

# CHAPTER 8: VERTICAL STABILIZER AND RUDDER

## REVISIONS

From time to time, revisions to this assembly manual may be deemed necessary. When such revisions are made, you should immediately replace all outdated pages with the revised pages. Discard the out dated pages. Note that on the lower right corner of each page is a "revision date". Initial printings will have the number "0" printed and the printing date. All subsequent revisions will have the revision number followed by the date of that revision. When such revisions are made, a "table of revisions" page will also be issued. This page (or pages) should be inserted in front of the opening page (this page) of each affected chapter. A new "table of revisions" page will accompany any revision made to a chapter.

## Arrows

Most drawings will have arrows to show which direction the parts are facing, unless the drawing itself makes that very obvious. "A/C UP" refers to the direction that would be up if the part were installed in a plane sitting in the upright position. In most cases the part shown will be oriented in the same position as the part itself will be placed during that particular assembly step. However, time goes on and changes are made, so careful attention should be paid to the orientation arrows. That old cartoon of the guy agonizing over the plans for his canoe, built one end up, one end down, should not happen in real life. Especially to you.

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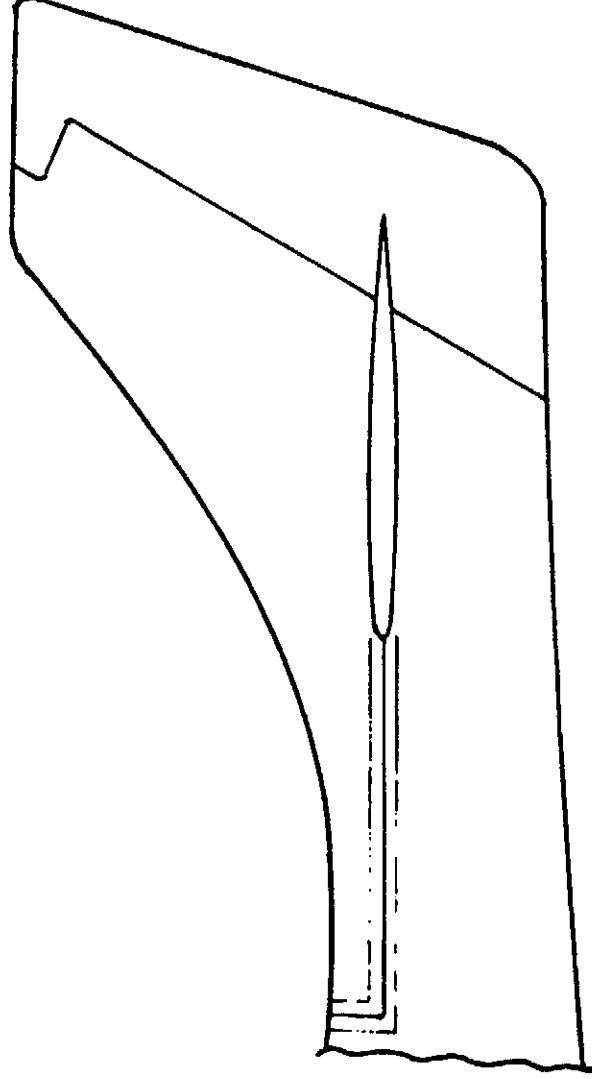
## 1. INTRODUCTION

Covering the assembly of the vertical portions of the tail, this chapter is relatively brief and simple to get through. The rudder will be built and counter balanced, and the vertical stabilizer will be constructed and attached to the aircraft.

**NOTE:** If you are planning on installing any antennas such as Loran, etc., that will be mounted within the tail, now is the time to get those parts together.

### Vertical stabilizer and rudder

Figure 8-1



## 2. DRAWING LIST

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page	Vertical stabilizer and rudder	Rudder side view	Attaching additional counter balance weights to rudder	Vertical stabilizer	Establishing plumb condition of the vert. stab. spar	Attaching vertical stab and H. stab	Vertical stab / rudder	Vertical stab attach	Closing vertical stabilizer	Elevator travel limits	Fitting in rudder	Rudder pivot pieces	Typical rudder pivot assembly	Rudder pivot pins	Spacing the lower pivot pc using shims	Rudder pivot cross sections	Lower rudder pivot / control horn	Upper rudder pivot	Establishing rudder travel	Safety wiring rudder pivot bolt retention tube

**3. EQUIPMENT REQUIRED - SPECIAL PARTS, TOOLS & SUPPLIES**

**A. Parts**

- Rudder pivot hardware
- Left rudder skin
- Right rudder skin
- Left vertical stabilizer skin
- Right vertical stabilizer skin



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## B. Tools

- rib and spar templates from blueprints
- Band saw or sabre saw
- Rivet squeezer or equiv.
- Transfer punches or equiv.
- Dremel™ type rotary grinder
- Drill motor
- Drill bits:
  - 3/8"
- Plumb bob
- Carpenter's level
- C-clamps (3" is sufficient)
- Communications antenna (optional)
- Tail navigational light (optional)

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**C. Materials & supplies**

- epoxy
- flox
- BID cloth
- micro
- 1/4" foam
- 1/2" foam
- 1" thick high density foam
- structural adhesive
- pop rivets (approx. 40)

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**4. PROCEDURE**  
**A. Rudder assembly**

1. Select either side of the rudder and locate the rib positions per figure 8-2.

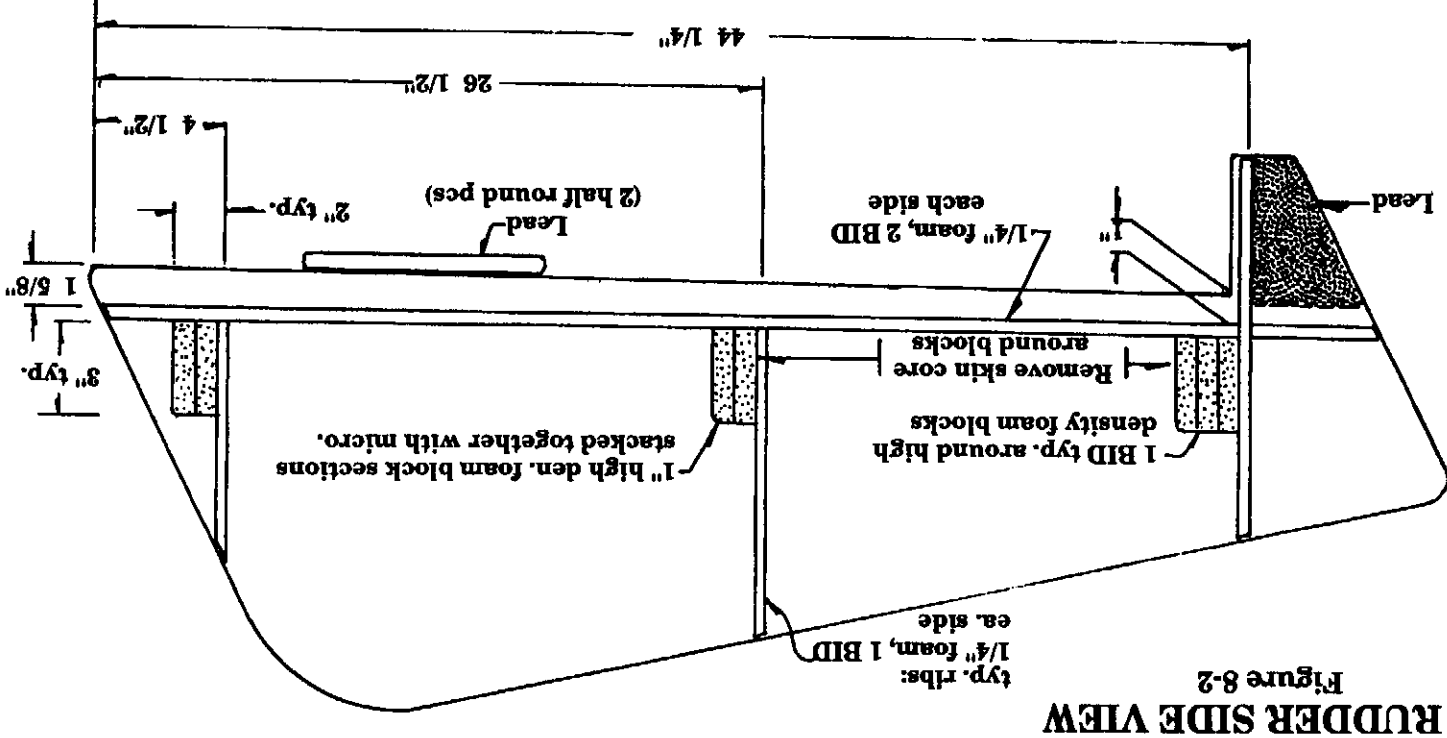


Figure 8-2

**RUDDER SIDE VIEW**

**NOTE:** It is best to NOT remove the "flash" from around the sides of the rudder halves yet. They will help to align the halves and provide a slight bondable edge to hold the pcs prior to applying the bonding tapes to the exterior joggles (similar to the approach used for the horizontal stab). Also, there are two acceptable methods for fabricating the internal ribs. They can be cut from either 1/4" foam with 1 BID per side or from the 1 ply prepreg honeycomb sheet. The other method may prove lighter and possibly easier; with this method you simply cut the ribs from 1/4" foam and lay up a single BID per side which both attaches to the skin and forms the 1 BID side of the rib.

2. First cut and fit the rudder spar. This requires 2 BID per side.
3. Micro the spar into position. See figure 8-2.
4. Cut the ribs out based on your chosen method (see above note).
5. Sand the ribs to achieve a good alignment to the skin.
6. Use micro to attach the ribs to the first rudder skin. Allow to cure.
7. Now sand the other edge of the spar and ribs to achieve a good fit to the close out skin.
8. Fit the lower high density foam block into the rudder per figure 8-2. This block will fit ONTO the foam core of the rudder halves.

**NOTE:** It is important that you position the lower foam block correctly so as to align properly with the block already established in the lower fslg tail section. The centerline of the rudder block should be 1/4" above the centerline of the fslg block for best fit.

see  
p 7-512

9. Fit the middle and upper foam blocks per figure 8-2. These blocks must fit INTO the foam cores of the rudder halves. This is to allow sufficient room for the rudder pivot pcs to be potted later.
10. Use micro to pot the high density blocks into position.
11. Add 1 BID around these blocks, contact 1" onto the rudder skins. Do not add more fiberglass thinking it will be stronger. The added weight will make it difficult to balance.

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12. After the above cures, sand down to a good fit against the remaining rudder half. Note that the remaining rudder half will require the core removal where the two upper high density foam blocks are installed. Be sure that there are no "voids" around the high density foam blocks where they contact the skins.

**NOTE:** Be sure to mark the locations of all three high density foam blocks on the outside of the rudder for later reference.

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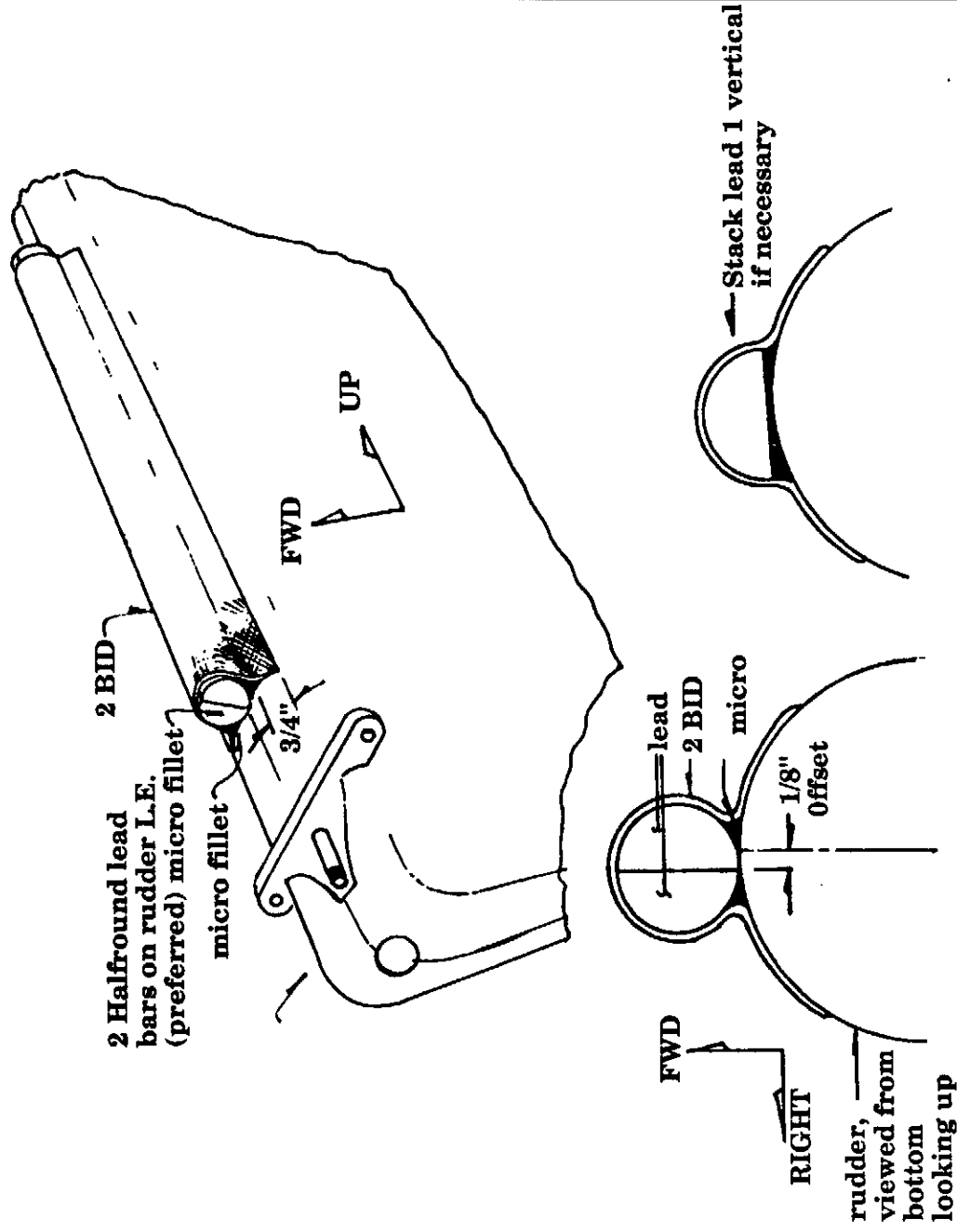
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## B. Rudder counter balance weights

1. Into the upper fwd area of the rudder (the part that swings through the vert. stab.), four (4) pounds of lead must be added. It is important to keep the lead as far forward as is possible to achieve the most advantageous balance effect. Using the half round lead bars, cut them to nest tightly into the area of the rudder halves. The core material termination will vary slightly from part to part but generally, there is sufficient room to tightly nest these pcs without removing core material.
2. When you have the lead fitted into position, remove and "POT" it in permanently with micro. Use a slightly wetter micro mixture than normal so that it can run down between pcs and pot everything in securely. Allow to cure.
3. You're now ready to permanently bond the rudder halves together. Use epoxy/flox in a manner similar to that used for the horizontal stab. As usual, be sure that all surfaces are cleaned well prior to bonding.  
When bonding the L.E., use a little epoxy/flox along the edge and onto the "flange" material that was left on, this will provide a means of holding the alignment until the BID tapes are added. Be sure to clamp a straight edge (or flat table top) to hold the T.E. alignment during cure.
4. When the part has cured, trim off the "flash" material and add the 2 BID around the L.E. where the joggles are.
5. Additional counter balance weights are required on the L.E. of the rudder between the middle pivot and the lower pivot positions. These two half round lead bars can not be added until the vertical stab is completed so that a clearance check can be made.
6. When the vertical stab is completed and all pivot hardware is fitted, fit two half round lead bars (full length) to the L.E. of the rudder between the lower two pivot positions. Locate their centers 1/8" right of the rudder centerline (i.e., 1/8" towards the passenger side when installed). This is to ensure clearance for the full 30°'s right rudder. The left rudder only requires 25°'s.  
Use hot glue or instant glue to quickly attach these pcs and make a fit check through full rotations. When the fit is established as o.k., place a micro fillet between lead and rudder and lay 2 BID over these lead pcs thus attaching them to the L.E. of the rudder. Contact the rudder with at least 3/4" of BID each side.

# Attaching additional counter balance weights to rudder

Figure 8-3



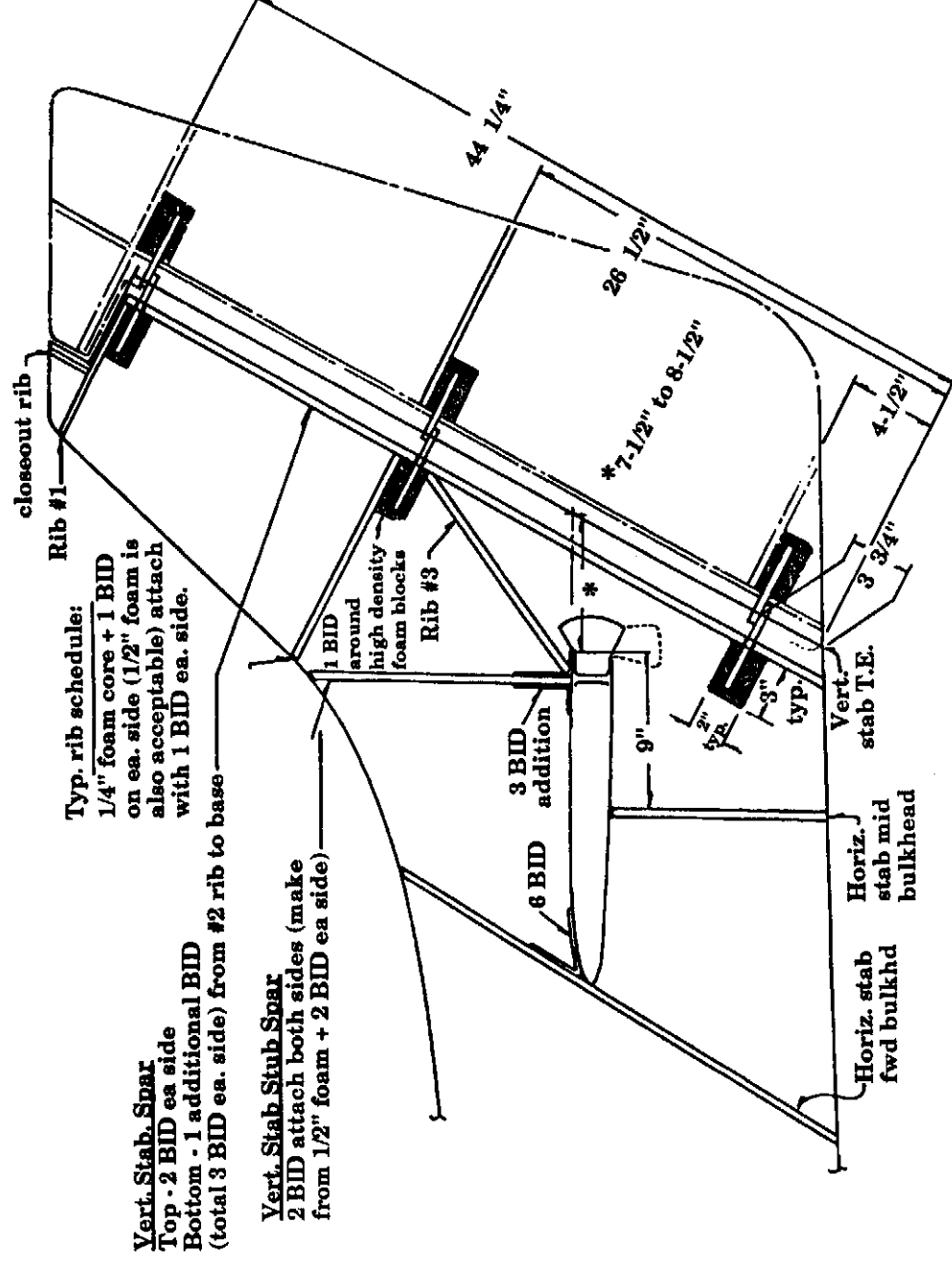
NOTE: If your particular installation is tight, you may not be able to position the lower two lead half-rounds as shown. It is acceptable to install singular half-rounds and stack the two along the fwd rudder L.E. skin line.

### C. Vertical stab assembly

This assembly is straight forward and quite simple. If you are intending to carry a loran antenna, the L.E. of the vertical fin is the best location. Also, a comm antenna can be installed into the vertical fin.

### Vertical stabilizer

Figure 8-4



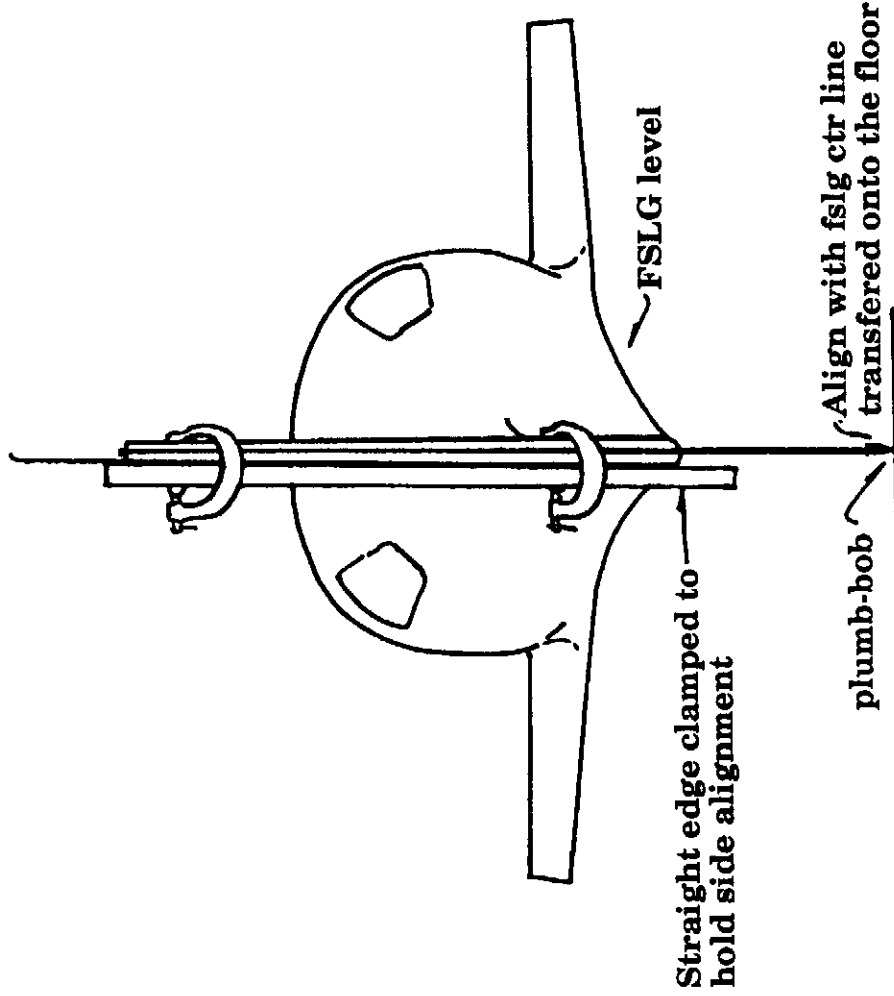
1. Level the fslg in both directions. Fslg should be upright.
2. Trim and fit one of the vertical fin sides to the fslg. The joggles will fairly well dictate position. Don't worry about the T.E. at this time, it will be trimmed to a straight line later.

3. For the initial fit, set one or two clecoes at the fwd edge of the vert stab skin and one at the T.E. You can also set one through the T.E. area of the H. stab skin and one at the L.E. of the H. stab upper skin.

**NOTE:** Prior to bonding the vert stab skin (next step) check to verify and reestablish the "plumb" condition of the vert stab spar.

### Establishing plumb condition of the vert stab spar

Figure 8-5



4. With the vertical stab "plumb" condition reestablished, the skin can be drilled for all attaching pop-rivets along the joggle. Fit the fwd H. stab bulkhead to mate with the vertical stab skin.

5. Clean all surfaces and bond in position. Use structural adhesive along the joggles and epoxy/flox along the vert stab spar and H. stab bulkhead. Clamp in position and allow to cure.

NOTE: During cure, place a long straight edge from base of fslg up to top of vert stab skin. Clamp with C-clamps, spring clamps or equiv. thus assuring a straight line along this surface.

NOTE: Do not set pop rivets into the H. stab since the drilling out process would allow them to drop down into the stab. Use clamps, weights or clecoes.

6. After cure, remove the clamps and add 2 BID along the inside or fwd face of the vert stab spar to skin juncture. Contact 1-1/2" onto the skin and run full width of the spar.

7. Add one additional BID to the lower 27" of the spar to skin juncture, see figure 8-4. (p 8-12) and fig 8-7 (p 8-16)

8. Add 1 BID along the juncture of the vert stab and the H. stab. This is in the rolling fillet area and will thus require a generous micro fillet. Keep the micro dry.

9. From blueprint "C", cut out the pattern for the vert stab ribs (3) and the stab spar.

NOTE: If you are intending to add any antennas, now is the last time available.

10. Fit the stub spar into position and attach with micro. Add the 2 BID attach full height and 3 BID additional to the lower 6". Contact 1-1/2" onto the top of the H. stab.

11. Fit the three rib sections and attach with micro. Add the 2 BID tapes to all sides. Allow to cure. Also fit the two remaining high density foam blocks. They must be in alignment with the blocks in the rudder. Position the rudder as closely as possible and mark the location. Ideally, the center line of the rudder blocks will be 1/4" higher than that of the blocks in the vert stab. But, there are adequate margins to allow for some position error.

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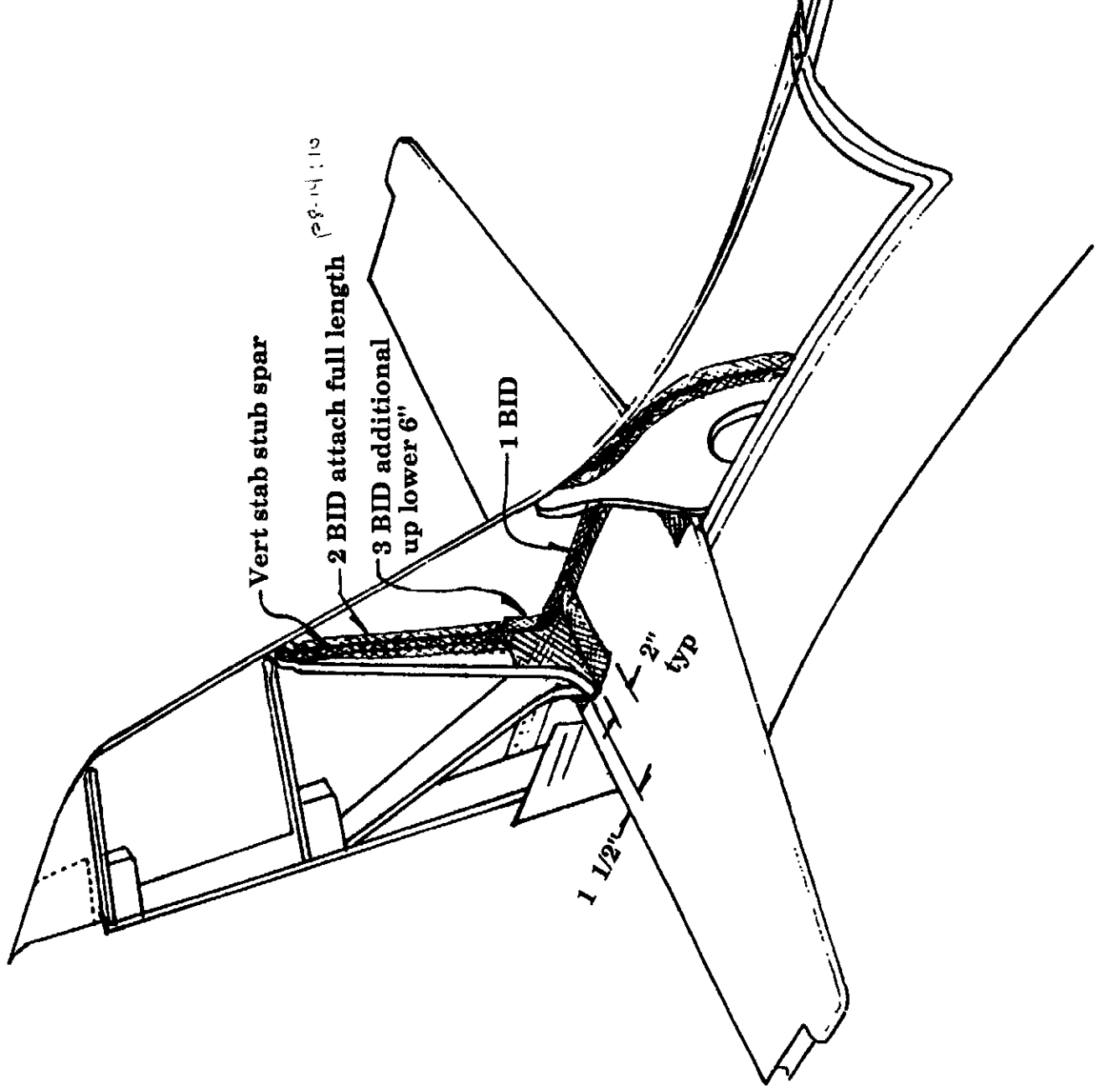
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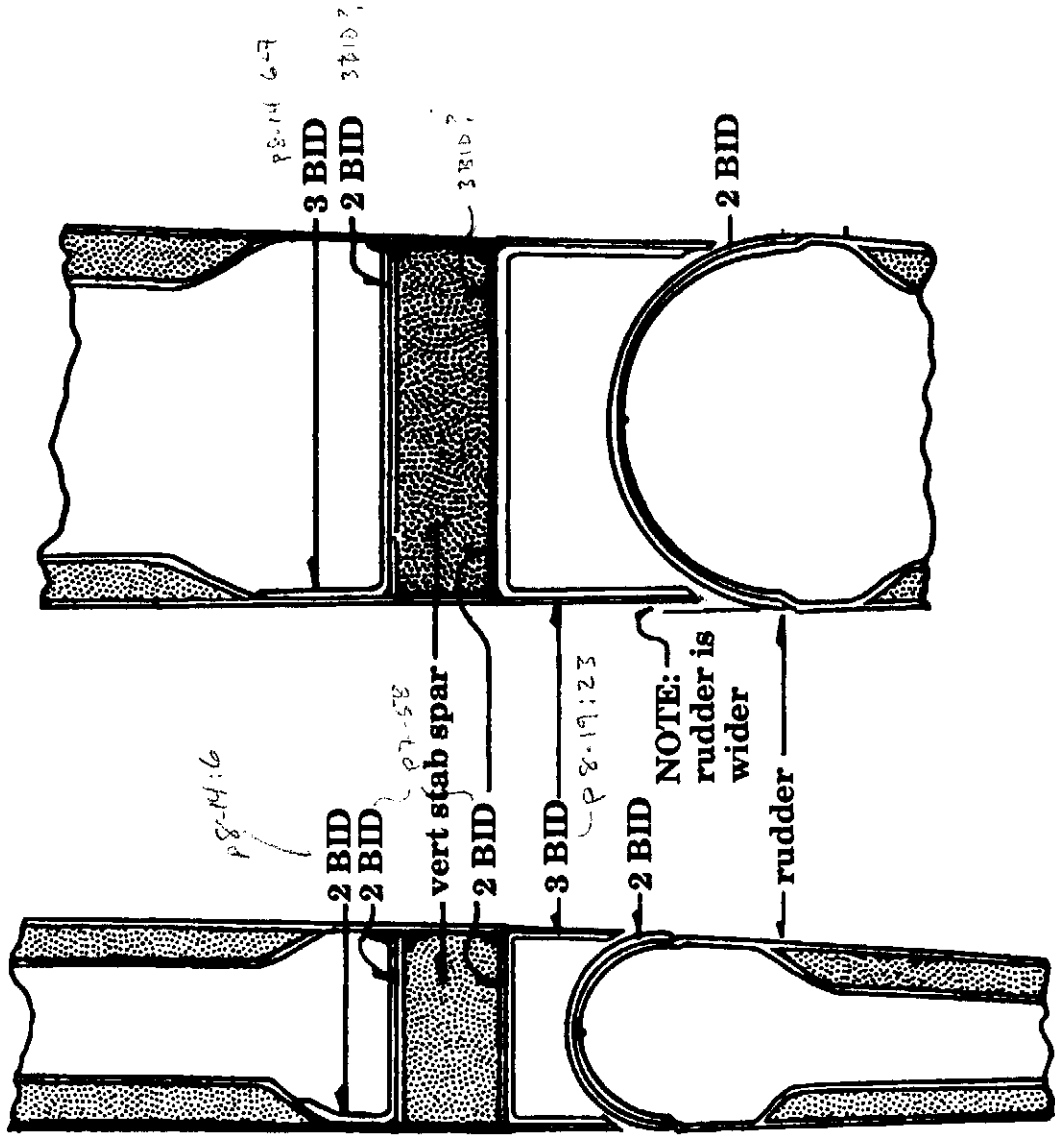
# Attaching vert stab and H. stab

Figure 8-6



## Vertical stab / rudder

cross sectional view, looking down from top  
figure 8-7



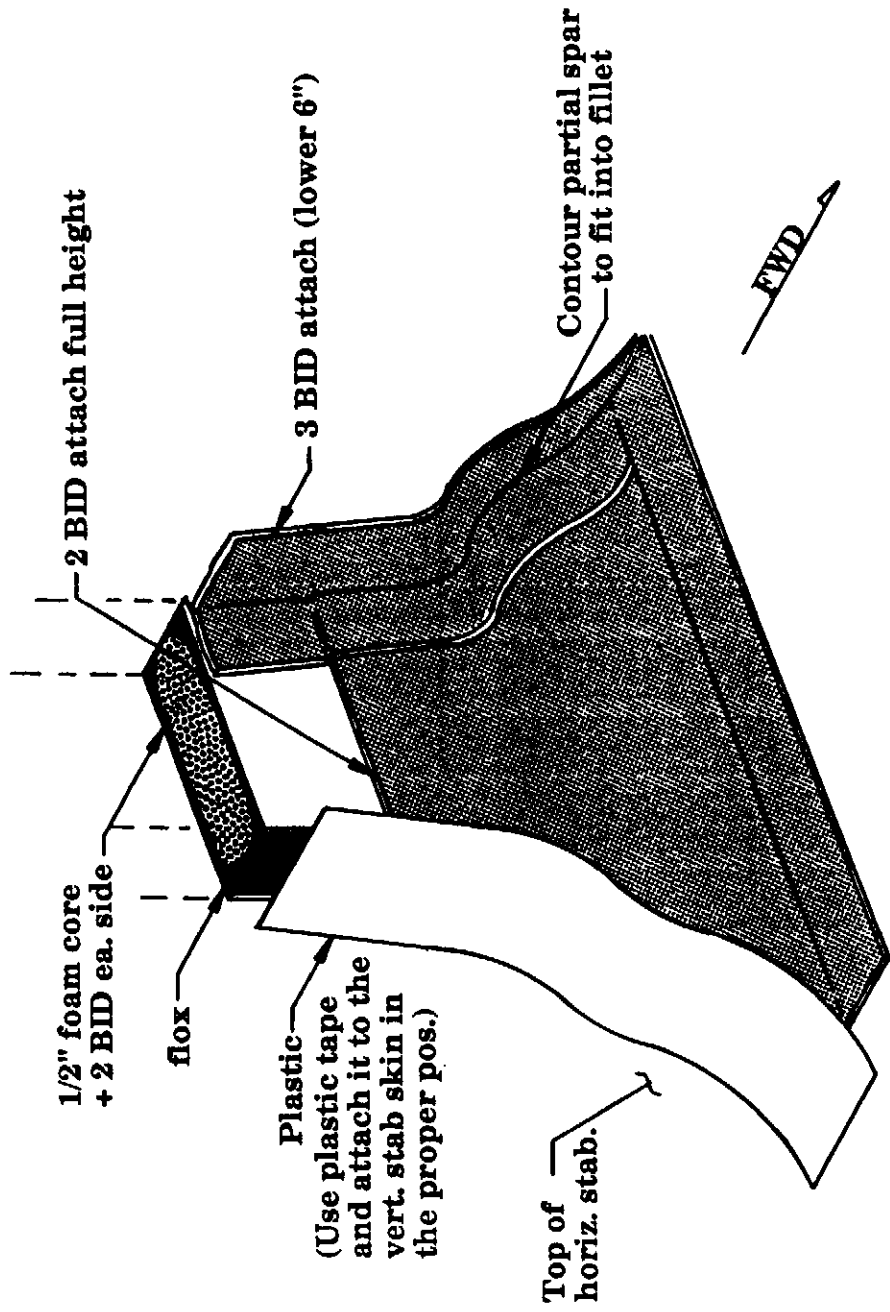
12. Now you're ready to fit the remaining stab skin. Position it in a similar manner as with the first side. Sand the ribs as required to get a good fit. You can check fit by setting a couple of clecoes and cracking it open just enough to see inside thus noting any conflicts of fit.



13. Mark all the rib, spar and foam block locations as a reference onto the remaining stab skin. Remove the skin and place wide strips of plastic tape over the areas where the ribs, spars and foam blocks will eventually bond. Allow plenty of over run with the plastic tape so that if the flox spreads, it won't get prematurely stuck to the stab.
14. Prep the ribs, spars and foam blocks for acceptance of the epoxy/flox mixture by grooving into the edges. You want to get 1/8" contact onto the INNER faces of the rib and spar skins.
15. Now add a generous amount of epoxy/flox to the edges of the ribs, spars and foam blocks to be mated.

### Vertical stab attach

Figure 8-8



16. Reposition the remaining vert stab skin and clamp lightly into final position. You should get a good squeeze out of flox along all the bonding surfaces. This excess can be trimmed off later when the skin is removed. The plastic tape will prevent the epoxy/flox from bonding to the skin and after removal of the skin, a perfect mating surface will be the result.

**NOTE:** During cure, check that the vert stab is "true". That is to mean that it should be aligned straight with the centerline of the fslg. There is no built in offset so if you detect an offset, it should be clamped in such a manner as to remove it.

It is easiest to check this alignment by running a string line from top T.E. of the vert stab to a point straight up from the firewall centerline. Then sight down this line and check the left to right alignment of the vert stab itself. If a twist is seen, it can be taken out with clamping action.

17. After the epoxy/flox on the ribs and spars has set up, the skin can be removed and all excess epoxy/flox can be trimmed off. If it is fully cured, use a heat gun to soften it and then trim with a sharp matt knife. If there are any areas where contact was not made, then they can be filled in. If they are shallow areas, just add additional adhesive with a little flox filler to those areas. If they are deep (over 3/32") then you should build them up using the fit-and-release method prior to permanently bonding the skin on.

18. Mark the locations of the high density foam blocks onto the outside of the vert stab skin.

19. When the fit is right, prepare the surfaces for bonding and spread a smooth coating of structural adhesive to all surfaces being bonded. Adhesive must be spread on both the vert stab skin and to the ribs, spars and foam blocks and to the joggles.

20. Position the vert stab skin in final bonding position. Set all pop rivets along the joggles and clamp along the T.E. using a long straight edge to achieve a straight line between fslg and vert stab skin, clamp and allow to cure.

21. The L.E. of the vert stab should be held in position with duct tape or equiv. Add into the joggle three or four small sections (about 2" long) of 1 BID layoffs between the duct tape strips. This will thereby hold the L.E. in proper alignment after the duct tape and clamps have been removed.

**NOTE:** Recheck for a true vertical of the stab and proper alignment. Allow to cure fully.

22. Now add 2 BID along the entire L.E. joggle. Run these BID over the 1 BID pcs used in step 21, it will be easy to blend in the .010" ridge.

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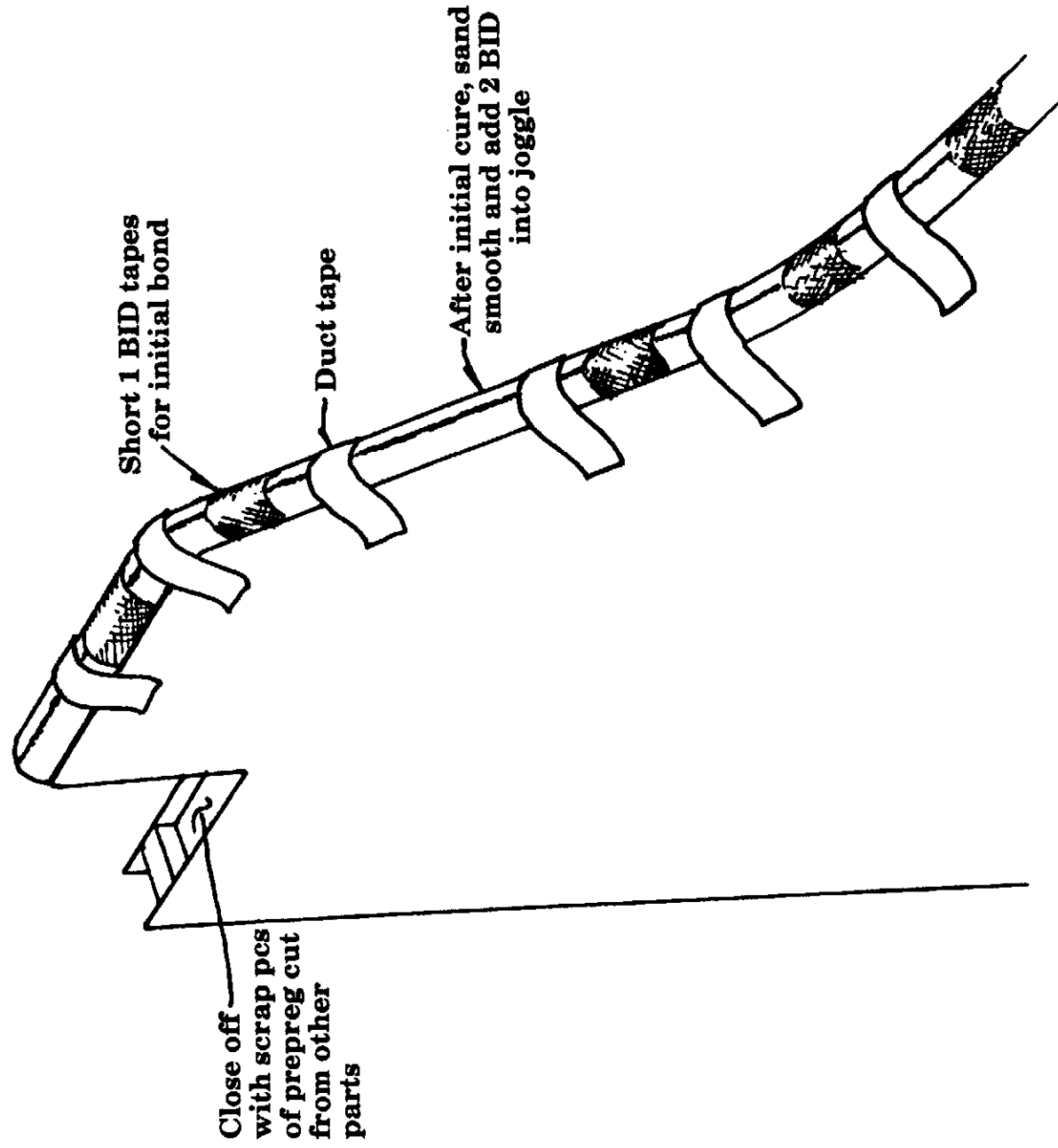
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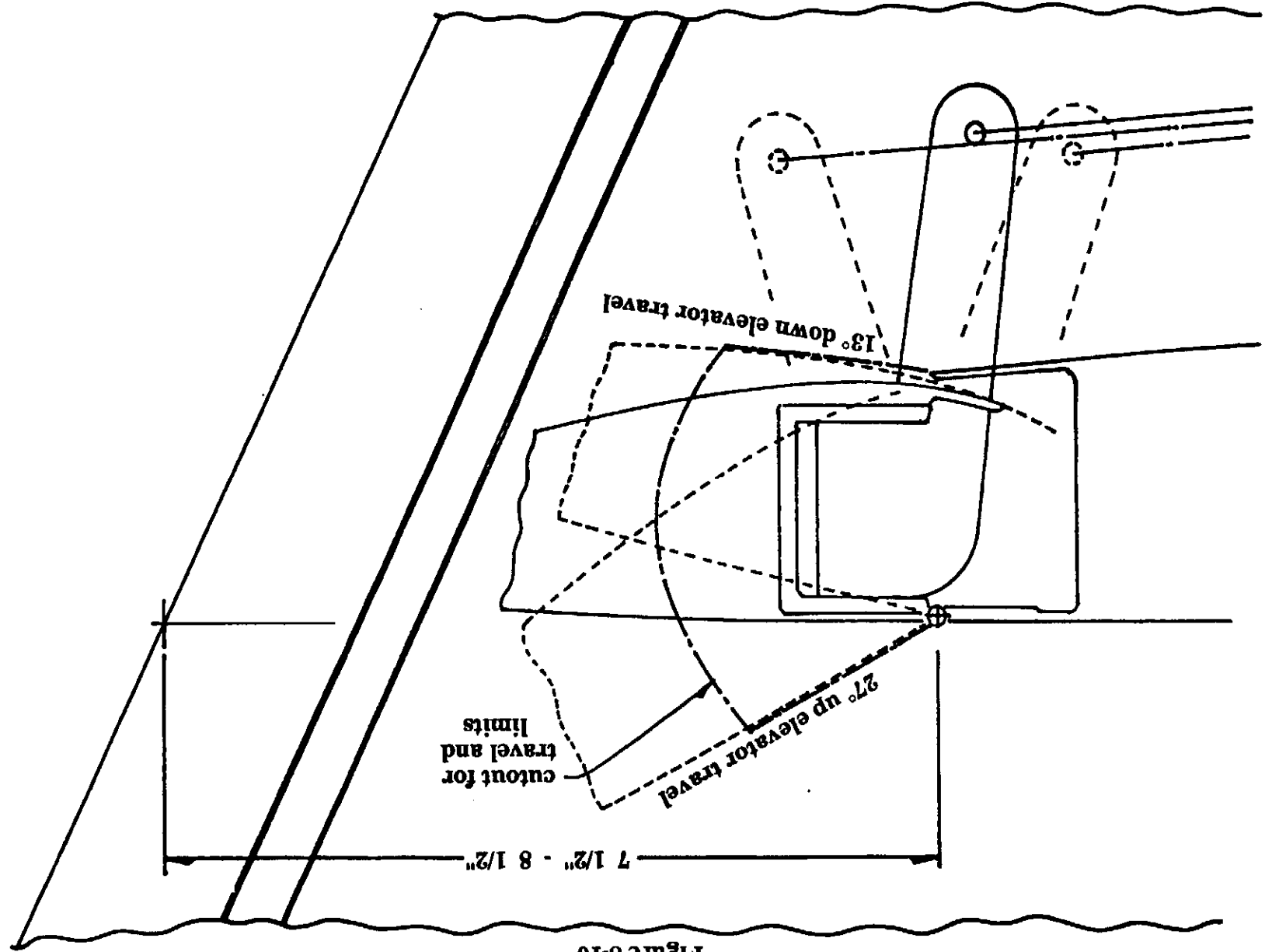
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23. Next add the 3 BID all the way up the T.E. channel formed by the vert stab skins and the vert stab spar (or stern post). See figure 8-9. *5-7 (PS-14)*
24. Add the 2 BID tapes to all joggles around the vert stab. Don't forget the short joggle along the fslg to stab line behind the H. stab.
25. Except for closing out the upper vert stab area where the rudder intersects, the vert stab is complete.

### Closing the vertical stabilizer

Figure 8-9





**ELEVATOR TRAVEL LIMITS**  
**27° UP TRAVEL, 13° DOWN TRAVEL**  
 Figure 8-10

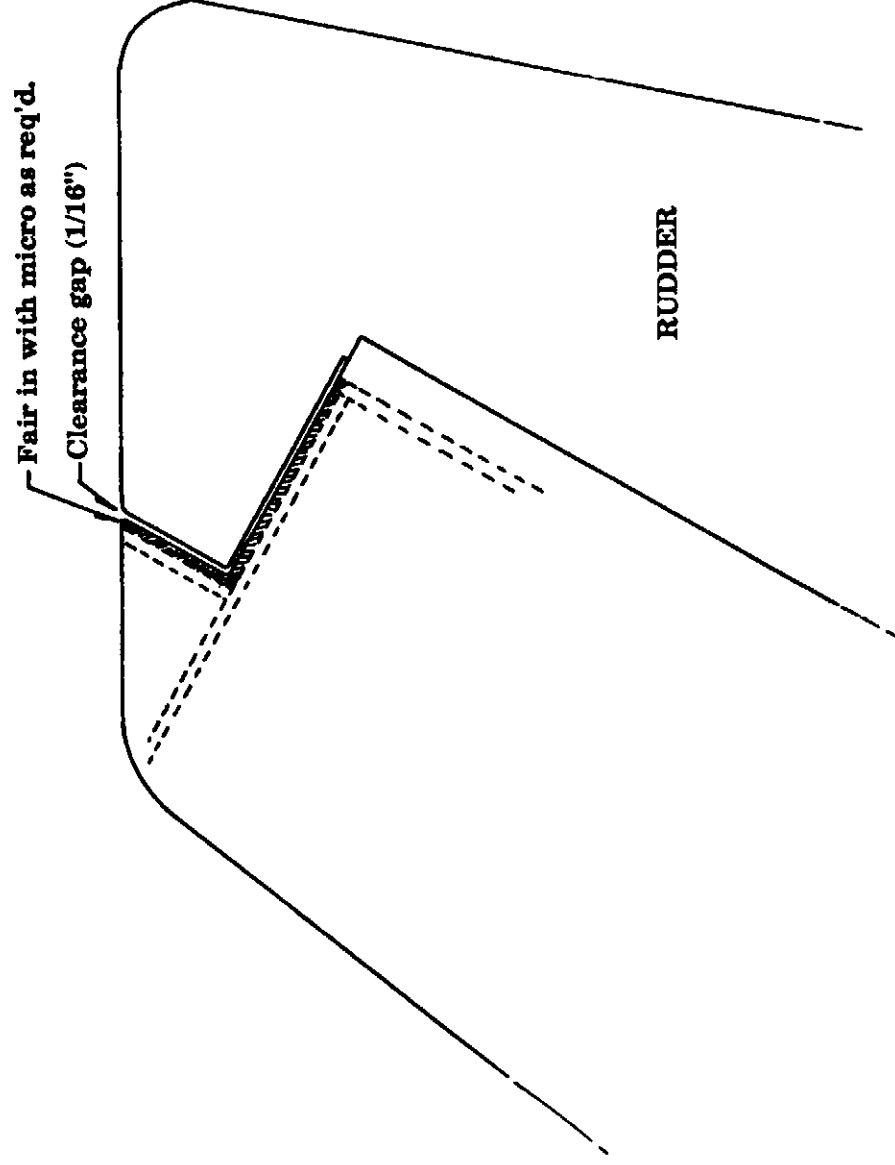
#### D. Rudder pivot assembly

Prior to setting the pivot pcs, the rudder must first be final fitted to the vertical stabilizer. This is fairly quick and easy to do.

1. Assuming that you have not yet made any cuts into the vertical stab to receive the fwd counter balance portion of the rudder, hold the rudder against the side of the vert stab and mark the lower trim line. Also mark the fwd trim line onto the vert stab. Set the base of the rudder to the best faired in position attainable and make any minor fairing adjustments to the top side with micro. The rudder will nest into the channel of the vert stab. Ideally, the rudder will be slightly wider than the vert stab to maintain attached airflow during flight.
2. The upper portion of the vert stab will require a closeout where it has been trimmed to accept the rudder counter balance. This final closeout and "fit" should be made after the pivot assembly is completed so that actual positions are finalized. At that time, micro is generally used to fill to a uniform clearance gap of about 1/16". Swing the rudder through full travel to check clearances.

#### Fairing in rudder

Figure 8-11



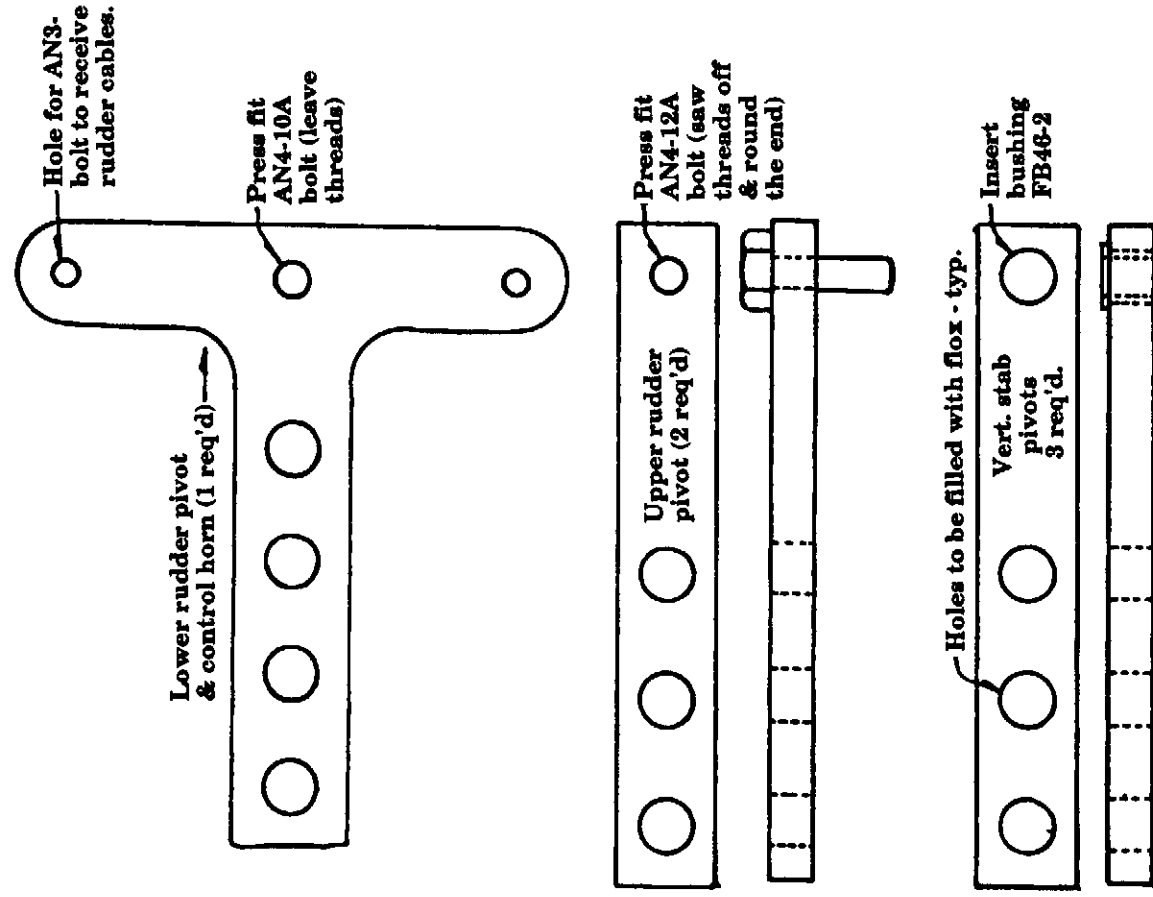
**E.**

1. **Setting the pivot pieces into the vertical stabilizer**  
Select the six rudder pivot pcs. The one with the "T" will fit to the lower rudder and receive the rudder cables. The ones with the 1/4" hole in the end will receive the AN4-12A bolt. This is a press fit, add a little epoxy or locite during the press. You should first saw the bolt threads off, see figure 8-12.

The three remaining pieces will have the 5/16" holes and receive the small bushing (FB46-2) which are also press fit. These pieces will mount into the vertical fin with the shoulder of the bushing facing up.

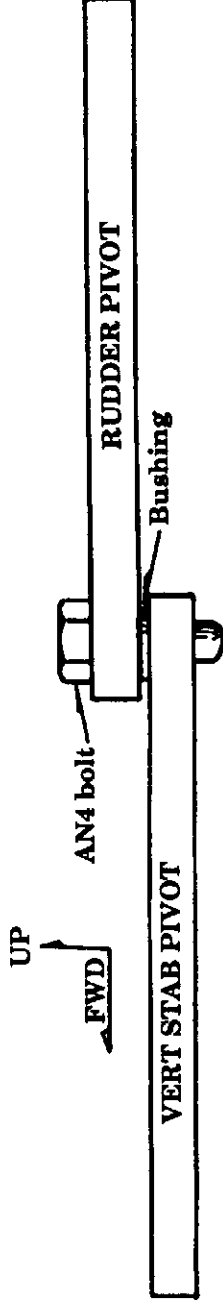
**Rudder pivot pieces**

Figure 8-12



## Typical rudder pivot assembly

Figure 8-13



2. First locate the proper vertical positions of the vertical fin pivots on the side of the stab. This is why you marked the high density foam positions on the exterior of the vertical fin. These pivot pieces will be potted into the high density foam blocks. If you forgot to mark the block locations, place a bright light behind the fin. With room lights out it is just possible to see the locations through the skins. The ideal position of the lower pivot assembly is per figure 8-4. You need not be exactly in the center of the high density foam block, any place <sup>L.P.S.-12</sup> within them will be sufficient.

3. Using a medium length drill bit (about 1/4" - 3/8" dia. is o.k.), drill through the center (spanwise) of the vert stab spar and on onto the high density foam block. The drill bit can be moved side to side so as to enlarge the hole to accept the aluminum pivot shaft.

**WARNING:** Do not drill completely through the high density foam block.

The angle of the drill bit into the high density foam block must be such that the pivot shaft will fit perpendicular to the vert stab spar. This is required for pivot pin alignment between all three pivot centers.

The hole should be made a little larger than that of the aluminum pivot pcs. A loose fit is actually what you want. Epoxy/flox will be used during the final potting in process and this mixture should be fully around the aluminum pieces.

4. Drill for all three pivot pins. These pivot pins will be spanwise centered across the vertical stab spar and must be extended out beyond the aft face of the vert stab spar per figure 8-14. This distance aft is important for the proper alignment of the rudder L.E. <sup>98-24</sup>

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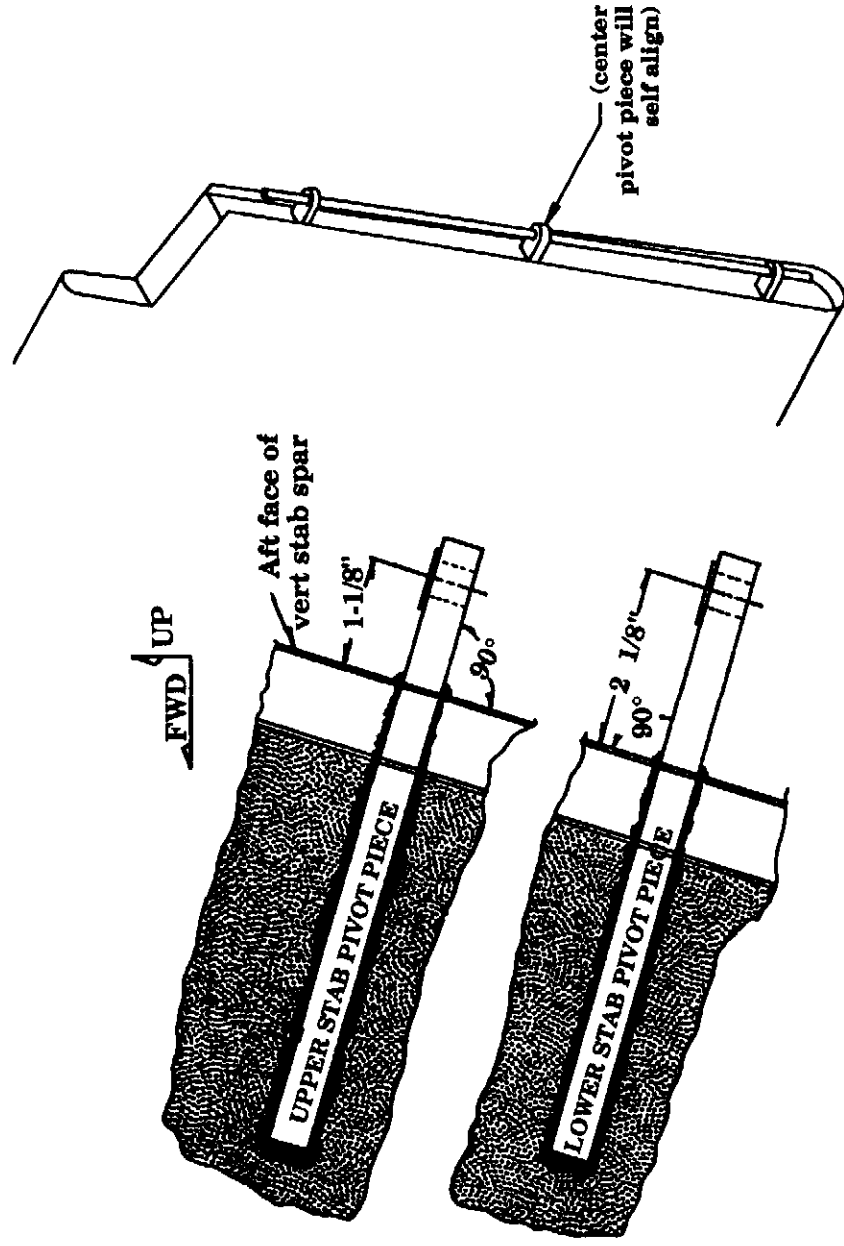
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## Rudder pivot pins

Figure 8-14



With the upper and lower pivot pieces potted in and centered left and right in the vert stab spar, run a long 1/4" rod through all three pivot bushings to assure concentricity of all pivot axes.

Use tape and wood shims to hold the pivot centers at the required distance aft of the vert stab spar web.

- Obviously, all three pin centers must be concentric with each other for smooth rudder rotation. It is very easy to achieve this concentricity.
- From your local hardware store, pick up some 1/4" steel rod. These pcs are usually stocked in 3' pcs which requires that you use two (the second pc can be cut down). Also, from your Lancair kit, select a pc of the 3/8" x .083 aluminum tubing. This tubing is generally used for the outbd gear door hinge assembly but it works well to align the two pcs of 1/4" steel rod by sliding over them thus making a good alignment of the two.

If your gear doors are already assembled, there should be a short pc of the thick wall tubing remaining as scrap.

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7. The 1/4" steel rod will slip through the three bronze bushings in the vert stab pivot pcs. See figure 8-14. Set the dimensions aft from the spar web at the top and bottom locations and the middle position will self align by virtue of the 1/4" steel rod. Use tape, and small shims (wood) to hold position when the final potting is performed.

8. Run a quick fit check with the full assembly of three pivot pcs and the 1/4" rod. The best method is to string the whole assembly onto the rod and then insert into the vert stab spar holes. Check that there is sufficient clearance room to nest all pcs into proper position. When it all fits in, remove and bond in permanently.

**NOTE:** The following can be done alone but you may wish to have an extra hand.

9. Mix up a good size batch of epoxy/flox, keep it a little on the wet side but not runny.

10. Pack the slots in the vert stab spar with this mixture. Use a mixing stick that is sanded down to a more narrow width - about the width of the slot so you can slip the mixing stick into the slot.

11. The slots must be well packed with epoxy/flox so that a good squeeze out of flox occurs when the pivot pcs are pushed in. Excess flox can simply be wiped away.

12. The aluminum pivot pcs should be lightly sanded and cleaned with acetone immediately before final assembly. Spread epoxy/flox into the large through holes of the pcs and get a good wet coat over the entire surface of the pcs that will be potted in.

13. With the slots now well packed with epoxy/flox and the aluminum pcs properly prepared (step 12), position and push all three pivot pcs into the slots thereby squeezing out excess flox. Scrape the excess off as it comes out to prevent it from dropping onto the lower assembly parts and making a big mess.

**WARNING: YOU MUST GET A GOOD SQUEEZE OUT OF EPOXY/FLOX MIXTURE THUS ASSURING THAT THERE ARE NO AIR VOIDS ON THE CAVITY BEING FILLED AROUND THE HINGE PIECES. MAJOR AIR VOIDS COULD RESULT IN FAILURE OF HINGE RETENTION.**

14. With the pcs not potted in, set the proper dimensions aft of the spar web. Also make sure that the whole assembly is spanwise centered. Secure position and allow to cure.

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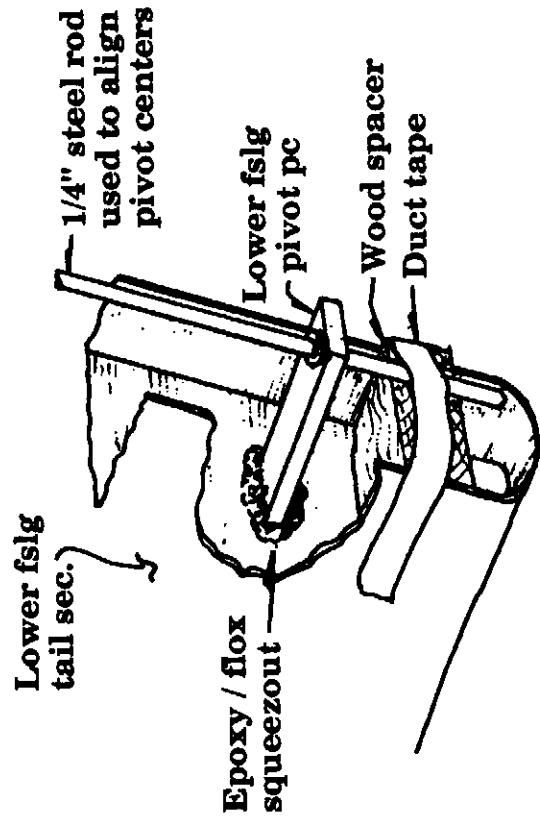
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## Spacing the lower pivot pc using shims

Figure 8-15



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## F. Setting the rudder pivot pieces into the rudder

With the vert stab pivot pcs now installed, the rudder pivot pcs can easily be fitted using the vert stab as an alignment jig.

1. Locate the correct position of the three pivot pcs by positioning the rudder and marking the relative locations for the pivots onto the skin of the rudder.
2. Note that the rudder pivots will install such as to be above the vert stab pivots by approximately 1/4" (It's actually 1/4" + the height of the bushing shoulder which is 3/64").
3. Mark the locations at rudder centerline where the pivot pcs will fit and in a similar manner is used on the vert stab, drill through the rudder L.E., through the rudder spar and into the high density foam blocks.

**NOTE:** The ideal location for the pivot pin centers is at the center of the front radius on the rudder. This radius dimension changes since the rudder is wider at the base than at the top thus the distance in from the L.E. will vary with each of the three pivot locations.

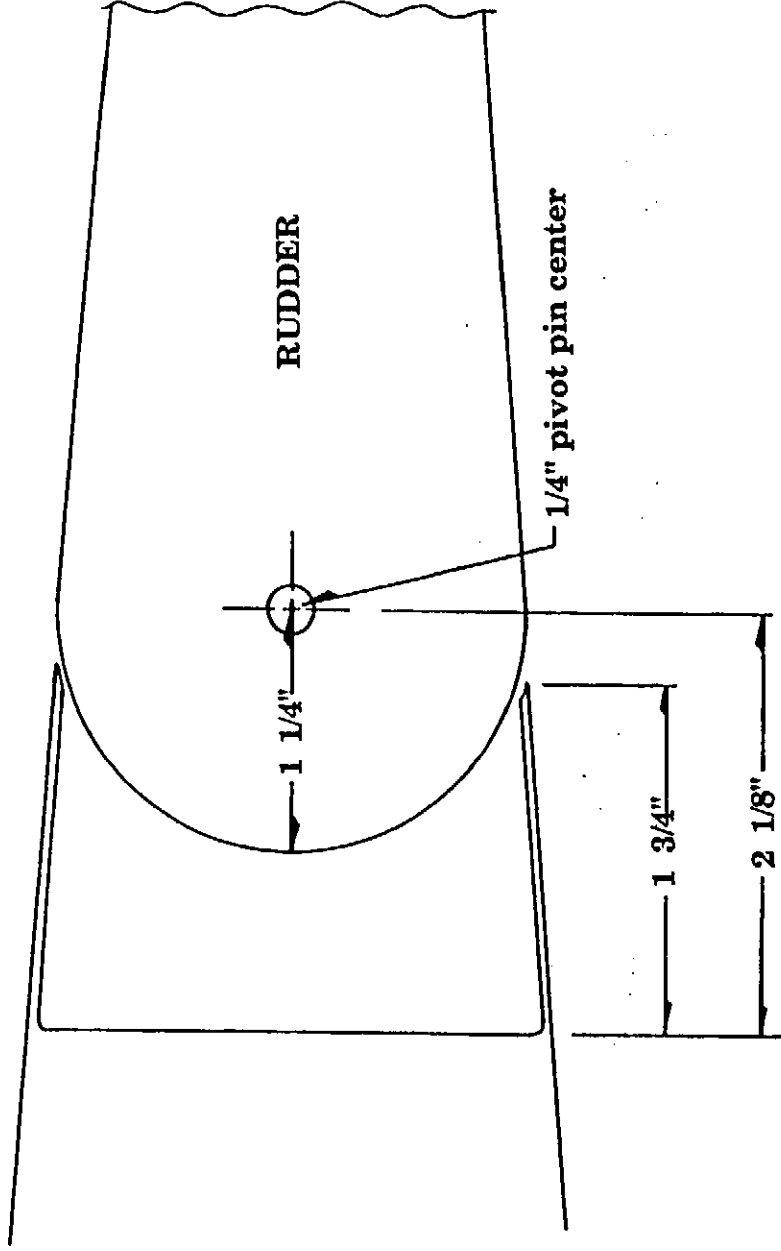
This is not extremely critical but if the locations of the hinge pin centers are off too much, the gap clearance between the vertical fin and rudder will change as the rudder rotates. However, pivot locations off as much as 1/8" - 3/16" do not seem to cause much loss of fit.

# Rudder pivot cross sections

## Cross section at lower pivot location

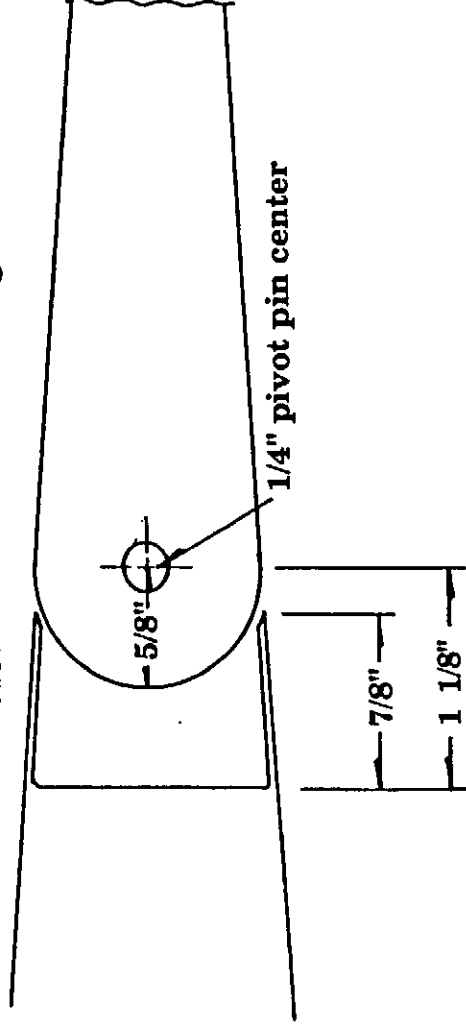
Viewed from above looking down

Figure 8-16



## Cross section at upper pivot location

Viewed from above looking down



4. With the slots cut into the rudder, slip the rudder into position on the vert stab to check clearances once more. It's best to make one dry run with the rudder pivot pcs just to be sure. To do this, slip the three rudder pivots onto their respective positions. Slip the rudder onto the three extending pivot pcs and see that the rudder can be "nested" fwd into it's proper position.

5. The lower pivot pc with the control horn ears will require substantial clearancing into the rudder to achieve a fit. It will also require a slot into the vert stab to allow insertion and travel range. This slot must be sized carefully since it will provide the control limit stops. The final sizing can be done later so for now make the slots only large enough to allow the control horn to be installed with just a little lateral rotation permitted. Use a Dremel type rotary tool and flat file to notch into the vert stab and a rotary tool to cut into the rudder as required.

6. **IMPORTANT:** It is also very important that the rudder L.E. have vertical slots long and wide enough to allow the rudder to be removed after its' pivot pcs are cured in place. You must make certain that sufficient room exists to allow removal (upward) of the rudder. This requires that the 1/4" pivot pins in the rudder pcs can be lifted out of the vert stab. And that requires clearance in the rudder L.E. to allow the vert stab pcs to slide down far enough to allow the 1/4" pins in the rudder to be removed.

Check this a couple of times in a "dry run" condition until you're sure the rudder will be able to be raised up far enough to free the 1/4" pins. See figure 8-17 and 8-18. (p 8-31 and 8-32)

7. These above slots in the rudder L.E. must also allow full, unrestricted movement of the rudder from left to right. That clearance however can be easily adjusted after cure and it is in fact best to wait until after cure to make this left/right travel adjustment.

8. The upper rudder pivot pc will generally require trimming down some what in order to fit into the rudder. The middle pivot, to a lesser degree, will require the same. Use a band saw or sabre saw to take only as much as required off in order to achieve the proper fit.

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9. **NOTE:** An easy method of determining how far the rudder should be pushed into the vertical fin channel is as follows:

Standing to the side of the vertical fin, measure the distance from pivot centers to the T.E. of the fin (measured along a perpendicular line to the vertical stab). Now nest the rudder into approximate position and run a pencil along the edge of the vert fin T.E. thus placing a mark on the rudder at that point. When you remove the rudder you can then easily calculate the location of the pivot pin centers from the reference line you just placed on the side of the rudder. If it is close to the ideal location within the rudder then you'll know that rotation of the rudder will maintain a reasonably consistent gap clearance. If you're off a lot, then some slight adjustment fwd or aft with the rudder may be possible to improve the fit.

10. With the above fit checks made, you're about ready to bond the rudder pivots into permanent position. This is performed very similar to that on the vert stab with one additional fit check.

11. Fill the slots in the rudder with epoxy/flox and prep the aluminum pcs as you did with the vert stab aluminum pivot pcs.

12. In order to verify that you're going to get a good squeeze out of flox, you'll have to push the pcs into their respective slots with the rudder off so that you can view the squeeze out. Note the squeeze out and remove the pc once again. If the squeeze out was adequate, simply replace the same amount of flox into the slot and you're ready for the final bond knowing that the squeeze out is going to be sufficient (since you won't be too able to view it during the mating cure period). If squeeze out was insufficient, add more flox and recheck by again inserting the aluminum pc into the slot and noting a good consistent squeeze out.

13. When the correct amount of flox is attained, slip the aluminum pcs onto the vert stab such that they all face straight back. Now push the rudder into position, secure in place and allow to cure. If you place mixing sticks into the gap between vert stab and rudder, the gap will be established and nicely sized to about .050" clearance. Plenty of duct tape wrapped around the rudder to vert fin will hold it during cure. Be sure there is clearance at the bottom also.

**NOTE:** You should also be careful to not get too much flox packed into the receiving slots since too much could result in excess epoxy/flox filling in around the pivot points and effectively locking the rudder into place. This would then require a lot of careful grinding in order to release the rudder and damage could thus result as well.

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Chapter 8

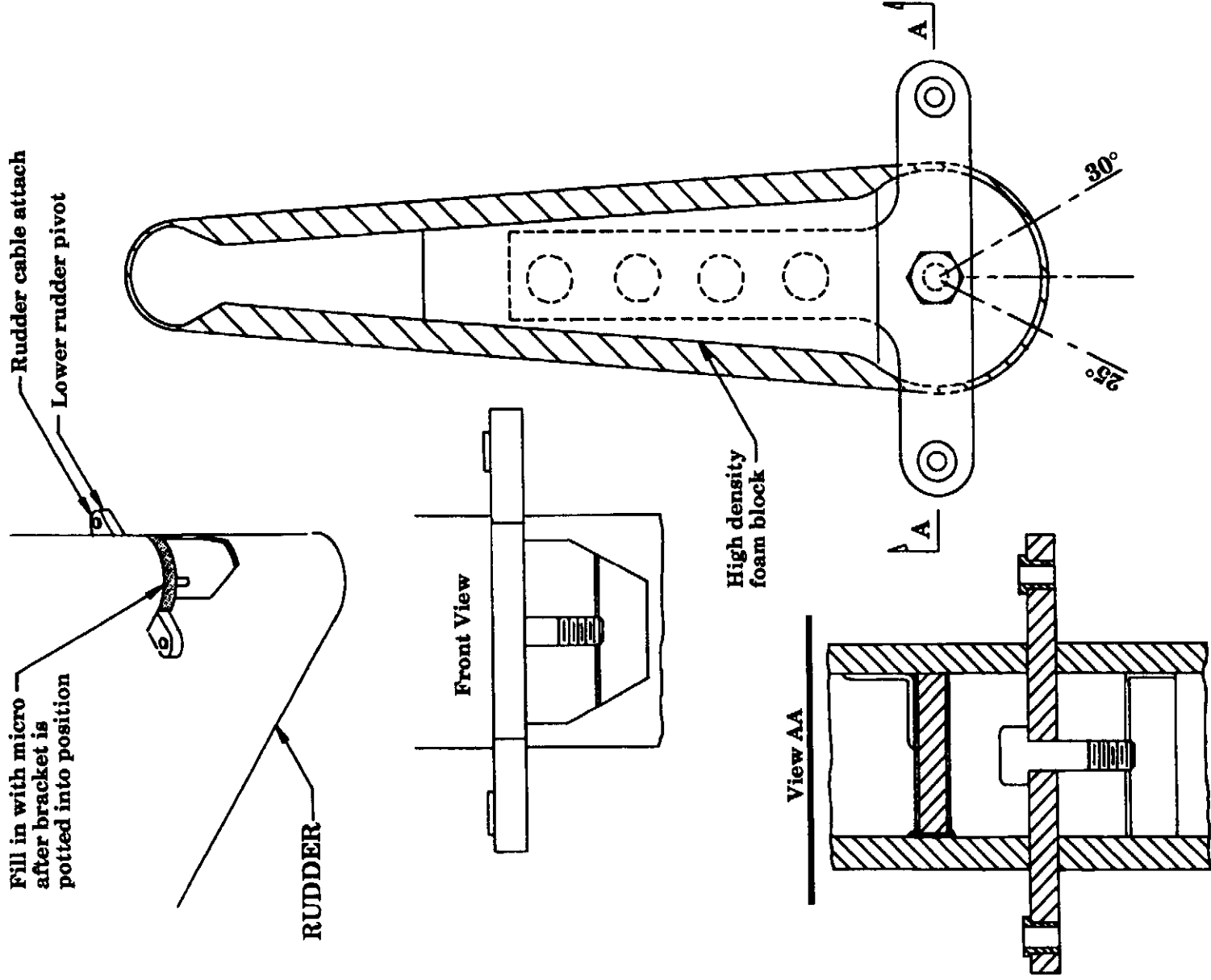
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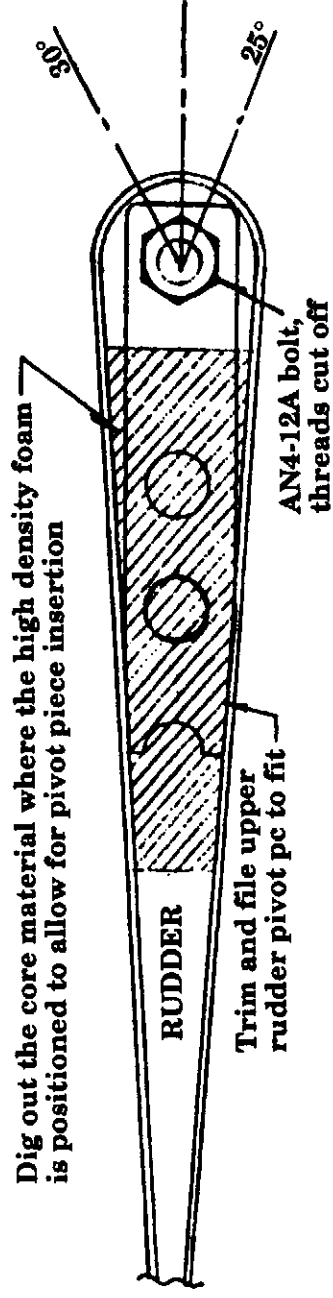
# Lower rudder pivot / control horn

Figure 8-17



## Upper rudder pivot

Figure 8-18



### Rudder travel: 30° RIGHT, 25° LEFT

14. With the rudder now cured, remove it from the vert fin by gently rotating and pulling upward (remember now, you did make those slots deep enough - right?)
15. Check for adequate squeeze out of flox and remove any large amounts of excess with a rotary tool and 1/8" ball end cutter.

**WARNING: BE CAREFUL NOT TO HIT THE ALUMINUM PCS WITH THE CUTTER. If it looks close, leave that glob of flox, don't risk hitting the aluminum with the cutter. STRESS CRACKS COULD RESULT OVER TIME, RESULTING IN FAILURE OF THE HINGE PIECE.**



### G. Rudder Travel Stops

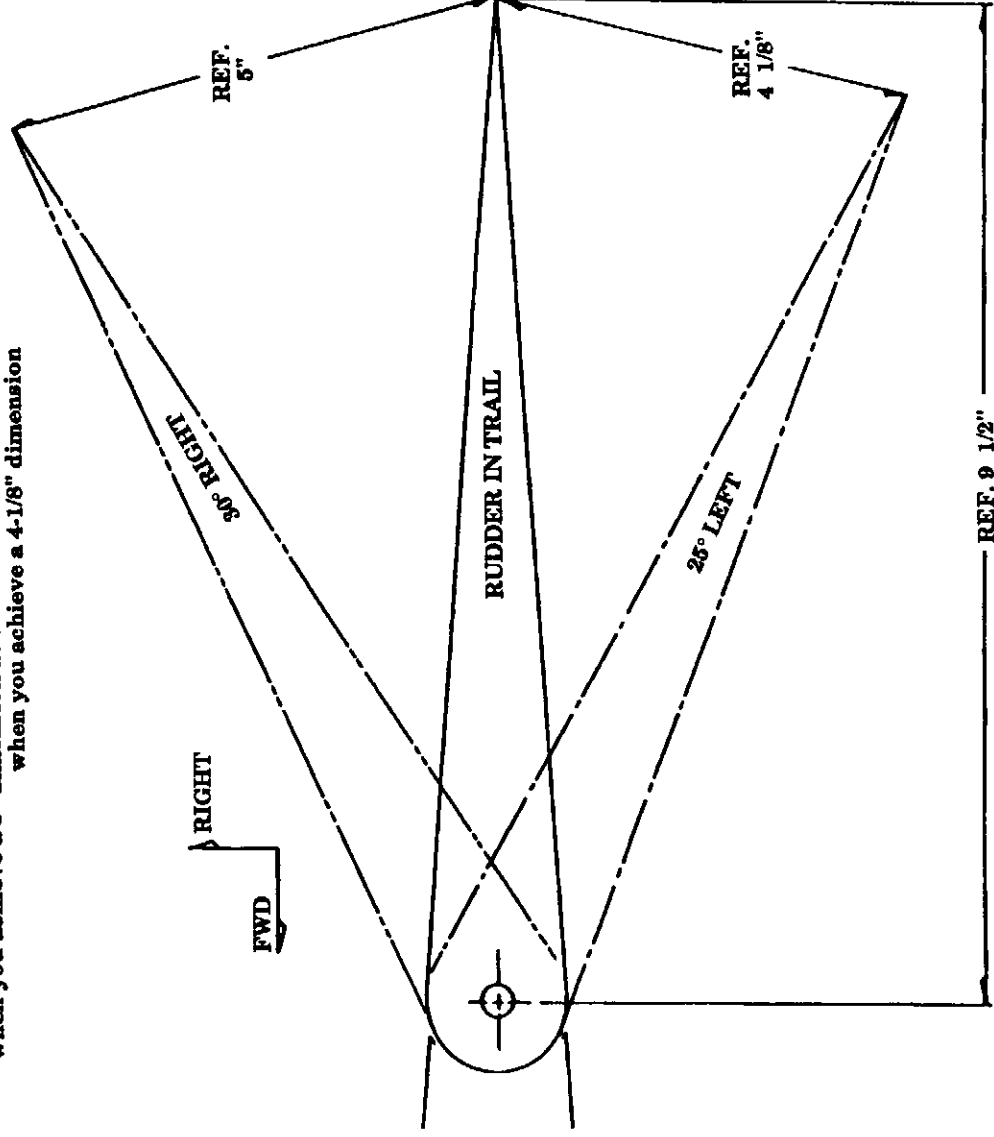
Positive rudder control limit stops must be established. We use the fslg to form these stops. See figure 8-19.

1. This will be a back and forth fit check. With the rudder on, you'll note that the fslg (at the lower pivot/control horn assembly) will require slotting to allow full rudder travel. This slot must be carefully cut to allow maximum travel and nothing more. This will then generate the travel limit stops for the rudder. Use a rotary tool and/or small flat file to neatly cut the slots in each side of the fslg. Fslg contact at the stop must be across the full face of the rudder control horn. A flox pad can be added if necessary.

### Establishing Rudder Travel

Figure 8-19  
30° Right Rudder, 25° Left Rudder

To check and establish the rudder travel limits, find a section on the rudder where the chord is 9-1.2" and use it simply as a reference point (the top of the rudder just below the counterbalance section is adequate). At this point, standing behind the rudder, you'll have 30°'s right rudder when you achieve a 5" dimension as shown below. 25°'s left rudder will be established when you achieve a 4-1/8" dimension



## H. Securing Rudder

The lower rudder pivot bolt (AN4) will also be used to permanently secure the rudder onto the vert fin.

1. Into the bottom of the rudder, cut a circular hole approximately 5/8" diameter. This hole must be located so as to align and be concentric with the pivot axis of the rudder.
2. Install the rudder onto the vert fin.
3. Form a piece of 3/8" x .085 x 5" aluminum tubing (thick wall 3/8" tubing), drill and tap a 1/4-28 threaded hole in one end. Use a #7 drill bit and 1/4-28 hand tap. Tap about 3/4" of threads into the tubing on one end.
4. Now insert the tubing and thread it onto the lower pivot bolt which has the threads remaining. It should be only snug, not torqued down.
5. With the tube threaded on, mark the line of the rudder bottom onto the tubing. Remove the tubing and cut it to the reference line thus making it flush when it is screwed back on.
6. Next make a slot across the tube end that is opposite to the threaded end. This slot should be sized to accept a standard screwdriver.
7. Next drill a hole through the same end, perpendicular to the slot, this will be for attaching safety wire. Use a 1/16" drill bit or about a #40. Also, drill a small hole into the rudder adjacent to the hole. Leave at least a 3/16" shoulder between it and the 5/8" access hole.
8. Now, simply snug up the threaded tube and safety wire it to the rudder thus locking the rudder in position. This safety wire check should be part of every preflight.

**NOTE: Be sure that you can easily make a preflight check of the safety wire to insure its integrity.**

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# Safety wiring rudder pivot bolt retention tube

Figure 8-20

