# 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.

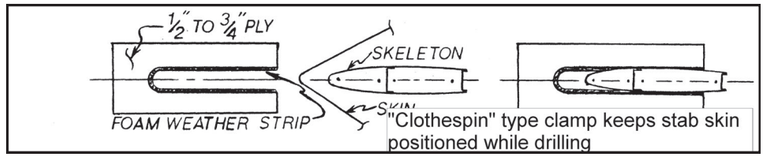
Empennage tips are attached with flush head CS4-4 blind rivets.

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.

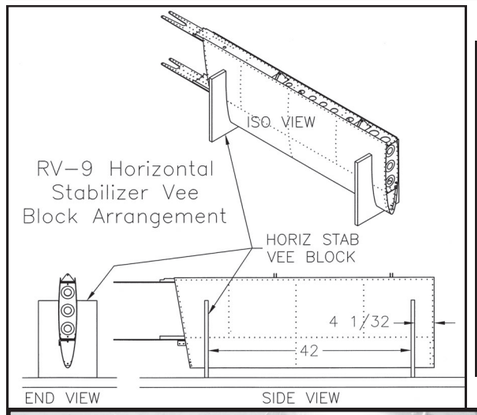
If you foresee the need to remove any of the fiberglass tips to service antennas or strobes, etc., they may also be attached with #6 countersunk screws and nutplates (not included in the kit) riveted to the fiberglass. Use the same spacing specified for the rivets.

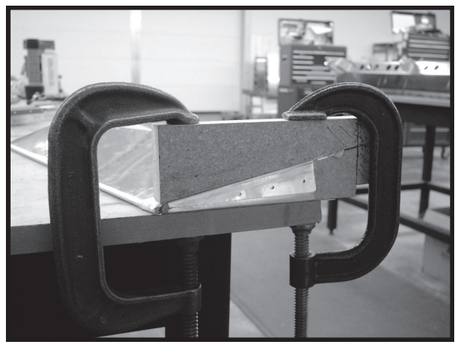
Auto body filler (“bondo”) may be used sparingly to fair and smooth the intersection. Don’t overdo it -- a clean but visible seam between the tip and the aluminum looks better than a smoothed over one, and bondo has a tendency to crack and spall over time if it is applied over 1/16” thick.

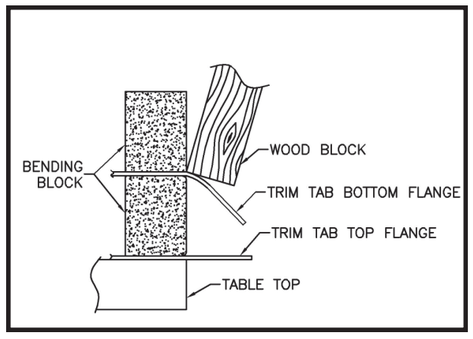
The aft sides of the HS-910 and VS-909 stabilizer tips are open. These must be plugged or capped for structural and cosmetic reasons. This may be done in a variety of ways, as shown in Fig. 6-12. A balsa or softwood plug may be fashioned and bonded into place; a foam plug may be inserted and sealed with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




"Clothespin" type clamp keeps stab skin positioned while drilling



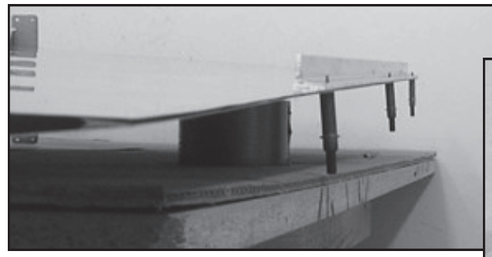



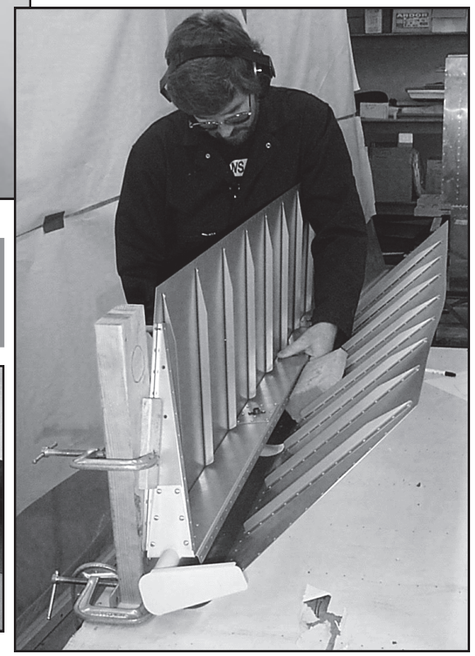




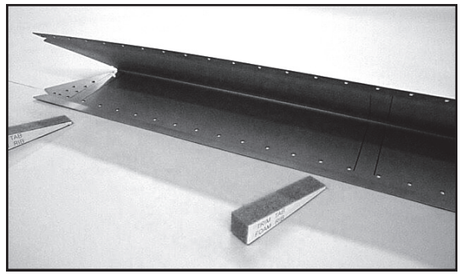


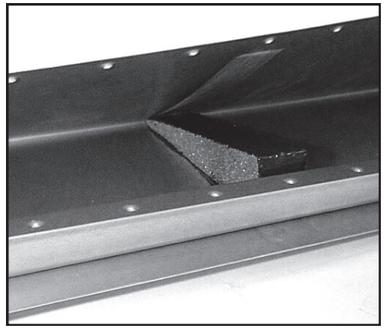

***Below:*** A board clamped to the bench helps hold the elevator while the top of the spar is riveted. A large sponge helps hold the skin open and keeps the bucking bar from denting the opposite skin.





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.





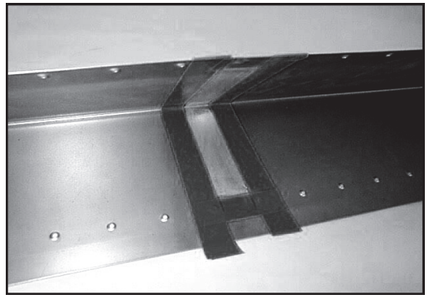


***Fig. 6-6:*** Foam ribs stiffen the trim tab. After the ribs are cut and sanded (above left), the skin is prepared by masking the contact area. The aluminum is sanded and cleaned carefully, (above) and the rib is bonded into place.

FIGURE 6–12

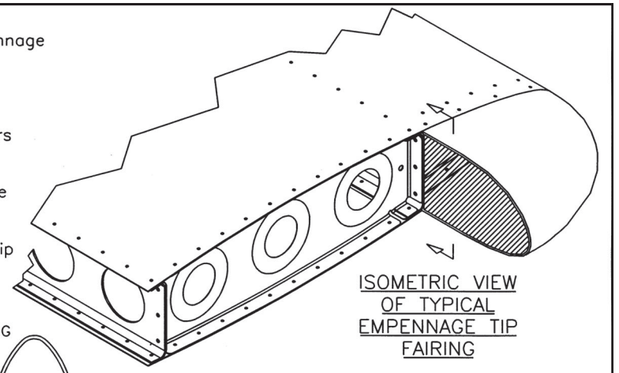
The open ends of the following empennage tip fairings must be closed:

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.

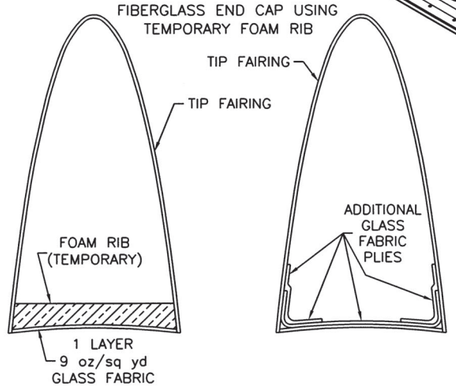
A couple of possibilities for creating tip fairing end ribs are presented here.



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

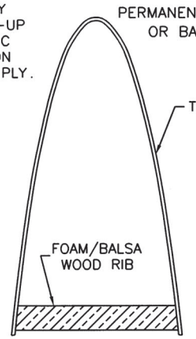



STEP 2

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

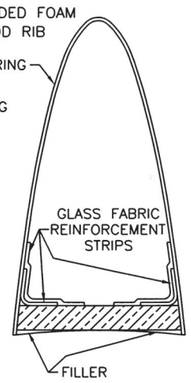
OPTION 2:

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