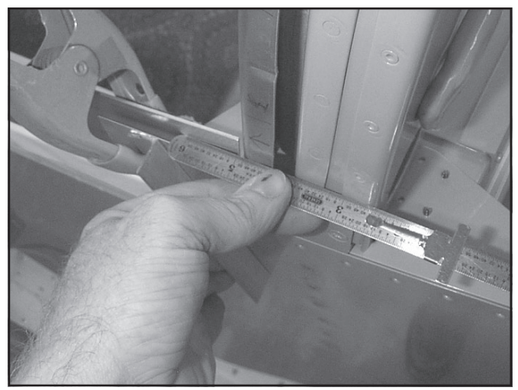




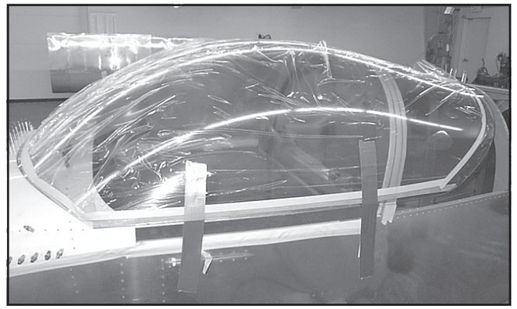


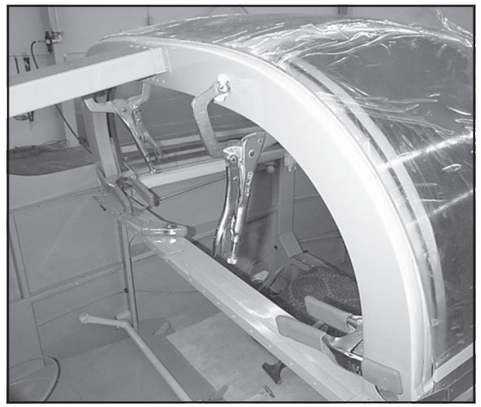


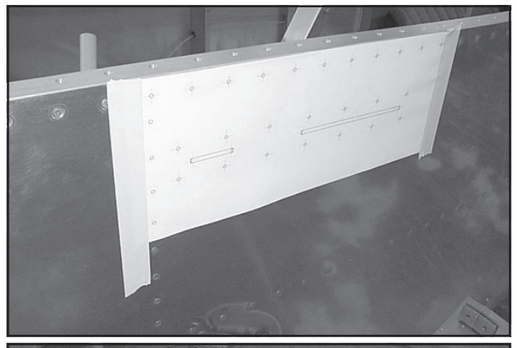


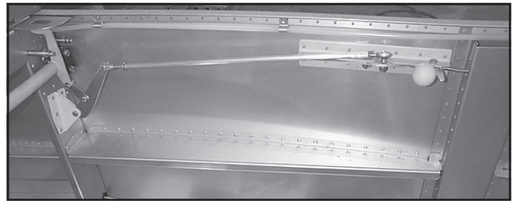


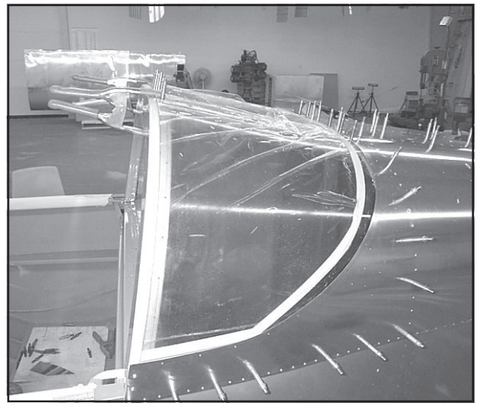
Aligning the tip up canopy frame to the fuselage and cabin frame.

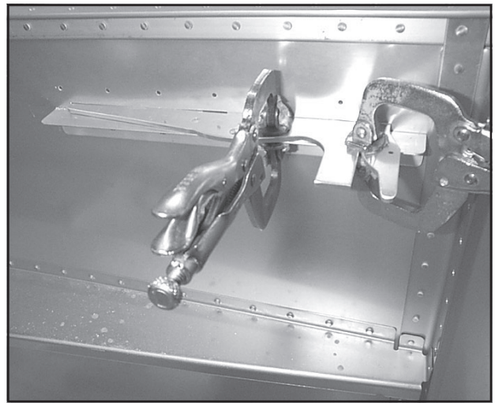




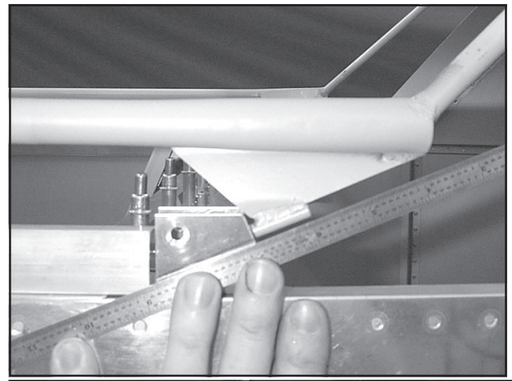


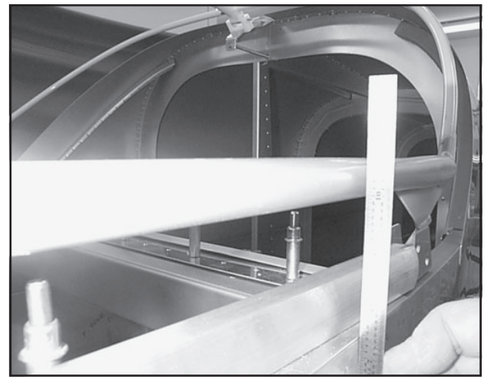


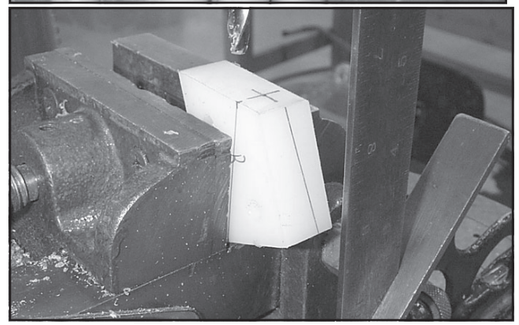


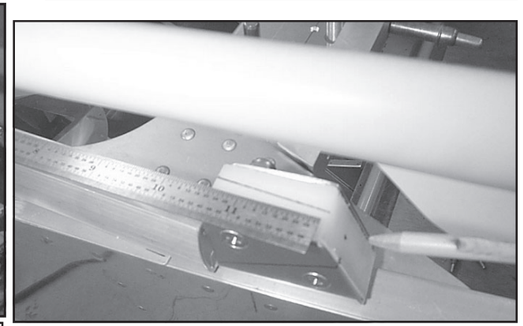


Fitting the plexiglass canopy bubble and tip canopy latch.

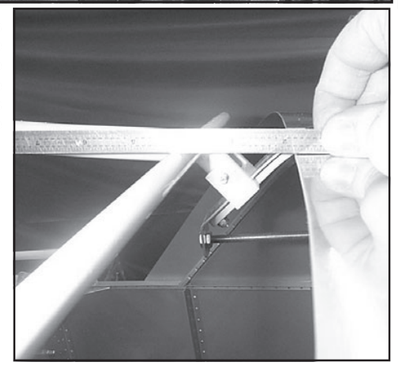


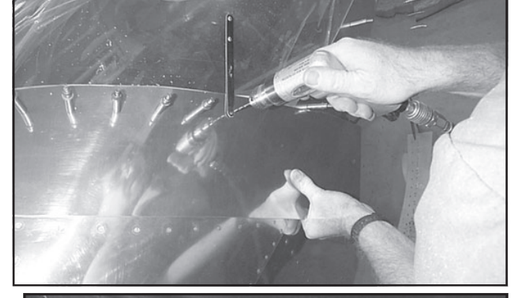


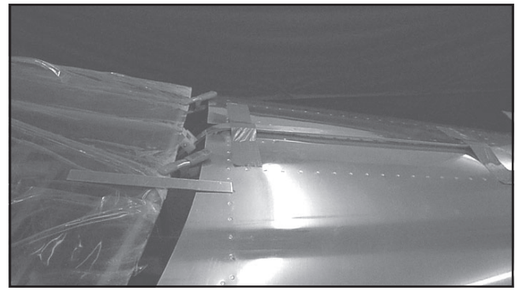


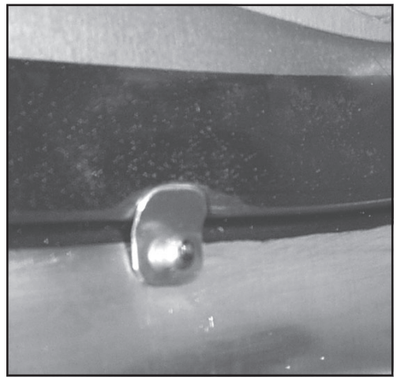


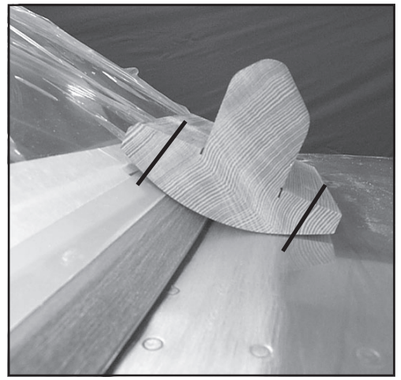
Various views of aligning the canopy frame and fitting the skirts as described in the text.





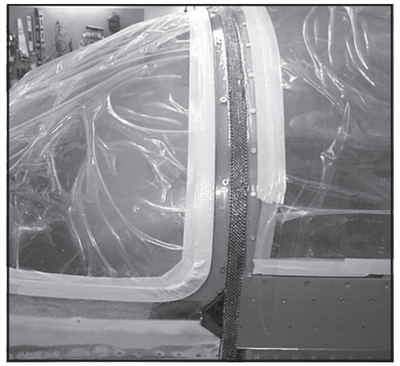


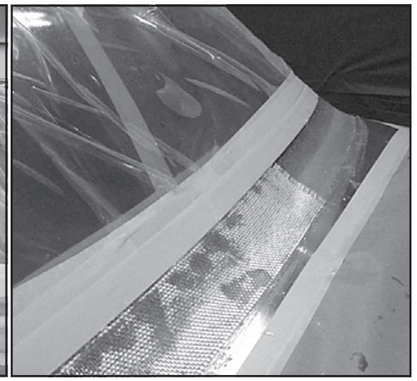




Left: Small clips of .040 aluminum can be used to hold the windshield in place. These are blind riveted to the forward deck and simply buried in the fiberglass fairing.

Right: A home-made sanding block contoured to the desired raduis. It was later narrowed to the width shown by the black lines.





Above: Laying up the fiberglass fairing around the front of the windshield and over the top of the sliding canopy. Note how well the plexi is protected .

Left: Nearing completion. The cleaner the lay-ups, the less sanding and finishing.

NOTES

SECTION 10. ENGINE MOUNT, LANDING GEAR AND LANDING GEAR FAIRINGS

The RV-9/9A uses a engine mount fabricated from aircraft grade steel tubing. The mount incorporates a mounting provision for a nose gear leg.

The landing gear itself is a well-proven tapered rod design. Developed by race pilot and aviation pioneer Steve Wittman, this gear arrangement has been widely used on both production and experimental aircraft. It is rugged, simple, relatively light, and inexpensive. By using simple landing gear leg fairings, drag is minimized.

Since the gear legs are round, they permit the wheels to move in all directions and do a good job of smoothing out runway bumps. But, because they are spring steel, they are not as well damped as are the air-oil ‘‘Oleo’’ struts on some aircraft landing gear installations. Spring steel gear legs do not absorb much energy, but rather tend to rebound to release the energy taken in by smoothing a bump. This is the same as a leaf spring gear (Cessna), but the leaf spring gear can only flex inward and outward from the aircraft centerline, not fore and aft as the round rod gear can. When flexing inward and outward, the tire ‘‘scrubs’’ on the runway and dampens the rebound action.

THE ENGINE MOUNT

The engine/landing gear mount is shown on DWG 46 (RV-9) or DWG 46A (RV-9A.)

DWG 46 (RV-9): The mount is fitted by squaring it with the firewall of the fuselage and aligning it with the pre-drilled holes in the corners of the firewall. Variations in the dimensions of the mount should be small enough that they can be compensated for by the differences between the undersize holes in the firewall and the 3/8" full size holes in the mount. The two center holes are also drilled at this time. Spacers can be used between these two attachment points and the firewall if necessary.

Drill the holes in the firewall to full size using the engine mount as a guide.

DWG 46A (RV-9A): The mount is initially secured to the firewall using the top two mounting points and 3/16” bolts. The holes in the remaining four bottom attachment points are then drilled into the firewall using the mount as a guide and then secured with 3/16” bolts. Ensure the drill is perpendicular to the firewall while drilling, and install a bolt into each hole before drilling the next. One at a time, the attachment points are gradually up-drilled to full size and secured with a 3/8” bolts.

INSTALLING THE MAIN LANDING GEAR LEGS

The main landing gear legs are made of alloy steel with poor corrosion resistance. They are supplied powder coated except for the axle and surfaces which contact the landing gear mount. These cannot be painted because the thickness of the paint would prevent installation. A film of wheel bearing grease applied during installation will keep unpainted areas from corroding.

Installation could scarcely be easier: a round rod is inserted into a round tube and secured with one bolt.

The following instructions for installing the landing gear, wheels, brake lines, fairings and stiffeners are much the same for both RV-9 and RV-9A installations, but actual dimensions may vary. Be sure you are working with the correct drawings. Details of the RV-9 main gear are shown on DWG 46. RV-9A main gear are shown on DWG 34A.

INSTALLING THE NOSE LANDING GEAR LEG

Attach the U-00019 Nose Gear Leg to the engine mount using the bushings and hardware called-out in DWG 46A. The nuts and bolts attaching the gear leg need to apply enough clamping force on the bushings that they rotate with the gear leg inside of the engine mount brackets. So, when applying grease to the cylindrical surfaces of the bushings, be careful not to get any grease on the flats of the bushings; this could significantly reduce the friction between the bushings and gear leg.

Next, install the U-01407 Elastomer Pad, the U-00020 Nose Gear Link, elastomers, spring, and U-01420-1 Cap. Slide on the washer and thread on the nut enough to compress the spring and remove any gap between the elastomers and pad. The final amount of spring compression is determined only after the nosewheel is installed as noted in the drawing.

Finally, attach the bottom end of the link to the gear leg.

INSTALLING THE WHEELS AND BRAKES

Details showing the installation of the wheels and brakes are shown on DWG C2. The axle and U-403 Brake Mounting Flange on RV gear legs have been designed to use the Cleveland 5:00x5 wheel and brake assemblies. The brake mounting flange has been honed and drilled to fit the axle at the factory. The hole through one side of the U-403 is still undersize, so, before final installation, pass a 5/16” drill through the assembly. Now install the Allen head screw that secures the brake flange to the axle. It is possible that the heat treating process used to strengthen the gear leg has expanded the axle slightly, and the flange (or wheel) will not slip on smoothly. A strip of fine crocus cloth briskly worked around the axle will remove the black scale and allow the flange to be installed.

Cleveland brakes are included in the kit. Swap the fittings on one brake assembly to make a left and right brake. Each brake has a mounting plate supplied, which bolts to the U-403. Three of these bolts, running through U-408 spacers, also attach the U-810 Wheel Fairing Mount. The exact length of these spacers may be altered slightly to achieve the correct gap between U-810 and the brake disc.

Mount the U-810, U-408 spacers and Cleveland mounting flange to the U-403 brake mounting flange. Install the AN822 brake line elbow in the Cleveland brake assembly. Remove the inboard brake shoe from the brake caliper, and bolt the caliper to the mounting flange. Brakes are mounted with the caliper aft of the axle, and the bleed nipple down.

Fit the 5:00x5 Cleveland wheels and U-405 Axle Spacers (one on each side of the wheel) on the axle. Install the VA-106 wheel nut. Tighten this nut carefully, until there is no side play in the wheel, but it still rotates smoothly. Then, through the cotter pin hole in the nut, center punch mark the position of the cotter pin hole in the axle. Remove the nut and wheel, and drill a 1/8’’ hole in the axle for the cotter pin.

MAIN WHEELS and TIRES

Split the wheels by removing the bolts holding the wheel halves together.

Remove and inspect the wheel bearings. This requires removing the circlip retainer and popping the tapered bearing assemblies out. Be sure they are fully greased with Aeroshell #5 or equivalent.

Re-install the bearings and mount the tubes and tires on the wheels. Dust the inside of the tire with talcum powder before installing the tube. Discard the nuts & washer on the tube. The red dot on the tire should be installed next to the valve stem of the tube.

Bolt the wheel halves together. Carefully observe the manufacturer’s bolt torque specifications, shown on the document in the wheel/brake package.

SLOWLY inflate the tire to 25 psi. Deflate it fully and re-inflate it SLOWLY a couple more times to work out any wrinkles in the tube. Inspect for a good seat around the wheel rim. Final tire pressure should be 25-28 psi.

Install the wheel and re-install the inside brake shoe with bolts and safety wire.

BRAKE LINES

DWG 36/36A shows details of the brake system, including both single and dual brake installations. The brake lines have been designed so the same master cylinders, brake fluid reservoirs, and flexible brake line segments can be used for either the single or dual brake system.

As the exact length and route of the tubing is being determined, the rudder pedals should be moved throughout their range of travel to observe the action of the tubes. In routing the brake lines, care should be taken to protect them from chafing where they pass through bulkheads or around corners. Such protection can be in the form of plastic fairlead bushings as shown, wrapping the brake lines with protective tape, or slipping a piece of polyethylene tubing over the brake line at the wear point.

Note the brake line routing at the lower end of the gear leg as shown in DWG C2. This routing permits the brake line to come straight out of the fitting for a distance before making a bend. The brake caliper moves inward and outward along the line of the axle as the brakes are used. The ‘‘spiral wound’’ routing shown accommodates this movement very well with little stress on the brake line or the fitting.

Once the brake lines are fitted, the brake fluid may be added.

NOTE: *Use ONLY the aircraft brake fluid recommended by the manufacturer. DO NOT use automotive brake fluid, especially silicone based fluid. The seals in aircraft systems are not compatible with automotive fluids. Serious damage may result if they are used.*

Brake lines must be “bled” to force air from the lines. Use a clean squeeze-pump handle oil can with the appropriate fluid. Connect it to the bleed nipple on the wheel cylinder with a clear plastic tube that seals tightly to the nipple, loosen the nipple about 1/4 turn, and pump the system full. Work carefully and watch the plastic lines that connect the master cylinders to the fluid reservoir until no more bubbles appear.

WOOD GEAR LEG STIFFENERS (OPTIOPNAL)

With a rod gear leg, the wheels can move fore and aft, so, with no scrubbing action on the tire, there is no damping, and a fore-and-aft shimmy can result. This is most prevalent at low speeds (10-15 mph) and on paved surfaces. Turf surfaces have sufficient rolling resistance to provide a dampening action. Out of balance wheels and higher than necessary tire pressures also promote wheel shimmy (lower pressure in the tires increases rolling resistance, and thus provides dampening). Generally such shimmy occurs on landing roll out or while taxiing, and can be stopped with light brake application. Un-checked shimmy can transmit vibrations into the landing gear mount and eventually cause cracking. However, wheel shimmy is a rather nebulous thing; it occurs on some airplanes and not others, and with varying degrees of severity. The cause, or combination of causes, is very difficult to detect and define. Fly the plane first to determine if you need the stiffeners.

Wheel shimmy tendencies can be minimized by using the lowest practical tire pressures, having well balanced wheels and tires, and brake discs which run true and don't drag at one point of rotation.

Bonding a wooden block to the spring steel rod gear leg will alter its vibration characteristics and decrease the tendency to shimmy. This is shown on DWG C3. The wood used in this illustration is a standard window molding available from most building supply stores. The shape of this molding provides a good place to start. Sawing two pieces of this molding lengthwise and bonding them together as shown will provide a tapered piece, which attaches easily to either the front or rear of the gear leg. The resulting assembly is attached with putty of epoxy and thickening agent or even a "Bondo" type body filler.

Once this has cured, sand or file the excess bonding agent smooth, and wrap the whole assembly with 2 or 3 layers of 9 oz. fiberglass cloth. Fiberglass tape, 2-3" wide wrapped around the gear leg works well because it is easier to keep taut than a large sheet of fiberglass cloth. These wrappings of fiberglass tape are saturated with polyester resin (or epoxy if you prefer) as they are applied.

The wood stiffener blocks may also be attached temporarily by spiral wrapping them with fiberglass filament re-inforced packaging tape. This should be viewed as a short term installation, because the filament tape will deteriorate and may not last for more than one or two years; much less if directly exposed to sunlight for long periods of time.

INSTALLING THE FIBERGLASS MAIN GEAR LEG FAIRINGS

Gear leg fairings are very important for drag reduction. While one might feel that a fairing on the large wheel and tire would add more speed than a fairing on the small, round gear legs, just the opposite is true. Wheel fairings add about 3-4 mph but the gear leg fairings add at least 8 mph. The combined wheel and gear leg fairings add around 12 mph to the top speed. Looking at it another way – it would take an additional 27 horsepower from the engine to achieve the 12 mph contributed by the fairings. Obviously, a good fairing installation is necessary if high speeds are to be obtained from your RV.

Proper alignment of the gear leg fairings is also important for several reasons. Since the gear legs are located forward of the aerodynamic center of the aircraft, they have a de-stabilizing effect on directional trim. Any mis-alignment will have the same effect as a rudder input, but in the opposite direction and of much greater magnitude. For instance, it was found that just a 1/4 inch mis-alignment of the lower trailing edge of one gear leg fairing produced a half-range deflection of the skid ball. A very noticeable opposite rudder input was required to re-center the ball.

Main gear leg fairing installation is shown on DWG C3. Place the fairing, leading edge down, on a table or other flat surface and use a square at one end to position the trailing edge exactly above the leading edge. Make sure that the other end of the fairing also has the trailing edge exactly above the leading edge. This will verify that the fairing was molded without twist. With the fairing in the "no-twist" position, place two or three spring clamps on the trailing edge. Wrap a piece of tape around the trailing edge and then use a razor blade to split it at the trailing edge or make a thin pen mark across the trailing edge. If the fairing becomes twisted, the tape edges or pen mark will not line up.

Cut out the paper trim template (for YOUR airplane) found on DWG C3. Position the trim template over the fairing using the molded-in scribe lines and the leading edge parting line as reference points. Smooth the template over the outside of the fairing and use spring clamps to hold it in place. Trace the root end, trailing edge, and tip end trim lines onto the fairing. Make small "tick-marks" on the tip and root at the gear leg centerline. Extend the gear leg centerline marks approximately ¼" to the center of the part after removing the template. The marks will be helpful later when positioning the fairings to the gear legs. Trim the root and tip ends of the fairing, but not trim the trailing edge. After trimming, file or saw notches approximately 1/16" deep in the edges of the fairing at the gear leg centerline marks.

Trim the hinge material to 2 inches longer than the length on the drawing. Do not trim the hinge pins yet. The hinge material is left 2 inches long so there will be a 1" excess on each end to help clamp the hinge to the fairing. Mark (but do not drill) fastener locations and final trim locations on each of the hinge segments. When drilling the hinge to the fairing, the fastener location marks will be visible through the translucent fairing. If the fairing is opaque, refer to Section 5.18 MATCH-DRILLING OPAQUE FIBERGLASS PARTS.

Place the trimmed gear leg fairing on the gear leg and clamp the trailing edge closed with two or three spring clamps. Use the tape or pen marks to be sure that the fairing is not twisted. Adjust the position of the fairing to align the gear leg centerline marks with the gear leg centerline. The trim as defined by the pattern was conservative, and the fairing may be slightly oversize. Trim the lower end of the fairing as required for proper fit.

Note: Each hinge half must be drilled, clecoed, de-burred, countersunk, and riveted before moving to the next hinge half because the fairing section is too thin at the tip to allow installation of clecos in both sides without interference.

Position the marked hinge inside the trailing edge of the fairing and clamp the ends of one hinge half in place. With the hinge ends clamped in position, begin at one end and drill #40 through the fairing and hinge using the fastener locations marked on the hinge to position the holes. Use light pressure and high drill speed, and allow the bit to cut through without distorting the hinge. Work from one end of the fairing to the other, clecoing each hole before drilling the next.

Un-cleco the hinge from the fairing and clean out any metal chips. De-burr holes and trim the 1" excess hinge from each end. Remove and countersink the fairing for AN426AD3 rivets. Because the fairing is quite thin, it is recommended to that you keep the hinge clecoed to the fairing while countersinking. The holes in the hinge will guide the countersink cutter and keep it from elongating the holes in the fairing. Rivet the hinge to the fairing, using a hand squeezer. Don't fully set the rivets as you would in a metal structure. This would cause the thin composite fairing to crack around the holes.

Remove the fairing from the aircraft and insert the hinge pin to join the trailing edge. Use a long sanding block to remove any excess "tail" on the fairing and even the sides of the trailing edge.

Remove the pin and bend the lower 1" to 90º. Grind the upper end to a chisel tip. This shape helps guide the pin through the eyes of the hinge. Drill a #40 hole in the upper surface of the lower end of the fairing. A piece of safety wire can be looped to hold the hinge pin in place.

Wrap the gear leg with wear resistant plastic adhesive tape at two or three locations to prevent chafing and hold the brake line in place. Slip the fairings over the gear legs and insert the hinge pin from the bottom. The hinge pin is thin enough to curve as it is inserted without taking excessive permanent bend.

Roughly align the fairing to the airflow, and align the gear leg centerline marks with the gear leg centerline. At the top end of the fairing, install a hose clamp around the gear leg capturing the ¾ inch wide fingers of the fairing to help hold it in place. When installing the hose clamp for the first time, use a heat gun to soften the fingers so they conform to the surface of the gear leg as the hose clamp is slowly tightened. When the hose clamp is fully tightened, leave the fairing in place and allow it to cool.

You can also, as an option, add one or two layers of fiberglass cloth under the fingers. The purpose is twofold: to strengthen the finger and to contour the inner surface of the finger to the landing gear leg. Cut one or two laminations of 9 oz. fiberglass cloth so they fan out and anchor to a larger surface area of the gear leg fairing. See the dashed lines on the full scale trim templates.

Before laying up the fiberglass, prepare the surface of the gear leg by locally coating it with wax, mold release agent, or thin cellophane packaging tape. Cut out the glass cloth doubler patches and attach them to the inside surface of the fairing with a liberal application of epoxy resin. Before the resin cures, install the fairing to the gear leg using the hinge pin to close the trailing edge. Lightly clamp the lower end of the fairing if necessary to hold the fairing in place. After cure, remove the fairing and trim any rough edges around the doubler patches. The exterior surface of the finger can be filed or sanded to provide a smoother contact surface for the hose clamp.

The alignment of the fairings is important and can substantially affect the way the airplane flies. While a very careful "eyeball" alignment job might come close, this is difficult because of visual illusions created by the sweepback of the gear legs.

The gear leg fairing must be aligned with *no load on the wheels*, simulating the in-flight condition of the gear legs. Jack and support the fuselage far enough off the ground that the wheels no longer touch. Set the tail up so the airplane is level at the cockpit longerons (datum line). Use caution while the airplane is on jacks. Don't let it tip or it will fall off the jacks!

Align the fairings as shown. Pick a point on the landing gear fairing and measure the distance to the center of the fuselage. Pull a string from a point on the landing gear to a similar point the same distance from the center of the fuselage near the tail of the airplane. This string is a displaced centerline of the airplane. A stick is clamped between the stabilizer and the floor at this point. The string is then wrapped around the leading edge of the fairing and both ends pulled tight to the stick under the stab. Be sure the string is held level and parallel to the longerons… usually measuring from the floor is accurate enough. The leading edge and trailing edge of the fairing should be centered between the strings.

The string is then relocated up and down the gear leg (and of course, the stick at the tail will have to be move inboard/outboard the same distance, so the displaced centerline remains parallel to the aircraft centerline). This will align the fairing and eliminate any twist. Slightly loosen the hose clamps so the fairings can be accurately aligned. When the alignment is correct, tighten the clamps.

The installation is completed by fabricating intersection fairings between the upper end of the gear leg fairing and fuselage/wing and between the lower end of the gear leg fairing and the wheel fairing. The process for creating the intersection fairings is outlined later in this Section.

On the completed wheel fairing/gear leg fairing/intersection fairing installation, the custom molded intersection fairings will define proper alignment of the gear leg fairing, so the hose clamp is used primarily to keep the fairing from sliding down the length of the gear leg. This also means that the gear leg fairing alignment procedure need not be repeated each time the fairings are removed.

INSTALLING THE MAIN WHEEL FAIRINGS

Main wheel fairing installation is shown on DWG C2.

The VA-157 wheel fairing consists of two pieces, the VA-157A forward half and the VA-157B aft half. They should mate as accurately as possible. Because of the variations possible in fiberglass moldings, the first step must be to make the halves fit. Use coarse sandpaper glued to a straight stick as a disposable file to remove any material that prevents the halves from matching smoothly. Typical areas that might need some extra work are shown on Details D and E; the inside radius of the flange on the rear half, the inside of the front half where glass cloth layers overlap, etc. Take the time to custom fit the halves of your fairings as exactly as possible.

Drill and cleco the VA-157 fairing halves together. Begin at the tops of the fairings and work down the sides to help minimize bulging and mismatch between the fairing halves. Space fasteners per Section A-A. Do not install the second fastener up from the bottom on the inboard side of the fairings as this part of the fairing will be cut away to clear the axle. The fairings as supplied are symmetrical (no right or left hand fairing) but the asymmetrical installation of the fasteners will establish which fairing will be installed on the right side of the aircraft and which will be installed on the left.

Attach front and rear halves of wheel fairings to each other as shown. Mark a lengthwise centerline across the top of the assembled fairing.

The airplane will need to be supported on jacks to get the wheels on and off the axles. Unfortunately, you may need to remove and re-install the wheels a few times while getting the bracket-to-disc gap just right. Use caution while the airplane is on jacks. Don't let it tip or fall off the jacks!

Install U-810-L and –R Brackets to the U-403 Brake Mount Flanges using 3 each: U-408 Spacers, AN4-11A Bolts, AN365-428A Nuts, and AN960-416 Washers. There should be 0.032" to 0.094" gap between U-810 and the brake disc when the wheel/brake assembly is installed.

Raise the airplane on jacks so the tires are just off the ground (zero to 1/16" gap). Level the airplane (longitudinally and laterally) at the upper longeron. Once again, use caution while the airplane is on jacks!

Attach U-808 Outboard Brackets to the VA-106 Axle Nuts using AN4-5A Bolts and AN960-416 Washers. There is not a right hand or left hand U-808, but the brackets do have a top and bottom to them. The longer leg of U-808 goes to the top. Using a carpenters square or drafting triangle on the floor, rotate U-808 so the forward and aft edges are perpendicular to the floor. Tighten the bolts.

Install a 1 inch thick wood/metal/plastic spacer between the top of the tire and the inside of the wheel fairing. This spacer will be placed on the top of the tire to establish the correct vertical position of the fairing relative to the wheel/tire. The 1" dimension assumes a 14" diameter tire is being used. The spacer thickness should be varied to account for tire wear or inflation pressure.

Tape the spacer to the top of the tire.

The inboard forward edge of the aft fairing must be locally trimmed to clear the axle. The wheel fairing is positioned correctly in the fore/aft direction when the forward edge of U-808 lines-up with the molded in "step" located approximately 1" aft of the forward edge of the aft fairing (see Detail C).

Center the rear half of the fairing over the tire while using the spacer to hold it in the correct vertical position. Locate and use some blocks of wood/metal/plastic to place under the aft end of the fairing to position the center of the aft edge of the fairing roughly 8 5/8" off the floor (see Wheel Fairing Side View). Mark the area of interference with the axle, remove the fairing, locally trim a small amount of the fairing, re-position the fairing over the wheel, re-mark and trim as required to achieve the correct final position. Trim the minimum required to clear the axle as this will make the shaping of the clay mold for the wheel fairing to gear leg fairing intersection easier.

When the weight of the airplane is off the gear, the wheels naturally camber inward. The vertical axis of the fairing is intended to be aligned with vertical axis *of the wheel and tire*.... not perpendicular to the ground. The tire tread provides a good alignment guide. The centerline on the top of the fairing and center of the opening on the bottom should align with the center of the tire.

When the aft fairing is located vertically (by the spacer on top of the tire), fore/aft (by alignment of the "step" with the forward edge of U-808), approximately leveled (by the blocks under the aft end), and aligned with the tire, (look and see) drill and cleco it to the U-808 bracket using the pre-punched 0.125" diameter holes in U-808.

U-808 mates to the wheel fairing in a region where the fiberglass thickness is changing. This will cause mis-alignment of the bracket, so a few plies of fiberglass cloth must be bonded to the inner surface of the aft fairing to make the thickness constant in the two areas where U-808 touches the fairing. Use coarse sandpaper to roughen the surface of the fairing --really roughen it, don't be shy --before bonding patches of fiberglass cloth in place with polyester resin.

Locate an approximately 1" wide shim thick enough (0.032" to 0.094") to fit tightly between the U-810 bracket and the brake disc. This shim will keep the bracket from deflecting excessively when drilling through from the outside of the fairing. Scrap pieces of aluminum with strips of duct tape added to achieve a snug fit work well.

Attach the forward half of the fairing to the aft half. Now carefully adjust the fairing position until it is aligned with the aircraft centerline both in a horizontal plane *and* in a vertical plane (see wheel fairing side view). Drop plumb bobs from the center of the fuselage, fore and aft, and mark the position on the floor. Snap a chalk line through these marks, transferring the centerline to the floor.

With the fairing held in its final position, drill and cleco the fairing to U-810 in four places (two front and two rear). It is easier and safer to initially drill the holes #40 and then work up to the final #20 size. Use your "sharpie" pen to make four ink "dots" on U-810 where each of the four fasteners will ideally be located. The ink dots can be seen through the translucent fiberglass and the holes are then drilled and clecoed. If required, refer to Section 5.18 MATCH-DRILLING OPAQUE FIBERGLASS PARTS.

When the holes are located, reinforce the area about three inches around them by laying up 2 or 3 layers of fiberglass on the inside of the wheelpants. Enlarge all holes to final size and remove the wheel fairing. Install K1000-08 Nutplates to U-810 using AN426AD3-5 Rivets. Attach U-808 to the aft half of the fairing using AN426AD4-6 Rivets. Remove all blocks, spacers, shims, etc., and install the wheel fairing to the airplane. Make sure that you have 5/8" clearance all around the tire and the fairing.

FINISHING THE WHEEL FAIRINGS

After the wheel fairings are fitted, it is necessary to remove them for sanding, filling and paint preparation. If the initial molded shape is not accurate enough to sand smooth, more fiberglass build up can be added, or a BONDO type filler can be used, and then re-sanded.

This can take longer than most people realize, but it is necessary to achieve a good finish when you paint. It will also cure you of any lingering desire to build a whole airplane from fiberglass!

When you put everything back together, remember to install and safety wire the inside brake pads and install the permanent cotter pin in the wheel nut before re-installing the wheel pants.

INTERSECTION FAIRINGS

To fully fair the landing gear, small intersection fairings cover the intersection of the gear leg or gear leg fairing and wheel fairing, and the gear leg/fairing and fuselage. Because of the variation between individual airplanes, these are best made in place.

A mold is made of oil based modeling clay. This can be the common modeling clay found in toy stores, or more professional variety used by commercial designers. The clay is applied between the gear leg and wheel fairing or fuselage and formed to a pleasing shape by hand or with any plastic or metal tool. A wet spoon works well.

The clay is oil based and is a natural parting agent. However, since the intersection fairing must part from one or more of the adjoining metal or fiberglass parts, it will be necessary to use automotive wax, PVA (a special liquid parting agent) or brown mylar packaging tape on these parts to prevent adhesion.

A lay up of three thickness of 9 oz. fiberglass cloth is about right for intersection fairings. After the initial lay up has cured, several more brush coats of resin are applied to fill the cloth weave. The final coat of resin should be "finishing" resin which cures to harder finish, making sanding easier.

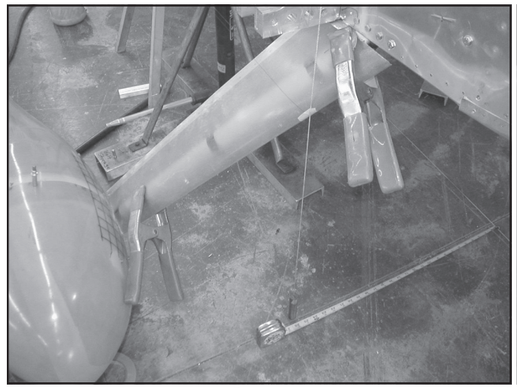
The upper intersection fairings are not permanently joined aft of the gear leg. The natural flexibility of the fiberglass allows them to be opened and removed if necessary.

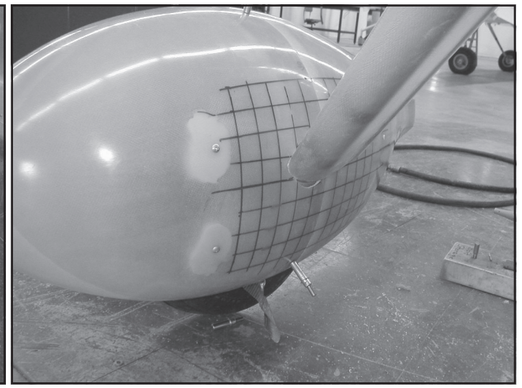
The intersection fairings for the gear leg/wheel fairings are intended to become an integral part of the wheel fairing, so sand the fiberglass surface of the wheel fairing with 60 grit sandpaper until all the gel coat is removed and fiberglass strands start to show. Clean with acetone to improve adhesion.

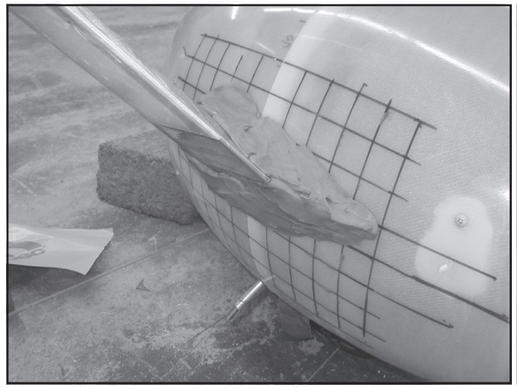
Lay up the fairing as one piece and when it is cured, split it top and bottom at the wheel pant joint, using a die grinder and cutting disc. The split can be made by carefully using a small cutting wheel in a Dremel tool. To protect the gear leg fairing, a 3/8 inch wide piece of scrap 0.016 or 0.020 aluminum which has had one end sanded to an edge can be slipped under the edge of the uncut intersection and the gear leg fairing at the split line. If the cut is started at the top of the intersection, the aluminum can be pushed in as the cut progresses down the intersection.

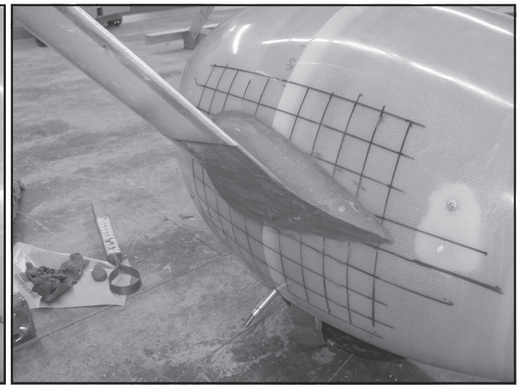
Be very careful not to damage the gear legs or brake lines.

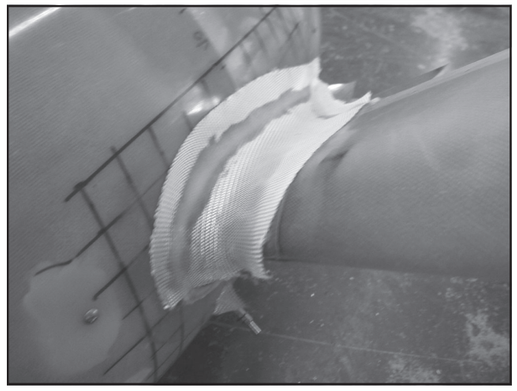
The following photos and text illustrate how we fabricated the gear leg to wheel fairing intersection fairings on our RV-10 prototype. Use a similar method to make the upper fairings.











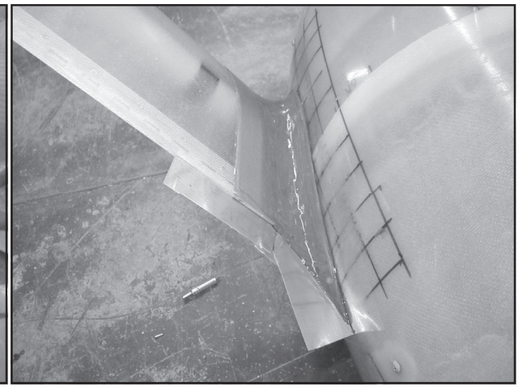
Top left: The wheel pant and gear leg are installed and aligned to their flying position, as explained in the builder's manual.

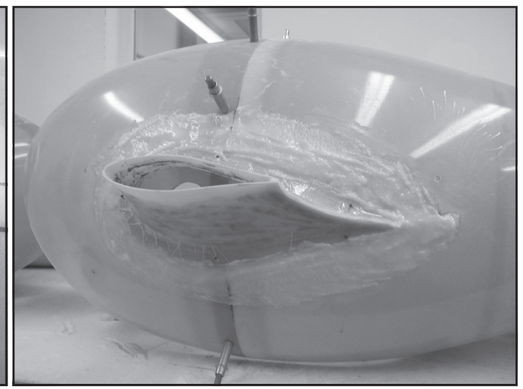
Top right: Before installation, a simple grid was drawn on the inboard side of the wheel pant. Without this reference, the swoopy intersection fairing would be almost impossible to make symmetrical.

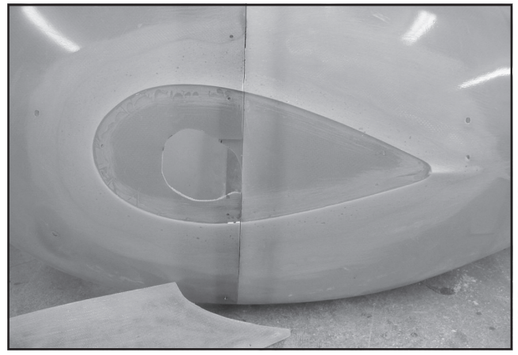
Middle left:: Oil-based modeling clay is applied to the intersection.

Middle right: Careful work with trimming tools like the one on the floor (simply a loop of crate banding strap attached to a wood handle. It works better if it isn't sharp), a damp spoon and a scraper made from a section of plastic milk jug streamlines the clay shape.

Bottom left: The intersection fairing will be a separate piece. It is not bonded to the wheel pant, so the pant is covered with a release solution or mylar tape. Strips of fiberglass cloth are laid up with resin. Be sure to cut all the cloth strips you will need before you start the lay-up.







Top left: Wider layers of glass cloth are applied. A total of four or five layers of 9 ounce cloth works well.

Top right: Scraps of taped aluminum sheet are inserted into the rear of the gear leg fairing to prevent the aft edge of the intersection fairing from bonding to itself. The finished intersection fairing will be flexible enough to open to remove from around the gear leg.

Middle left: The cured, sanded intersection in place, held by clecos. In the finished installation, nutplates will be installed on small fiberglass pads laid up inside the wheel pant and the fairing will attach with # 6 screws and recessed washers.

Middle right: For a smooth transition, the surface of the wheel pant is built up around the edge of the intersection fairing. The intersection fairing, covered in release solution, is screwed on, and a slurry of resin and cotton fibers (brand name Cabosil) is applied to the sanded surface of the wheel pant.

Bottom left: the hardened slurry is sanded to a smooth surface. After the usual filling and sanding, the landing gear fairings are painted and begin a hard, hard life.

INSTALLING THE NOSEWHEEL

Coat the interior and bead of the tire with talcum powder. Also coat the inner tube so it will easily slide into the tire.

Van's uses Matco brand wheels for the RV-9A nose wheel. See DWG C1. The bead of the tire fits very tightly on the rim of the wheel. Insert the wheel halves into the tire and align them as carefully as possible... then, with two people, compress the halves together enough to get the three bolts started. BE SURE that the tube is NOT caught between the two wheel halves. Use the bolts then to draw the halves together. It is often helpful to inflate the tube slightly during this process to keep the tube away from the wheel parting line.

Once the wheel halves are together, torque bolts to the AN specification of 50-70 in-lbs, inflate the tube slowly to at least 60 psi and then remove the valve stem to allow it to relax completely. Doing this a couple of times will insure that the tube and tire are both in their correct positions. Final tire pressure should be around 30-35 psi.

Now, prepare the wheel bearings for installation. Clean the interior of the wheel, including the installed bearing races. Then grease the wheel bearings with the appropriate lubricant (Aeroshell #5 or equivalent). The bearings have a seal of black rubber. This seal MUST have a coat of grease on its perimeter where it contacts the aluminum wheel. Insert the greased bearing sections into the wheel being sure that the rubber seals also fully insert. Then install the U-00710 Axle and U-00711 Spacer.

Next, thread on the axle nut. The rubber seals on the bearings produce considerable drag on the wheel and tend to cause the bearings to spin with the wheel rather than remain stationary with the axle. The nut will need to be tightened to provide just enough frictional force on the bearings to prevent them from spinning, but not overly tightened which would place undue load on the bearings. To accomplish this, tighten the nut while rotating the wheel back and forth. When the bearings are fully seated and the bearings seals no longer rotate with the wheel, tighten the nut to align the next available slot /hole combination in the nut and axle. Install the U-00712 Axle Nut Pin by inserting the bent end of the pin into the hole in the axle and then pulling the remainder of the pin over the circular, non-hexed portion of the nut. At this point there may be considerable rotational wheel drag; this is normal. Taxiing will break in the rubber seals and, within a short time, the wheel will rotate more freely.

The final step is to insert the wheel and axle assembly into the WD-630-1 Nose Fork. Once centered on the axle bolt hole, insert the axle bolt and any washers, brackets, etc., and install the nut on the axle bolt.

SETTING THE BREAKOUT FORCE OF THE NOSEWHEEL

When installing the nose wheel/fork assembly for use, tighten the nut down so it requires 14 ft/lbs of torque to swivel the fork on the axle. Measure this by rigging a small tension scale (like a fish scale) to pull in-line with the axis of the axle. DWG C1 shows this arrangement. Progressively tighten the axle nut while swiveling the fork and taking readings with the scale as the ''break out'' force increases. When the scales measure 22 pounds, temporarily safety the axle nut. Swivel the fork several times from stop to stop. Measure the pull both to the right and to the left. Be sure the scale is perpendicular to the wheel when pulling. If the scale reading varies significantly from one direction to the other, re-adjust the axle nut as required to achieve a scale reading of 22 pounds for the direction that produces the highest load.

If the cotter pin hole in the axle is more that half way between two adjacent notches in the nut, tighten the nut to align the notch with the hole; if less than half way, loosen the nut to align. Install the cotter pin.

INSTALLING THE WHEEL FAIRING and U-00713C-L/R-1 FAIRING BRACKETS

Install the WD-630-1 Nose Fork and the nose wheel, with tire mounted, onto the nose gear leg as shown in DWG C1. The airplane must be properly set up to use the dimensions on the plans for fitting the wheel fairings. See Note 1, DWG C1.

Finish the U-00713C-L/R-1 Nose Wheel Fairing Brackets by removing the material shown in the U-00713C-L/R-1 Trim Detail on DWG C1 and deburring all the edges. The screw holes in the tabs of the fairing brackets that attach to the U-813A Rear Nose Wheel Fairing will not be visible through the wheel fairing. To locate these holes on the wheel fairing, incorporate the method in Section 5.18 MATCH-DRILLING OPAQUE FIBERGLASS PARTS into this section.

Tape a 1/2" thick spacer – almost any solid material will work – to the top of the nose wheel tire. Slide the U-00713C-L/R-1 brackets onto the nose fork, fitting the slot of the brackets around the smaller NAS washers of the axle bolt. The brackets will be "sandwiched" between the larger washers and the nose fork. Use the socket head cap screws to secure the brackets to the fork.

In order for the U-813A Rear Nose Wheel Fairing to slide into position, it will be necessary to trim the bottom of the fairing to clear the tire, and the top of the wheel fairing to clear the gear leg. During this iterative process, keep all trimming to the minimum required. When this is accomplished, slide the fairing into position and support it with blocks on the floor.

All the tabs of the U-00713C-L/R-1 Brackets should rest on the inside surface of the wheel fairing. Note any adjustments necessary on the tabs, remove the wheel fairing and bend the tabs to fit. While the wheel fairing is off, make

measurements and marks on the floor (or a temporary template) to the position of the socket head cap screws. Replace the rear wheel fairing, allowing friction to hold it on the brackets.

Fit the U-813B Front Nose Wheel Fairing. Cut a slot in the top of the fairing that will clear the nose gear leg and allow the front and rear halves of the fairing to join. The fairing will ultimately require additional trimming to clear the gear leg as the nose wheel is rotated to its stops, but, even at this point, keep the clearance gaps to a minimum. Drill, then cleco the wheel fairing together (3" between the nutplate screw holes on both sides of the gear leg slot should provide sufficient edge distance after the final trimming of the slot is completed). Trim the bottom of the fairing for a at least a 5/8" clearance with the tire in all directions.

Adjust and block the wheel fairing into position. Drill and cleco the rear wheel fairing to the tabs of the brackets.

Now, rotate the nose wheel back and forth while noting and marking locations of fairing interference with the gear leg. Trim to clear. Repeat the process until the nose wheel can be rotated to both stops without interference. Although the clearance gaps will be covered by the bottom of the U-00019 Nose Gear Leg Fairing, excessively large gaps will be visible; so, keep the gaps to a minimum.

Remove the front wheel fairing and determine the position of the socket head cap screw on the outside of the rear wheel fairing. Drill this hole undersize, file any adjustment necessary to keep the hole centered on the bolt, and finish the hole to the called-out dimension for the socket head cap screw or to sufficient size for tow bar access to the bolt.

Remove the wheel fairing and brackets and install the nutplates in both the bracket and rear wheel fairing. Complete the necessary countersinking, etc. on the fairings.

Permanently install the brackets on the nose fork and re-install the nose wheel fairing.

COWL/NOSE GEAR LEG INTERFACE

It will be necessary to inter-relate the following instructions with those for cowl installation in Section 12. Refer to DWG 45 which shows the relationship of the bottom cowl and the nose gear leg.

A slot must be cut in the fiberglass cowl to allow it to slide on and off around the nose gear leg; DWG 45, SECTION T-T provides information for making the slot. The slot leaves an opening in the cowl forward and aft of the leg. To strengthen the cowl, and to improve cooling air outflow and aesthetics, removable close-outs are installed. Details for the close-outs are also shown on DWG 45.

As shown in DETAIL K, cleco the FF-00097A Close-Out and FF-00097B Doubler together, locate the parts on the bottom cowl, then drill the screw holes into the cowl using the holes in FF-00097A as a guide. Similarly, locate the FF-00096 Close-Out and drill the screw holes.

Machine countersink the required rivet holes in FF-00096 and FF-00097A & B, then rivet the parts and install the nutplates.

FIBERGLASS NOSE GEAR LEG FAIRING

The U-00021 Nose Gear Leg Fairing is a fiberglass wrap-around fairing with one end molded to match the curve of the bottom of the nose gear leg. Details are shown on DWG C1.

Remove any twist from the gear leg fairing in the same way as the main gear leg fairings. The nose gear leg fairing has an obvious flange along the trailing edge. With twist removed, tape the flanges together in several places, then drill three #40 holes through the flanges and cleco to hold them together. Remove the tape.

Trim the nose gear leg fairing to within 1/4" of the factory marked trim lines on both ends of the fairing.

The nose gear leg fairing is attached using a through bolt at the top of the fairing and two screws at the bottom. The holes for the attachment hardware will need to be located from the gear leg by sighting through the fairing. In order to make the fairing transparent enough to see the underlying holes (the magnetic ball locating method will not work here), the gelcoat in the area of the holes will need to be removed with sand paper. The sanding locations are indicated by two factory marked dots on both sides of the fairing. A final sanding with 400 grit sand paper should achieve the required degree of transparency (when actually sighting the holes, using water to wet the area will improve transparency).

The gear leg fairing is fitted using an iterative process. The fairing is slipped onto the gear leg, locations that require trimming are marked, the leg fairing is removed and the lower and upper ends are trimmed, then the faring is slipped back on the leg and checked for fit. Repeat this process until:

1. The fairing can close around the attach bracket at the bottom of the gear leg with the trailing edge clecoed together. (This will require trimming the lower end of the leg fairing until the fairing can drop enough, relative to the gear leg, to place the bracket in a deeper portion of the fairing cross-section.)

2. The lower end of the gear leg fairing covers the clearance gap in the wheel fairing forward of the gear leg.

3. The gear leg fairing clears the wheel fairing and the structure at the upper end of the gear leg. (Minimum clear-

ance with the wheel fairing is sufficient for now, more clearance trimming comes later.)

Now the attachment holes are located and drilled. With the fairing in place on the gear leg and the trailing edge clecoed together, make sure the fairing plane of symmetry is aligned with the plane of symmetry of the airplane. Sight through the sanded areas of the fairing and mark the locations of the underlying attachment holes. Remove the fairing and drill the holes in the leg fairing as dimensioned in DWG C1.

Next, the hinge is located and drilled. Sand any resin build-up on the inside surface of the nose gear fairing where the hinge will lay. It must be smooth so that the hinge will lay flat against the surface as shown on DWG C1, SECTION A-A. The length of hinge shown in the drawing is the final, installed length; at this point, the hinge will need to be long enough to extend beyond both ends of the fairing by about and inch. Draw the rivet line on the outside of both hinge halves. Cleco the trialing edge. Place the hinge inside the fairing so that it extends beyond both ends of the fairing and rests flush against the inside without forcing the trailing edge open, then clamp in place. Mark the ends of the rivet line on the fairing from the rivet line drawn on the hinge, then complete the rivet lines on the fairing by connecting the marks. Mark the rivet spacing on the fairing (note that the location of the first rivet hole at the bottom of the fairing is dimensioned from the hole in the attach bracket; the lower hinge trim is based on this hole) and drill and cleco the fairing and hinge. Mark the upper end of the hinge to be trimmed flush with the end of the fairing. Remove the hinge, remove the hinge pin from the hinge, then trim the hinge to length. Machine countersink the fairing and rivet the hinge halves in place. Cut the hinge pin roughly one inch longer than the hinge. The extra length is bent and secured to the upper end of the fairing with safety wire. Trim off the trailing edge flanges.

Install the nutplates on the attach bracket at the bottom of the gear leg, then install the leg fairing. Trim the leg fairing as necessary to clear the nose wheel fairing as it sweeps through its range from stop to stop.

NOTES