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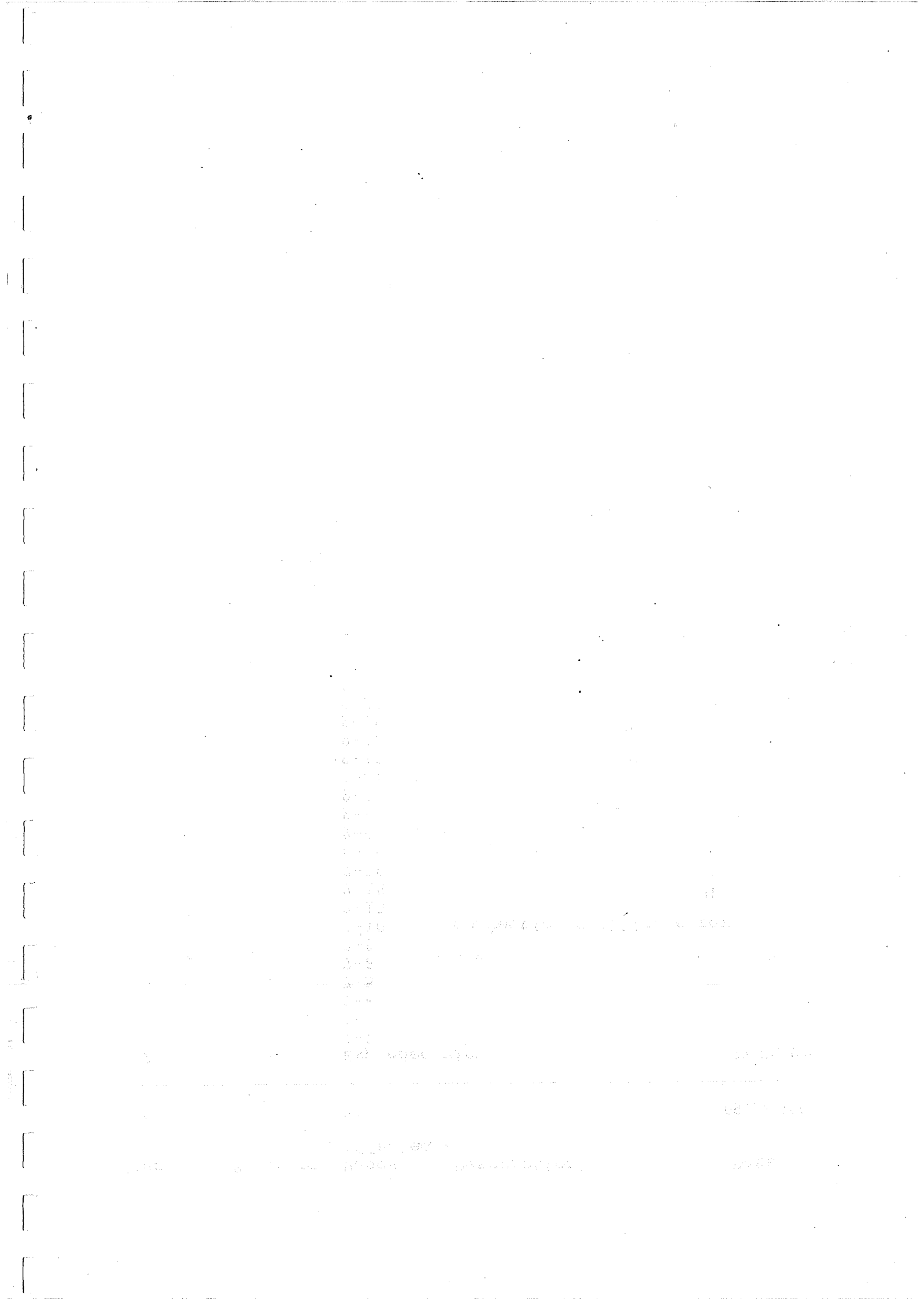
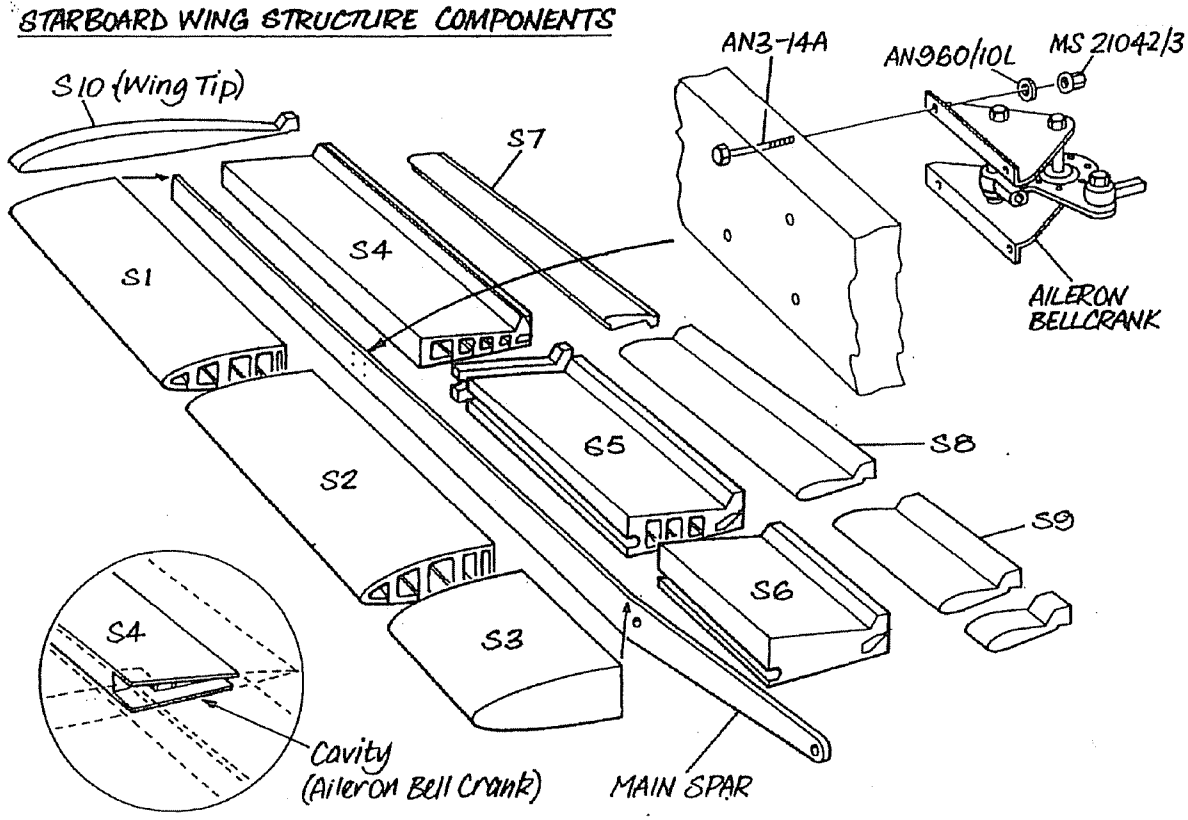
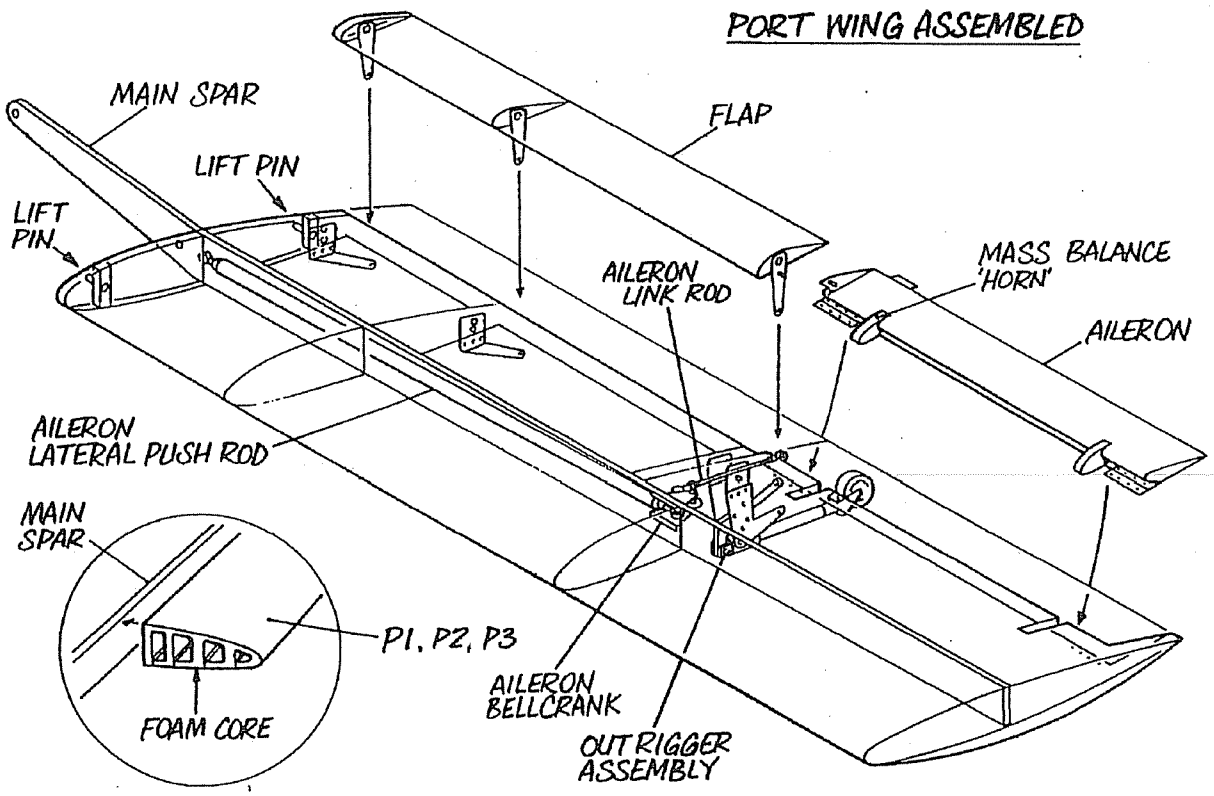
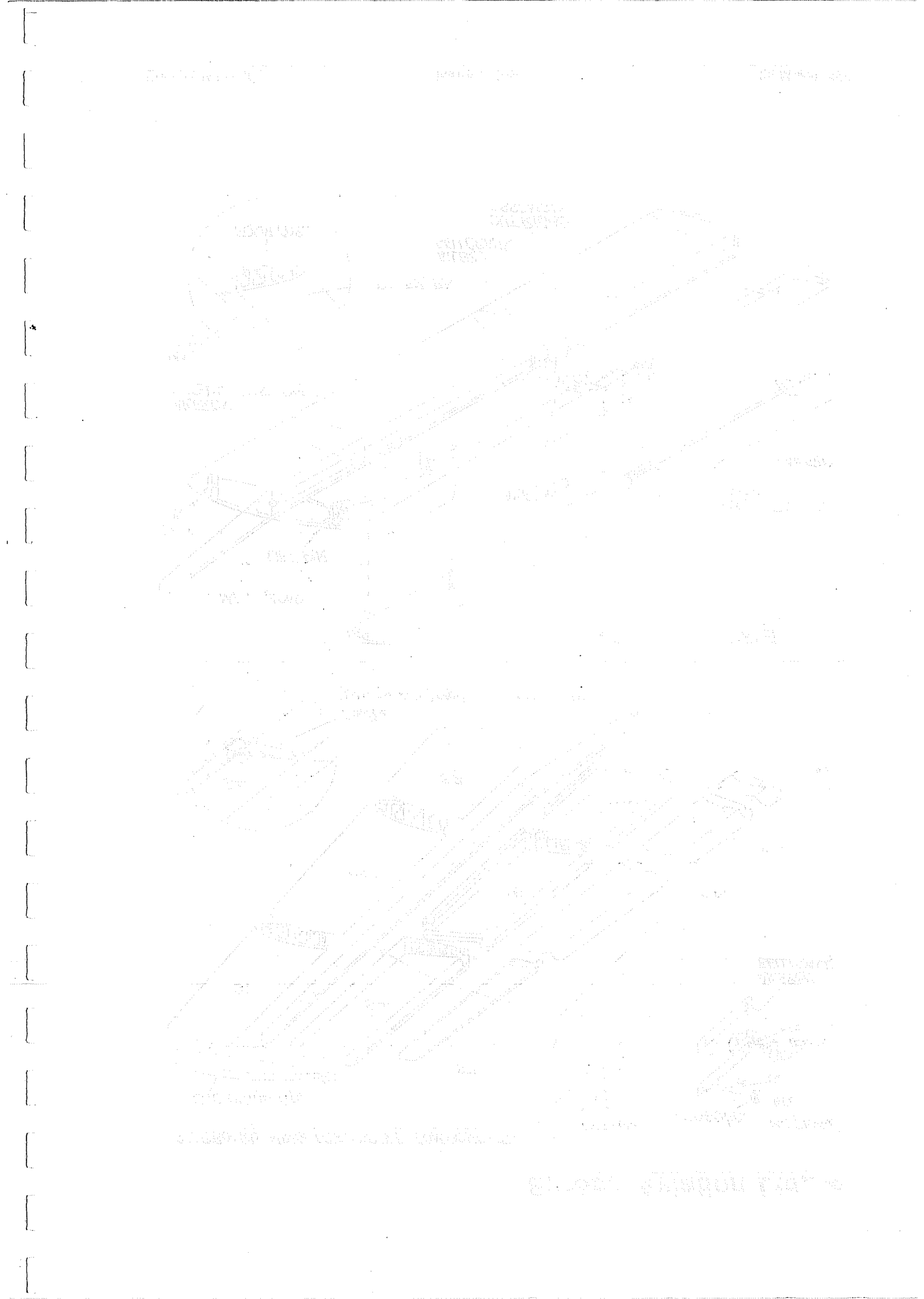


STARBOARD WING STRUCTURE COMPONENTS



PORT WING ASSEMBLED





WING KIT SPACERS AND BUSHES

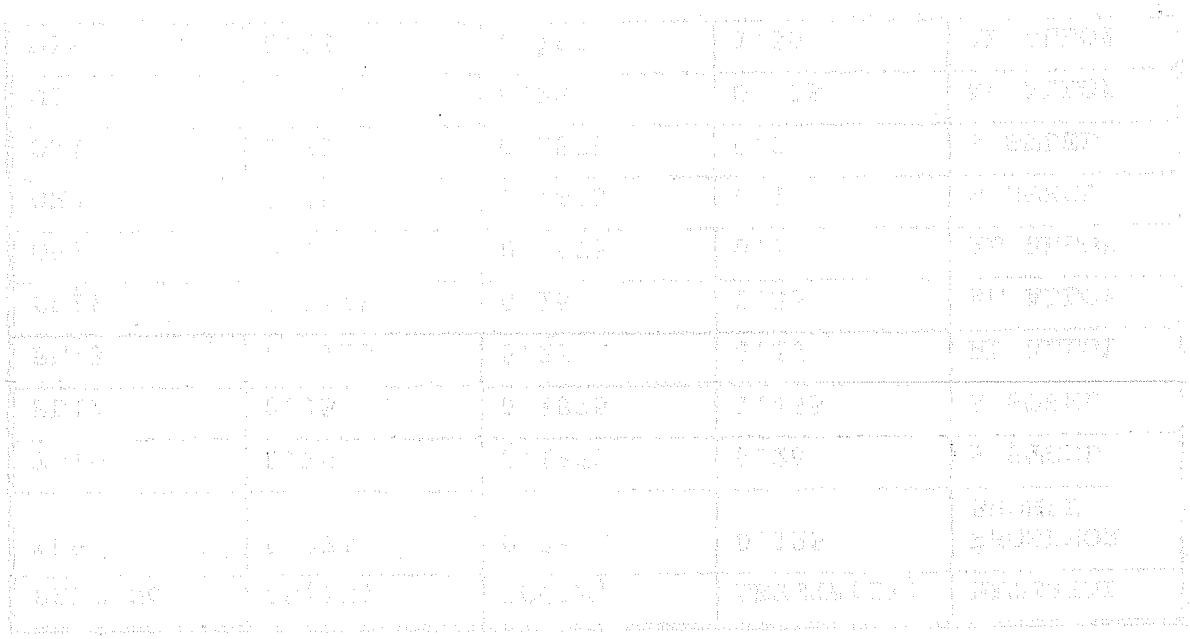
PART No	OD(IN)	ID(IN)	LENGTH(IN)	MATERIAL
FL9	0.375	0.25	0.125	PHOSPHOR BRONZE
FL10	0.25	0.1875	0.26	S STEEL
FL12	0.25	0.1875	1.435	S STEEL
FL13	0.3125	0.25	0.56	AL ALLOY
FL14	0.3125	0.25	0.25	AL ALLOY
OR8	0.25	0.1875	0.5	AL ALLOY
OR9	0.25	0.1875	0.2	S STEEL
OR10	0.25	0.1875	0.7	S STEEL
W14	0.3125	0.25	0.725	AL ALLOY
W15	0.25	0.1875	1.35	AL ALLOY

AN BOLTS (UNF THREAD)

Dash No	AN3(3/16") and AN4 (1/4")
	Length +1/32 -1/64
3	15/32
4	17/32
5	21/32
6	25/32
7	29/32
10	1-1/32
11	1-5/32
12	1-9/32
13	1-13/32
14	1-17/32
15	1-21/32
16	1-25/32
17	1-29/32
20	2-1/32
21	2-5/32

Example: AN3-10A is 1-1/32" long (measured from under the head), 3/16" diameter.

If no 'A' follows the part number then the threaded end of the bolt will have a hole for a split pin.

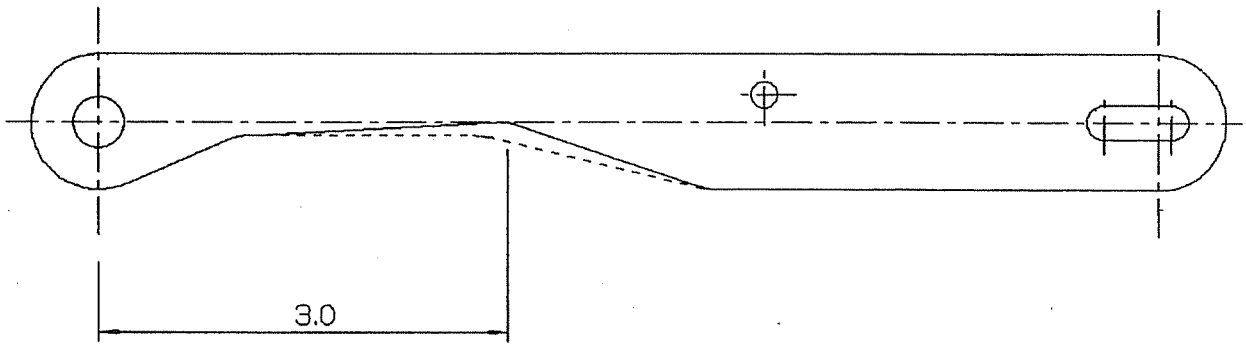


Mod to OR5 Outrigger Actuating Arm

The aluminium blocks OR7 used in the outrigger mechanism may interfere with the outrigger actuating arm OR5. Referring to page 9-16 will clarify where the interference will be.

To gain the required clearance, don't remove material from the block OR7 but file the profile of OR5 as shown in the figure below.

Ensure the corners are radiused to prevent making a "stress raiser"



7. WINGS

OVERVIEW

This chapter will take you through the building of the wings, including fitting inserts for the flap hinges and for pins which will be later screwed into the wing root. You will also fit the aileron bellcrank brackets to the spar.

Each wing is made in two basic stages. Attachment and layup of the leading edge to the spar then, subsequently the trailing edge. Please note that these instructions include cloth cutting dimensions and quantities for the building of *one wing* at a time.

The metal parts supplied have been punched or nibbled out and require their edges to be smoothed off with a file. Take care that no scratches are left on the metal's surface or edges as these could lead to cracking after a while in service.
If you have to do any marking on aluminium parts don't use a scriber or even a lead pencil. Carbon from pencils has been known to lead to cracks developing!

There is a protective coating of plastic on them which needs removal before installation.

Items that get painted when the aircraft is sprayed include W18, FL1, FL2 and FL3. Items that should *not* be painted are A2, FL7, FL9, FL10, FL12, OR6, OR7, W17, W22 and W23.

It is advisable to protect your metal parts from corrosion. Anodising is suitable as is painting the part with Zinc Chromate.

Remember, keeping your working area clean and tidy especially just before layup will give you the best chance of making a neat job of your aircraft components. Lets get stuck in.

PREPARATION

Step 1

Spar

First of all decide which spar will be for which wing, port or starboard, and label them including which way is up and which is the forward or rear face.

Note: The wing's dihedral is set by the kink in the spar.

Sand the spar's unmoulded edges to form a radiused corner similar to that of the moulded side. It is permissable to increase the size of the radii slightly on the edges where the wing structure will be to make it easier for the cloth to go around onto the shear web. Don't overdo it here, though. The aim is to enable the foam cores to sit flat on the unmoulded side of the spar.

Scuff sand the spar sides and edges with 60 grit paper to prepare it for bonding to within about 5cm (2") of the metal bush.

Make up the aileron bellcrank bracket assembly (part nos. W11, W12, W13, W14 and W15 as in figs. 1 & 2).

If you intend to paint these parts, do this before assembly.

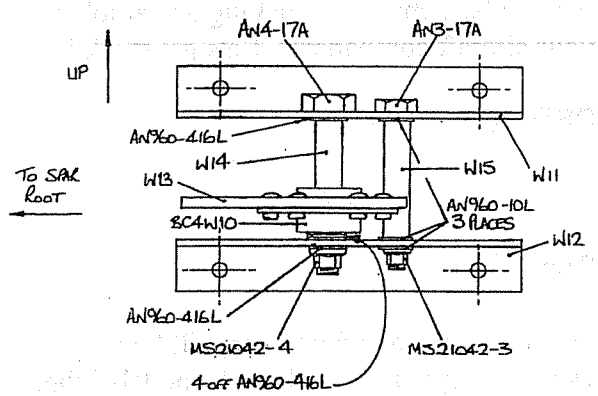


Fig 1. Bracket assembly looking at T.E. as installed (stbd)

Initially attach a BC4W10 bearing to a W13 bellcrank with six AN470AD4-7 rivets noting that these sub-assemblies are handed port and starboard.

Now attach the bracket assembly to the rear face of the spar with four AN3-14A bolts, smearing wet flox onto their shanks to bond them in place, MS21042-3 nuts and AN960-10L washers. See figure 2.

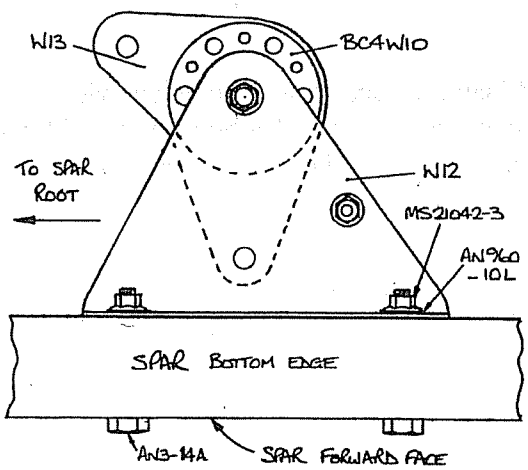


Fig 2. Bellcrank bearing assembled on spar (stbd).

This is a convenient time to attach the two rod-ends to the bellcrank. Fasten them according to figure 3.

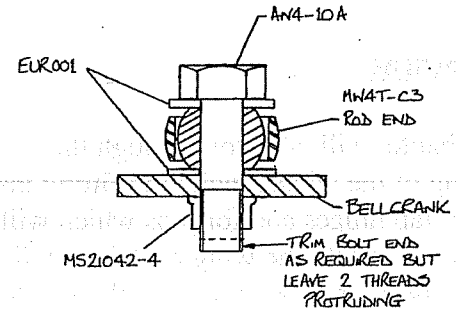


Fig 3. Attachment of rod-end to bellcrank.

Cover the bellcrank assembly with plastic to protect it from splashes of resin during the leading edge layup.

Step 2

A simple 'jig' needs to be made on which to place the spar for the leading edge layup. Four pieces of wood 7.5cm x 7.5cm x 60cm long (3" x 3" x 24") are all that are required for this 'jig'. (We said it was simple.)

Decide where you want to do your wing leading edge layup then clear the area on the floor of your workshop. You will need to have room to walk right around the spar when it's jigged onto the wood.

Figure 4 indicates where the wood supports want to be relative to the spar. Make sure that you miss the aileron bellcrank assembly of course.

As the kink at the end of the spar means that one of the supports will have to be slightly out of line with the others double check that its position coincides with the spar you want to build on. The two spars are identical so if you want to build the port wing then the spar's moulded side (shiny side) should be uppermost.

Initially bond the two end supports on the floor with bondo first and, when secure, pull a string across them to make sure when you fix down the two supports between them all tops are at the same height.

Put blobs of bondo on the tops of the wooden supports and squidge the spar down onto them making sure that it is level laterally and straight. Check for level in various places along the spar's length, using the moulded side, to ensure also there is no twist. See figure 4.

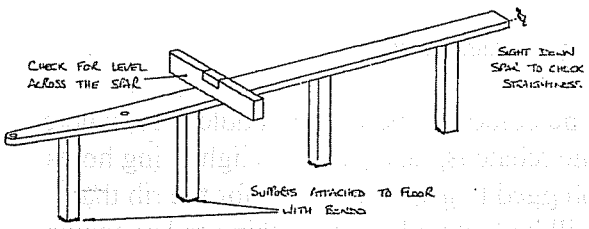


Fig.4 Supports for spar (port spar shown).

Step 3

Mark a line on the spar 95mm (3.75") away from the centre of the metal insert as in fig. 5.

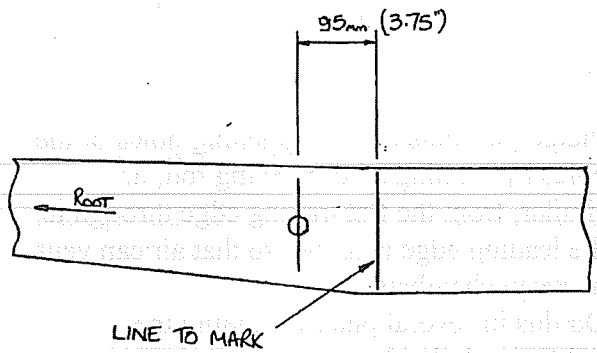


Fig.5 Marking spar for root core position.

Set the No.3 core onto the spar to act as a guide when marking this line which will be used as an aid in locating the core during bonding.

Step 4

Foam Cores

Each wing is made up with seven main foam cores, the flaps have two and the aileron is in one piece, see figure 6.

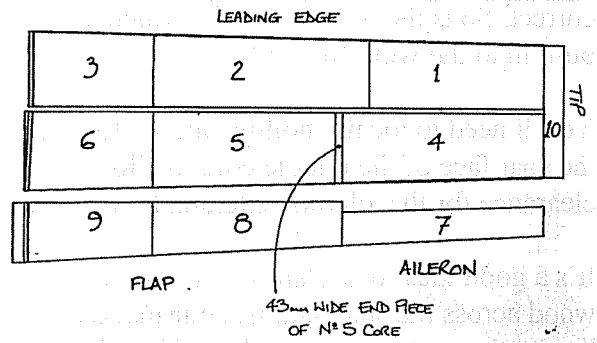


Fig 6. Foam core locations (starboard wing shown).

Each core has been identified with a number marked on one of the jig blocks, and a P or S indicating port or starboard.

Clear your bench and place each of the leading edge foam cores (1, 2 & 3), for the wing you want to build, in their jig blocks so their bottom surfaces (with all the slots) are uppermost.

Remove the lightening hole cores but save them. You'll need bits of them to bond back in place at various stages of the build.
To avoid confusion later it may be an idea to identify each of these cores in some way or another.

If the jig blocks are bowed, 5 minute epoxy bond them to a flat bench to make sure they

stay flat and if your cores refuse to sit snugly in them bond them in place using *small* blobs of 5 minute epoxy. Once you are happy that the cores are straight and true, scrape some 5 minute epoxy into the slots, much as you did with the fin and tailplanes, to hold the profile shape. Two or three blobs per slot should suffice.

Set all three foam leading edge cores onto the spar in their relevant positions and check that they all line up reasonably with one another. You may notice the cores overhang the spar's end by a couple of centemetres or so. This is correct. So is the spanwise twist which is built in to the wing for 1.5° of tip washout.

You'll need to locally hollow out the foam on the spar face of the middle core to allow clearance for the aileron bellcrank bolt heads.

It's a good idea to G-clamp a straight piece of wood across the spar against your marked line so the root core can be located against it. See figure 7. *Use a piece of wood under the clamp's screw to spread the load onto the spar underneath.*

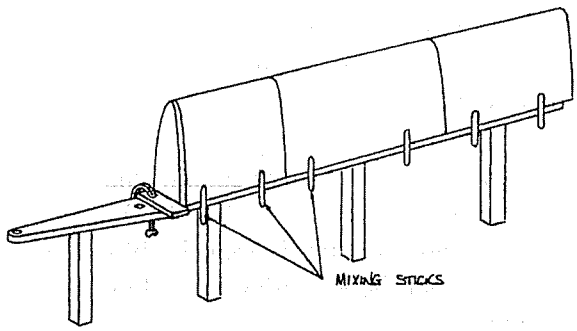


Fig 7. Leading edge cores in position on spar.

To stop the cores moving about when you come to bond them to the spar, glue some mixing sticks to the spar edges to act as guides between which the cores can sit. Don't position them too close to where the foam joints will be as they'll only get in the way.

A hot glue gun is ideal for this sort of thing.

On the *outboard ends* of the root and middle cores (Nos. 2 & 3) sand a small rebate, about 1.5mm(1/16") deep and 25mm (1") wide, as in figure 8 to allow for ribs of 2 plies of 'bid'.

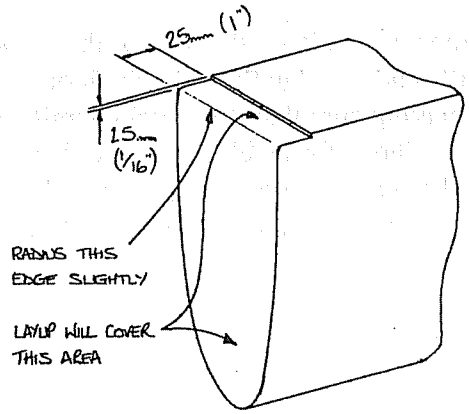


Fig 8. Extent of ribs.

The outboard end of the middle core, where the rebate is, now needs its lightening holes plugged to give something for the rib that will be laid up here something to lay against. Find the relevant core plugs and cut 2-3cm (1") from the end of each then 5 minute epoxy them in place ensuring they are flush. You'll notice that the starboard cores have an extra lightening hole. This is because the starboard spar is further aft than the port spar to allow them to overlap.

Attach the 25mm thick end piece temporarily to the No.3 root core.
The short lines marked on this end piece will be used to accurately position the core to the spar so don't obscure them.

Pierce the walls of the lightening holes of the cores by running a hot welding rod, or similar, from the flat trailing edge through to the leading edge chamber so that air can vent between chambers.
Do this in several places avoiding the lightening hole plugs.

Step 5

Leading edge ribs layups.

Cut 4 pieces of 'bid' at +/- 45° 55cm x 15cm (22" x 6").

Dry micro fill any gaps and dings then micro slurry the core end adjacent to the rebate and the rebate area itself. Now paint epoxy over the slurried area and layup 2 plies of 'bid' at +/- 45°, one at a time, onto the core side and into the rebate squeegeeing and scissor trimming as close to the foam edges as you can.
It's better for the glasscloth to be short of the rebate step than for it to be proud of the core's flat spar surface.

Sand the ribs down to fair in with the wing's profile and dig out a small triangle of foam either side of each rib, to make a flox joint between the rib and the skin, as in figure 9.

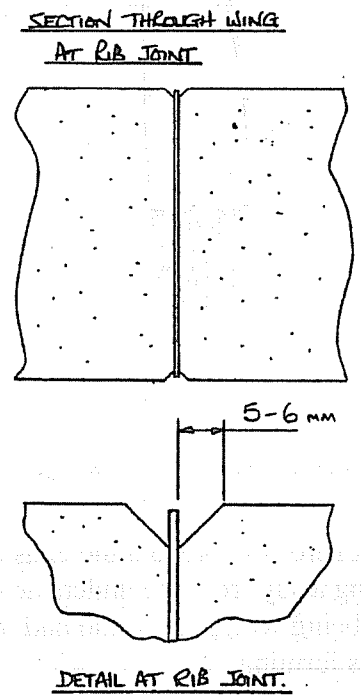


Fig 9. Channels for flox joints.

Bonding L.E. cores to the spar.

Firstly, pierce the ribs with a small drill through each of the lightening hole plugs, making sure you go right through the foam plug as well, to allow air to vent through.

Scuff sand all over the rib layup with 60 grit paper in preparation for bonding.

Start this bonding process by firstly applying dry micro to the ***root*** foam core's spar edge (flat surface) keeping the micro away from the sides to avoid it oozing out. Adding blobs of 5minute epoxy at the corners can be useful to hold the core whilst the micro hardens

Position the core, complete with the 25mm piece, onto the spar next to your guide, pushing it down, giving the micro time to squidge down, and checking that the marked lines are set vertical by placing a level against them. See figure 10.

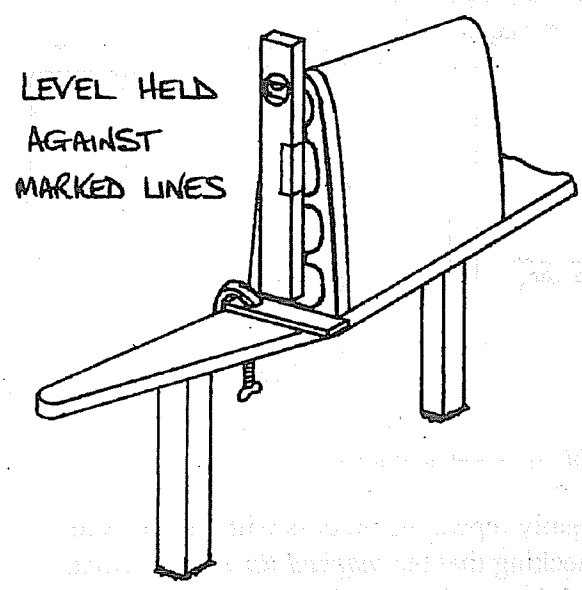


Fig 10. Bonding root core to spar.

Next apply some flox to the glassfibre in the rebate of the No.2 core and also the aileron bellcrank bracket bolt heads to pot them securely in place.
Trowel dry micro onto the lightening hole walls, but not the edges, of both Nos.2 and 3 cores, and to the foam *only* of the spar face of the No.2 core as before. See figure 11.

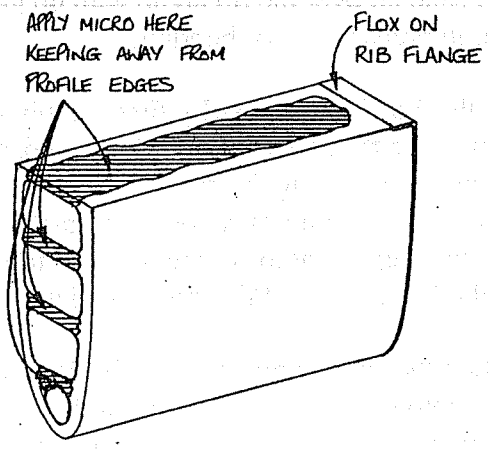


Fig 11. Applying dry micro for bonding.

Place the core onto the spar and squidge it down ensuring it lines up with the root piece. See figure 12.

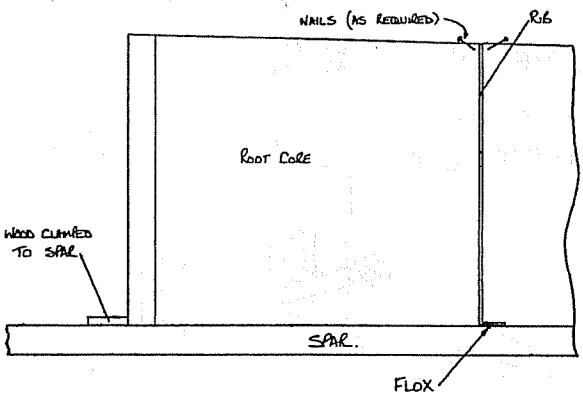


Fig 12. Leading edge core on spar.

Finally repeat the process with the tip core, checking that the ***marked lines are vertical*** and that all the cores line up.
If necessary push sharp nails through the leading edge joints to ensure they stay lined up with each other and allow to cure.

Cut a piece of scrap foam to be the same section as the spar and long enough to extend the spar to the end of the leading edge tip core and dry micro bond it in place.

Step 6

Leading edge skin layup.

Preparation.

Carefully sand the foam flashing off the leading edge and ensure no foam chippings are left around to contaminate the layup.

Prepare some lengths of foam from your scrap and supports long enough to jam the foam up against the spar's underside as shown in figure 13. Using plastic angle section instead of foam is ideal.

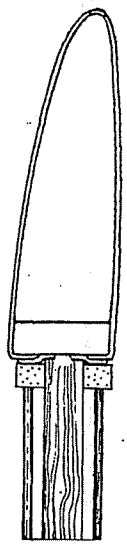


Fig 13. Supports used to hold plies against spar.

The object here is to prevent the ends of the cloth falling away from the underside of the spar after being wrapped around and to stop air bubbles forming.

Cut pieces of cloth to the following dimensions:

1 off 'biaxial' - 3.5m long x full width. (skin)
1 off 'uni' - 1m long. (skin root)
2 off 'bid' - 30cm x 120cm at +/- 45°.(root reinforcement).
Cut also several pieces of peel ply.

Apply peel ply to the 25mm root core, stopping it short of the spar, using pins or double sided tape to hold it place.

Mark the foam surface with a couple of lines running at +/- 45° to the spar to aid orientation of the cloth during layup.

Step 7

Skin Layup

This layup is probably the longest single layup to do on your Europa. It's recommended that two people carry out the work as the epoxy's working life is limited.

Dry micro fill any dings in the foam and the gap between the cores and spar being ***very careful*** not to get any on the spar itself. Now micro slurry the whole surface but avoid getting micro onto your ribs, spar or peel ply.

Mix up some flox and fill the grooves at the ribs.

Paint the foam and spar edge, and underside 3cm in from either edge, with pure epoxy.

Lay the biaxial cloth along the leading edge ensuring that the longitudinal axis of the cloth (marked by stich lines) lies parallel to the leading edge of the wing. See figure 14.

Trim the cloth to about 2-3cm (3/4"-1 1/4") below the spar. You'll have to trim it shorter locally where the supports are. Trim the rest of the edges to within 1cm (1/2") of the foam.

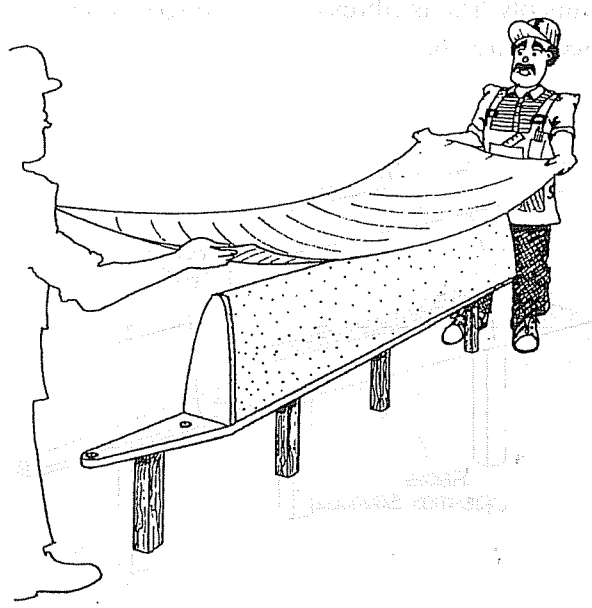


Fig 14. Laying on biaxial cloth on leading edge.

Wrap the cloth around onto the spar as in figure 15 then squeegee and wet out the whole surface. Take care not to cause indentations at the flox joints.

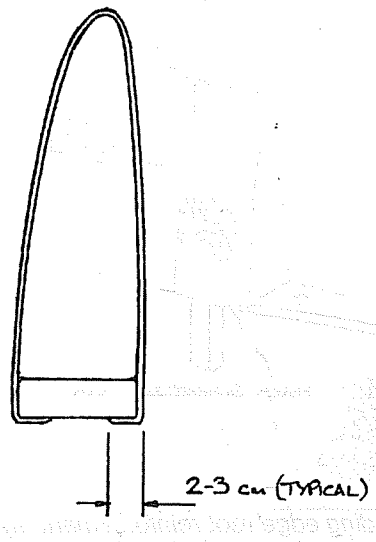


Fig15. Typical section through leading edge.

Now lay the 1m length of 'uni' to cover the top surface of the root from the spar, around the leading edge and trim to 15cm (6") back on the under surface.
This ply has its fibres orientated spanwise.
See figure 16.

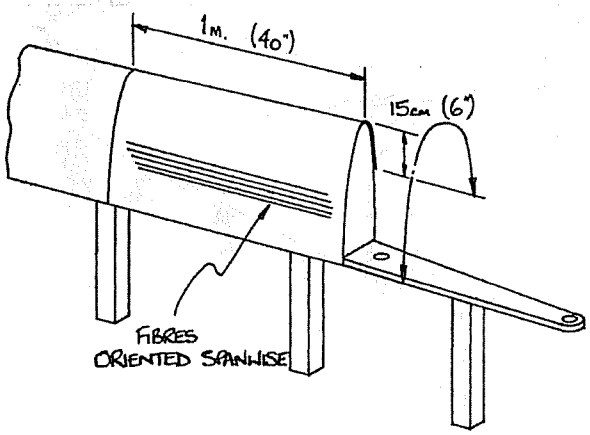


Fig.16. Wing leading edge top surface reinforcement.

The final plies to be applied are the two pieces of 'bid' cloth which cover from the root to 30cm (12") outboard at +/- 45°.
See fig 17.

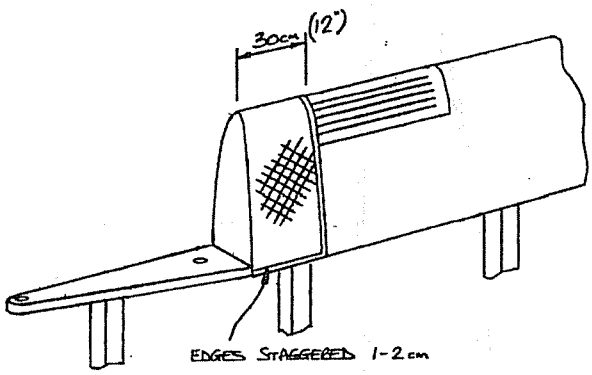


Fig17. Leading edge root reinforcement layers.

Note: *These last three plies should not be wrapped under the spar and it may be neater if you stagger the outboard and spar edges of the 'bid' plies by about 1-2 cm (1/2" - 1").*

Peel ply all the fibre ends, also over the spar edge and towards the leading edge to a width of about 5cm (2") altogether.

Finally fix in place the lengths of scrap foam under the spar with their supports, or use the plastic angle section if available, to prevent the cloth from drooping away from the spar.

Knife trim the edges when the layup has sufficiently cured and sand them back to the foam after full cure.

You have now completed the biggest layup on your Europa and you'll be happy to know that all subsequent skin layups on the wing take half as long as the one you've just done.

Whilst you have the four supports in place it may save time to get the second wing to this stage before continuing with the trailing edge. Just re-site the support at the spar's root end first.
If you decide to do one wing at a time just go straight to step 8 and you'll be referred back to here at the appropriate stage

Before removing the spar and leading edge from the supports cut two pieces of 12mm plywood or similar to approximately 60cm x 20cm (24" x 8").

Place one piece on the spar against the root leading edge section and mark the profile onto the wood. Do similarly at the tip, lining the board up with the spar front face. Cut out the profiles then slot the boards over the leading edge about 30cm (12") in from each end using bondo to secure them, making sure

that the tops are level with the spar.
See Fig. 18.

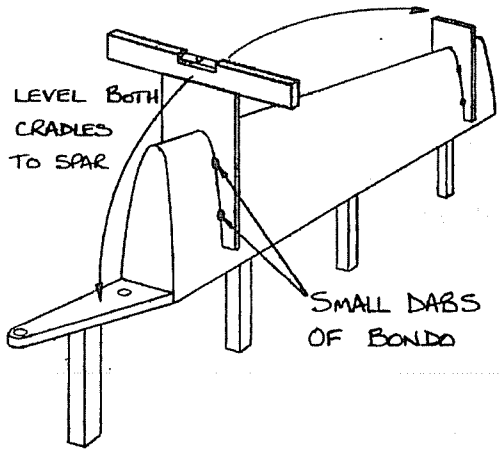


Fig 18. Setting on leading edge cradles.

Crack the wing off the four supports with a sharp tap with your hand. Don't use any thing hard otherwise you could damage the structure internally. Invert the wing and stand it on the cradles then, making sure the spar is level laterally, fix the cradles to the floor with bondo.

Step 8

Trailing edge cores preparation.

When you first have a look at the trailing edge cores you'll find a triangular sectioned strip of foam which has been pre-cut from both number 4 tip core trailing edge support blocks. ***Don't throw these away***, you'll need them later on so keep them in a safe place.

There are a few small layups which need to be done to the trailing edge foam cores before they are attached to the spar and you can do these all together or separately as you wish.

The flap hinge plates, W18, will be bonded in place with ribs which you will layup. Also a cavity needs to be made and laid up in which the aileron bellcrank will be housed. There is also a quick layup to be done in the root core push-rod channel.

Before we go further though, making sure the cores are sitting snugly in their jig blocks and are not bowed, apply 5 minute epoxy to the slots as usual and then referring to figure 19 plug up the middle and tip cores' lightening holes with the relevant pieces of hole core cut down to about 2-3cm (1") in length.
Use 5 minute epoxy to hold them in place.

If you feel you have to dispose of the lightening hole cores be sure to save the rearmost one from the trailing edge tip core as parts of this are to be used later to plug holes in the aileron mass balance channels.

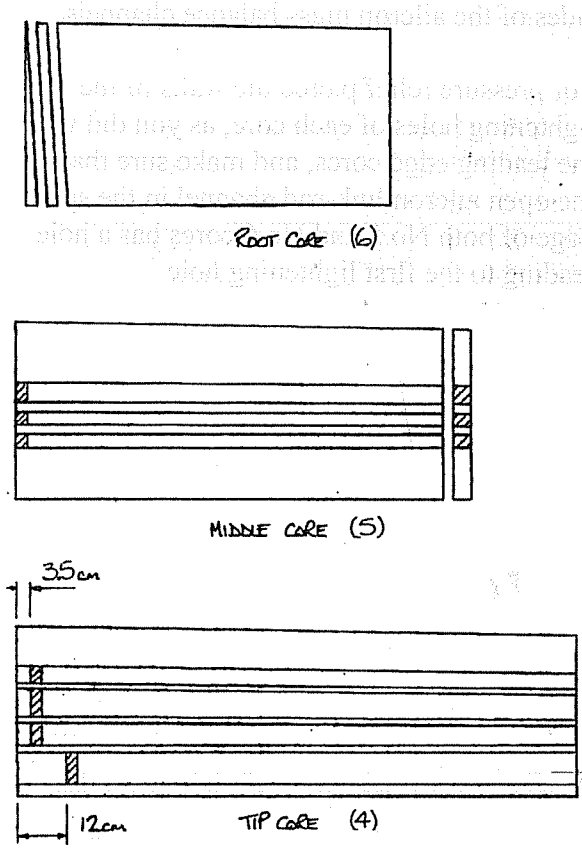


Fig19. Sections through trailing edge cores.

The tip core need not have its tip plugged as a separate tip block will be added later and its root should have the core plugs set 3.5cm (1 3/8") in, except the core plug nearest the spar face which should be set 12cm (4 3/4") in towards the tip.
These plugs then form walls of the aileron bellcrank housing and push-rod channel.

The 43mm (1.7") wide core can have its lightening hole cores bonded in place complete. The remainder of the plugs should be flush to the ends of the cores. (All this shouldn't be as confusing as it seems if you have the parts in front of you, honest.)

The remaining lightening hole plugs may be discarded except for the tip core's rearmost one. Parts of this will be used to blank off the sides of the aileron mass balance channels.

For pressure relief pierce the walls of the lightening holes of each core, as you did with the leading edge cores, and make sure that the open aileron link-rod channel in the spar edge of both No.5 and No.6 cores has a hole leading to the first lightening hole.

Step 9

Aileron bellcrank housing and link-rod channel.

Take the No.4 tip core and cut out the walls of the lightening holes to the depth of the plugs you bonded in place and to the width of these plugs to make a channel (see fig.20).

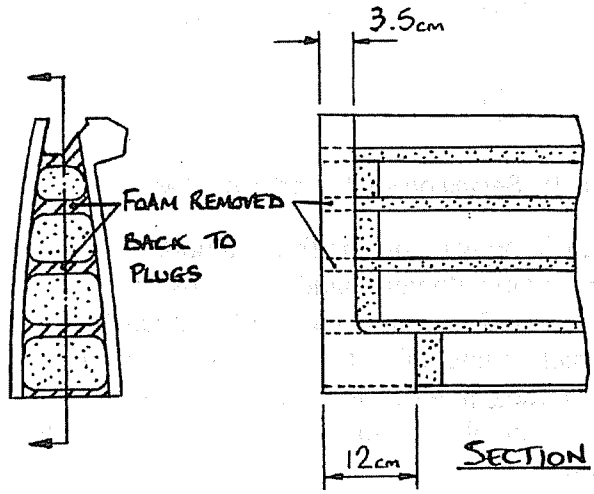


Fig 20. Root end of No.4 T.E. tip core.

Round off the square corner to allow for a 'bid' cloth layup. See figure 21.

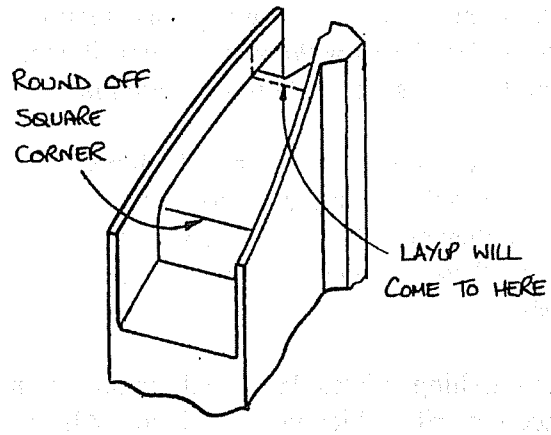


Fig. 21. Aileron bellcrank housing / link-rod channel.

Lateral push-rod channel.

Now take the No.6 root core and sit it on its trailing edge to give access to the aileron's lateral push-rod channel. See figure 22.

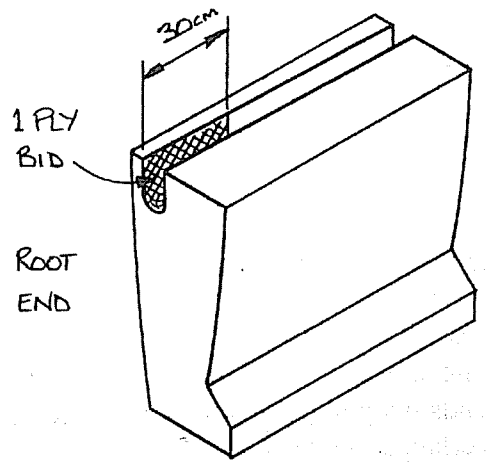


Fig 22. T.E. No.6 root core.

By the way, the reason that the port wing's channel is deeper than the starboard's is due to the port wing spar being further forward and the aileron lateral push-rods emerging from the fuselage at the same fuselage station as each other.

Step 10

Cut pieces of 'bid' at +/- 45° to the following dimensions:

1 off 60cm x 20cm (24" x 8") - (Aileron bellcrank housing/link-rod channel).
Either 1 off 20cm x 30cm (8" x 12") - (Port wing aileron lateral push-rod channel).
Or 1 off 15cm x 30cm (6" x 12") - (Starboard wing aileron lateral push-rod channel).

Micro slurry the aileron bellcrank housing/ link-rod channel in the No.4 tip core and also the first 30cm (12") from the inboard end of the aileron's lateral push-rod channel in the No.6 root core then lay in one ply of cloth to cover these areas. Trim the cloth in the No.4 core to be about 1cm (1/2") short of the aileron close-out channel (ref figure 21). Use offcuts to cover the sides of the bellcrank housing which will have been left exposed, overlapping any joins and wetting the cloth out thoroughly.

When the layups have cured, trim the excess cloth back to the foam in all areas and double check your vent holes have been left uncovered in the root core.
Drill a small vent hole through the layup of the bellcrank housing making sure you enter one of the lightening holes.

Step 11

Jigging for the trailing edge layup

If you decided to make each complete wing one at a time now's the time to jig the spar up to bond on the trailing edge blocks.
Refer back to the end of step 7 on page 7-8 for instructions on jigging up then come back here to carry on.

Step 12

Preparing for rib layups.

As you did for the leading edge, (ref fig.5), mark a centre line on the spar at the kink but this time mark a line at 90° to it 70mm (2.75") from the centre of the hole of the metal bush. This dimension takes into account the wedge shaped piece of foam at the root. Clamp a strip of wood lined up on the line's inboard side as a guide for the foam core.

Four of the W18 plates will be installed in each wing and are bonded in at the same time as the ribs you're about to lay up.

The trailing edge cores which the ribs are attached to are the root (no.6), middle (no.5) and the 43mm (1.7") outboard piece.
This narrow piece will have a flap hinge plate on each side of it which must be set so they are 45mm (1.75") apart so you'll need a block of wood or similar of this thickness which can be placed between the plates during cure.

The root and middle cores will have the flap plates attached to their inboard ends.
At the root end of these two cores sand a rebate on the spar face, similar to the ones you did on the leading edge cores (ref. fig.9), 1.5mm (1/16") deep and 25mm (1") wide.

Mark a line all around the end of the 43mm core 3mm (1/8") back from the spar face and sand this much off. This is to allow for the plies from both ribs, which will be laid on it, to have their ends overlap on the spar face. Don't forget to round off the edges where the rib layups will go.

Mask the plates as in figure 23 to act as a reference line and save cleaning epoxy off them up after layup.

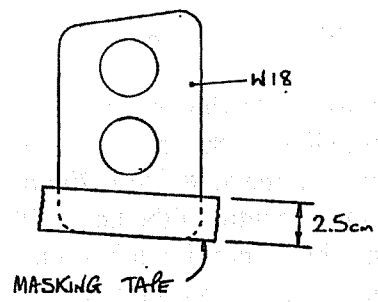


Fig 23. W18 Flap plate.

To give a better key to the W18 flap plates when bonded into the wings scuff sand the unmasked portion with 60 grit paper.

Cut also a 5-6mm (1/4") triangular channel in the foam around the root core's aileron push-rod hole layup for a flox corner.

Step 13

Rib layups.

Cut pieces of 'bid' at +\- 45° as follows:

4 off 25cm x 18cm (10" x 7") - 1 ply/rib.

12 off 45cm x 18cm (18" x 7") - 3 plies/rib.

The ribs to be laid up on core nos. 5 & 6 are identical so just one will be described here.

The ribs which will be laid up on the 43mm piece are similar to the others but, instead of their ends wrapping round into a rebate, they are overlapped sequentially onto the spar face.

Each rib is comprised of four plies of 'bid' cloth with the W18 plate set between the middle two plies with flox. The third ply to be applied is not full length.

On the root core only fill the trough around the aileron's lateral push-rod hole with flox. Micro fill any gaps between the cores and lightening hole plugs where the layup will go then micro slurry the surface.
Layup the first two full length plies, wetting out and trimming each, as indicated in figure 24, wrapping the ends into the rebate on the spar face.

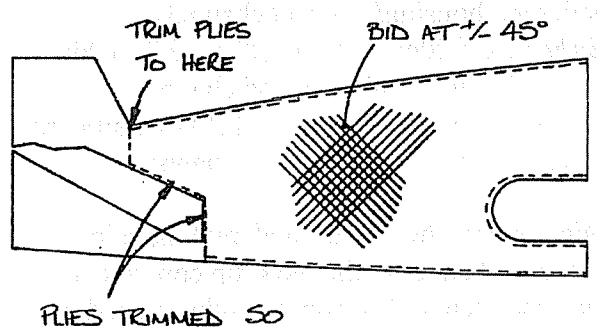


Fig 24. First 2 plies of rib layup.

Next, coat the unmasked portion of the W18 plate with wet flox and position it on the layup as in figure 25.

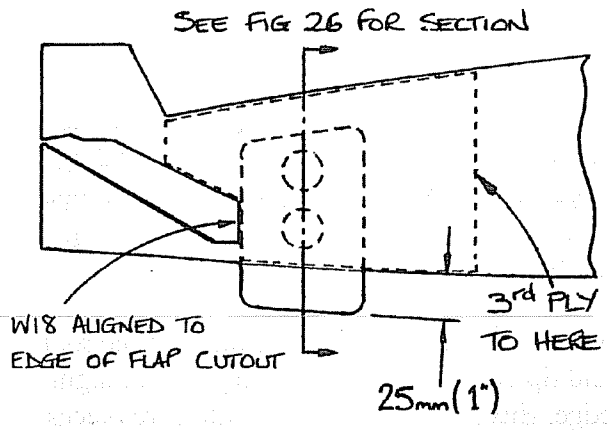


Fig 25. W18 Flap plate position.

Keep an eye on W18's position as you go along with the layup. It's bound to move slightly until you can leave it alone.

Hint: *To ensure the W18 plates stay put, stab some strategically placed cocktail sticks through the large holes into the foam.*

Apply a skim of flox to the the other surface of W18 and make fillets with flox around the holes and edges of the plates for the next plies of cloth to run down. See figure 26.

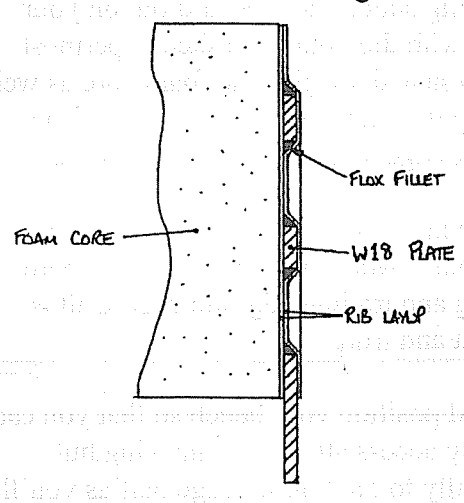


Fig 26. Section through T.E. rib layup.(See fig 25).

Lay on next the local ply of 'bid' (3rd ply), wet it out and trim it then repeat the process with the final (4th ply) full ply.

Trim the layup to the foam edges then peel ply the entire rib. Once again check the plates have not moved then allow to cure.

For the 43mm piece the procedure for laying up is the same as described above except that plies should be laid up on alternating sides in turn with their ends interlocking on the spar face.

When the W18 plates have been positioned make sure a 45mm wide hard spacer block will fit snugly between them. Add plies locally under the plates if necessary. The outrigger's retraction mechanism fits here so it's important to end up with the correct fit.

Having completed laying up both sides apply peel ply to both ribs and place the assembly on its side, on a flat surface covered with a sheet of plastic to stop it sticking. Put the spacer between the W18 plates and place a small weight on top, supporting the rest of the core so the bottom W18 plate is flat on the bench. Ensure nothing will move then leave to cure.

After cure carefully sand the rib's edges back to the foam.

Step 14

Bonding T.E. cores to the spar.

Stand the cores on their spar faces on a flat surface and remove foam locally at the areas adjacent to where the W18 flap plates are so they are able to fit nicely together. Do this even with the 25mm (1") root piece and temporarily attach it in place with 5 minute epoxy.

The 25mm root piece should then be 5 minute epoxied back in place, to be used in making a flange, and the wedge shaped piece then 5 minute epoxied to the the 25mm piece. Always use only small blobs of adhesive as these pieces will be removed later on.
The wedge shaped piece is used only for aligning the root core, when bonding it to the spar, as it has the vertical level lines marked on it.

Try the cores on the spar in their relative positions to see if any adjustments are required before bonding them in place.
When the trailing edges are bonded to the spar the level lines marked on the root and tip must be in line with those of the leading edge so a straight edge with a cut out in it for the spar will need to be made.
Use a piece of faced board, the type commonly used for making shelves with, and make the straight edge according to fig. 27.

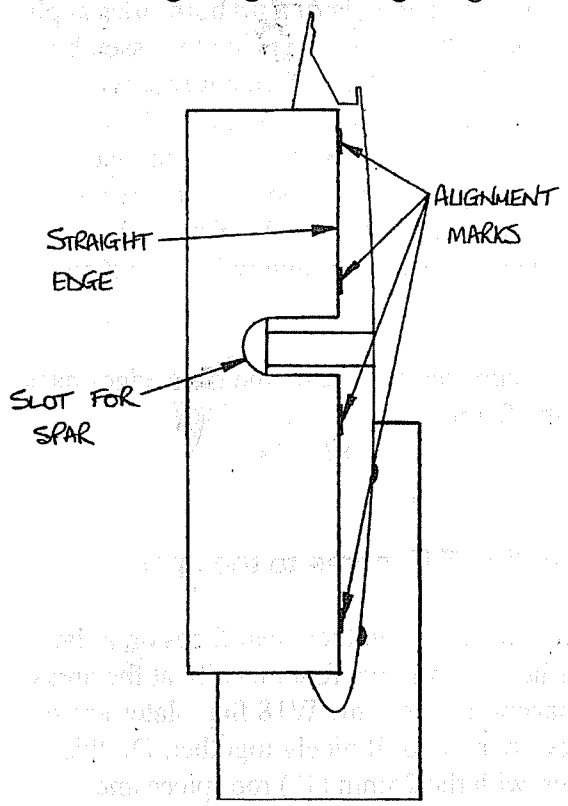


Fig.27 Straight edge for lining cores up with.

Step 15

When you are happy that the cores will go together properly scuff sand the spar, where bonding will take place, with 60 grit paper.

Apply flox to the glassfibre in the spar face rebate then trowell some dry micro onto the cores' foam spar face as you did the leading edge, starting with the root core, and squidge them down in position one at a time having applied micro also to the ribs.

Make sure that the reference lines on the root and tip cores are lined up using your straight edge. Ensure also that the middle core pieces line up with the two end ones and take special care that the trailing edge is a straight line by sighting along it.
Ensure that the cores won't move then leave to cure.

Step 16

Carefully remove the wing from the floor, but keep the cradles as you'll need them again later. You won't have to set the wing to any level reference from now on so there's no need for them to be mounted back in exactly the same place.

The wing should now be laid flat on your bench with the bottom surface uppermost and, to save damaging the foam core as well as keep it steady, lay it in a couple of the leading edge and trailing edge foam jig blocks.
Your wing should be stiff enough by this stage but it won't hurt to sight down both leading and trailing edges to ensure all is straight and true.

Try and position your bench so that you can get easy access all around the wing but especially to the trailing edge half as you'll be laying up on it.

Step 17

Trailing edge bottom skin layup.

Lightly sand the leading edge skin over the spar and forward from the rear face of the spar about 6cm (2 1/2") with 60 grit paper in preparation for bonding.

Cut a triangular channel in the foam cores about 5-6mm (1/4") deep either side of each rib for flox joints. *Remember that the 25mm root piece is only there to make a flange on so don't flox this to the rib. As the flange need only be 25mm wide, remove the wedge shaped piece of foam from the root and discard it.*

Cut pieces of cloth to the following dimensions:
1 off 'biaxial' 3.4m (134 ") long x 63cm (25") wide (this is half the full width - the other half will be used later for the trailing edge top skin layup).
2 off 'bid' at +/- 45° 50cm x 30cm (20" x 12") and also several pieces of peel ply.

Step 18

Use dry micro to block the lightening hole slots then micro slurry the foam surface but keep micro away from the rib channels as much as possible. Fill the rib channels with flox until they are flush with the foam surface, then paint the surface with neat epoxy.

Lay the ply of biaxial cloth with the selvage edge overlapping the leading edge layup 5cm (2") from the rear face of the spar, carefully cutting slots to allow the W18 plates to go through. See figure 28.

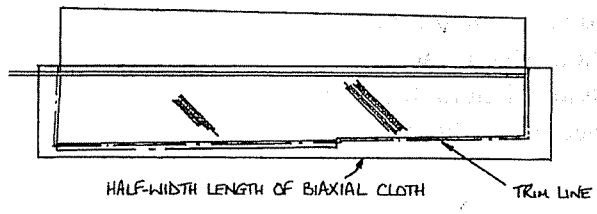


Fig 28. Trailing edge layup.

Trim the edges of the cloth to within 1cm (1/2") of the foam.

Squeegee and wet out the cloth taking care not to create indentations in the flox at the joint areas.

Now apply the two plies of 'bid' cloth at the root for the root rib reinforcement. Arrange them so the second ply is trimmed 1-2cm (1/2"-3/4") shorter at the spar and outboard edges than the first to allow for a smooth transition of the edges.

Peel ply all cloth ends and joints then leave to cure, knife trimming when appropriate. After full cure carefully sand the skin back to the foam edges.

Step 19

Trailing edge close-out.

Re-jig the wing now, leading edge down, in its cradles. It doesn't have to be levelled just upright to ease access to the trailing edge.

The next small layups to be done form a close-out all along the trailing edge which will house the flap and aileron leading edges.

Flap close-out

Draw a line on the bottom skin 5cm (2") towards the trailing edge from the rear most slot, which can be seen through the cured skin, all along the flap portion of the wing. See figure 29.

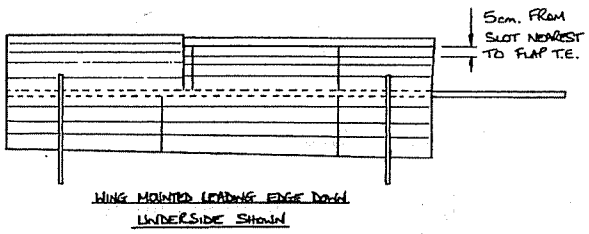


Fig 29. Trim line for flap area of wing T.E.

Using a hack-saw blade cut through the skin and remove this strip of glass fibre and foam from the root up to where the aileron starts.

The final trim line will make this flange even shorter when you come to hang the flaps so you needn't spend time making sure that its straight and accurate at this stage. You are trimming it now just to give yourself access to do the layup.

Remove the foam back to the skin as in figure 30 and prepare this skin for a layup.

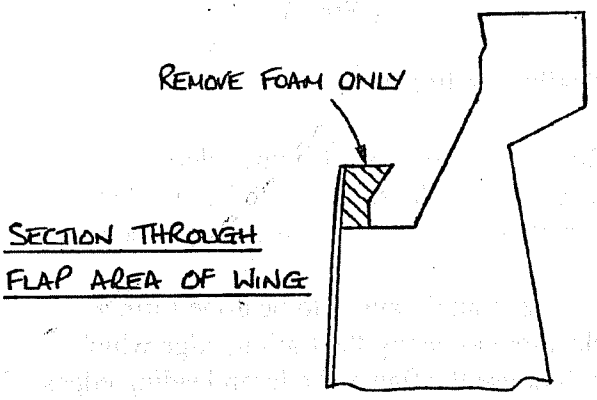


Fig 30.

Step 20

Aileron Close-out

It's a little awkward to do but remove the foam all along the aileron close-out as per figure 31.

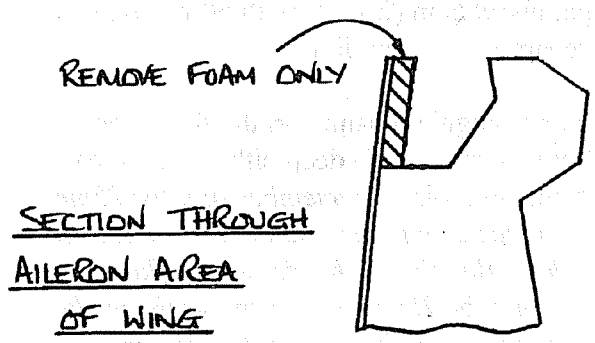


Fig 31.

Once done, get that long triangular sectional strip of foam you've been guarding jealously and try it for size in the position shown in figure 32 Make sure it sits in place properly as it will be microed in place just before the layup to stiffen the skin as the aileron is hinged from it.

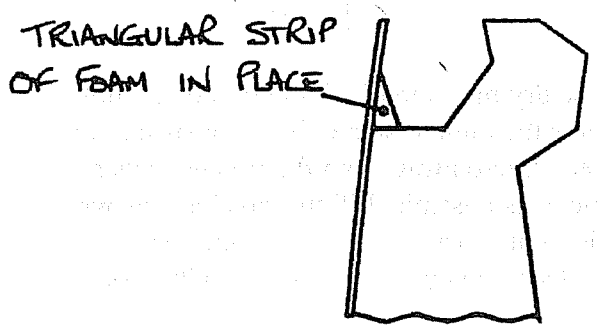


Fig 32. Section through aileron close-out.

Lastly, cut 5-6mm (1/4") deep triangular troughs each side of the ribs to allow for flox joints.

Step 21

Close-out Layups

The close-outs of both the flap and the aileron will have two plies of 'bid' at +/-45° each, cloth dimensions being:

3 off 25cm (10") x full length possible. (Don't cut ends square) Flap close-out.

2 off 25cm (10") x full length possible. (Don't cut ends square) Aileron close-out.

4 off 20cm x 8cm (8" x 3") Aileron hinge reinforcements.

Start off by filling the rib troughs with flox then attach the triangular strip with dry micro in the position shown in figure 31.
Micro slurry all the foam ready for layup making sure that any stray micro is wiped off the glassfibre flange before layup.

Now comes the tricky bit. As you will have discovered, when making the rudder, 'bid' cloth can change shape quite a bit especially when in long strips. If you gently roll the length of cloth up, initially unroll it over the close-out channel in the trailing edge then feed it into place from one end, adjusting the width to suit progressively you will stand a better chance of not losing your patience with this layup.
The plies used in the aileron's close-out will have to be stretched a little to cover it without a join so the cloth has been deliberately sized extra wide to accommodate this.

Stipple the epoxy through with a brush to wet out the cloth. Take care not to use too much epoxy though, as it's difficult to get in to remove the excess in the small space that there is. The joint in the cloth necessary in the flap close-out must be an overlap of about 2-3cm (1").
Try to make overlaps in different places on subsequent plies to avoid building up the thickness.

When you get to the area where the close-outs run into the aileron link-rod's channel run the plies down into it to over-lap onto the glassfibre of the channel ensuring no foam is left exposed.

Scissor trim the first ply to limit the excess cloth to no more than 1cm (1/2") to give you better access for laying in subsequent plies.
Place the hinge reinforcement plies in the aileron's close-out channel, as shown in figure 33, wet them out then scissor trim them.
The dimensions are taken from the inboard end of the aileron close-out flange.

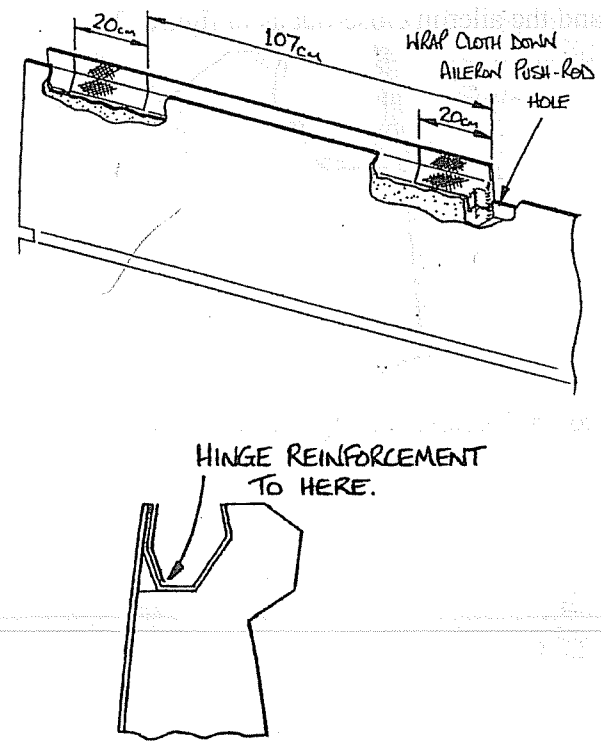


Fig.33. Hinge reinforcement positions.

Now lay in the final ply, scissor trim then leave to cure, knife trimming when appropriate.

After full cure trim the fibres' ends back to the foam or to where the bottom skin has been trimmed to.

The layup in the flap close-out covers the area shown in figure 34.....

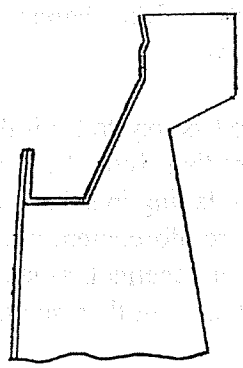


Fig 34. Section through flap close-out.

and the aileron close-out as in figure 35.

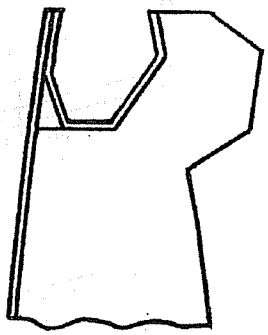


Fig 35. Section through aileron close-out.

Step 22

Trailing edge top skin layup

For the next skin layup the wing wants to be laid on the bench with the top surface uppermost. This layup is essentially a repeat of the under-surface's layup. The only difference is that *three* plies of 'bid' cloth are to be positioned at the root for the walkway as this is the area that will be stepped on the most.

Preparation.

Hack-saw off and sand down the trailing edge support block to blend the foam surface in with the trailing edge close-out skin as in figures 36 and 37.

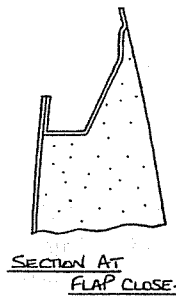


Fig 36.

Fig 37.

Cut pieces of cloth to the following dimensions:
1 off 'biaxial' x 3.4m (134") long x 63cm (25") wide (left over from the bottom skin layup).
3 off 'bid' 55cm x 30cm (22" x 12").

Cut triangular channels each side of the ribs for flox as before then micro slurry the foam surface and flox fill the channels before painting the entire surface with epoxy.
Do remember to take care not to cause indentations at the flox joints.

Apply the biaxial cloth with the selvage edge overlapping the spar by 5cm (2"). Trim the edges to within 1cm (1/2") of the edges. Wet out and squeegee the cloth.

Add the *three* plies of 'bid' cloth at the root as reinforcement for the walkway, staggering their edges by about 1cm (1/2") for a smooth transition.

When all plies are in place, properly wetted out and squeegeed apply peel ply to the 'bid' cloth ends at the spar and outboard edges. Allow to cure, knife trimming when appropriate.

After full cure sand the glass-fibre edges back to the foam and trailing edge line.

Step 23

Root close-out rib.

Sandwiched between plies in the root close-out layups will be three small plates. Part numbers W22 in the leading edge and W23 in the trailing edge.

These will later be drilled and tapped to take the 12mm stainless steel pins which transfer the lift, drag and torsional loads of the wing into the fuselage.

Scuff sand these plates and keep them clean and handy for incorporation into the following layups.

Cut pieces of 'bid' cloth at +/- 45° to the following dimensions:

6 off 65cm x 25cm (26" x 10").
(3 each full length on L.E. and T.E. ribs).

10 off 35cm x 25cm (14" x 10").
(plies to be sandwiched between the W22 and W23 plates).

and several strips of peel ply.

Remove the 25mm thick root foam pieces from both the leading and trailing edges and tear away any peel ply from the inside of the resulting flanges.

Remove the peel ply or, if not applied, scuff sand the trailing edge root rib in readiness for laying up.

Dry micro fill the gaps around the plugs and make a *small* fillet in all the corners, just enough to prevent air bubbles forming under the layup.

Now micro slurry the foam surface of the leading edge in preparation for laying up, taking care to wipe off any that may have strayed onto the glass-fibre flange, then paint the whole area with epoxy.

Lay two plies of 'bid' cloth to cover the whole of the leading edge and trailing edge close-outs' ribs wrapping the cloth around onto the glassfibre flanges and also onto the spar.
Stagger these plies on the spar so that the first ply runs about 5cm (2") beyond the metal bush and the subsequent two plies are about 25mm (1") shorter each time.

Coat one of the W22 (L.E.) or W23 (T.E.) plates with flox and position as in fig. 38.

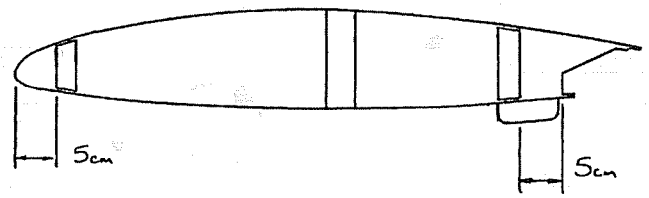


Fig 38. Positons of W22 and W23 inserts.

Referring to figures 39 and 40 make a fillet around the edges of the plates with flox for the cloth to run down then apply two shorter plies wetting each out in turn.

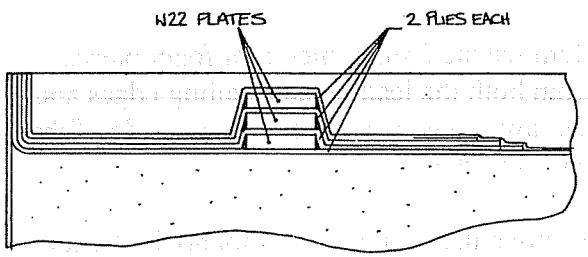


Fig 39. Diagrammatic section through leading edge root rib

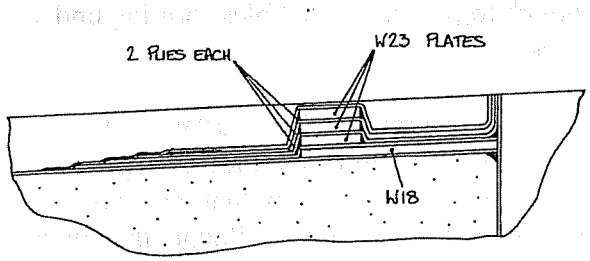


Fig 40. Diagrammatic section through trailing edge root.

In the leading edge, these shorter, local plies need to go right onto the leading edge flange and back to approximately 10cm (4") aft of the plates. Stagger the ends of each ply to be about 1-2cm (1/2") shorter than the previous one to give a gentle transition for the final ply to run up.

At the trailing edge get the cloth into the vee between the top skin and close-out flange to about 10cm (4") forward of the plate, again staggering the ply ends.

Attach another plate directly on top of the first one, having smeared flox all over it then make a fillet around its edges before laying on the next two local plies.

Apply the third and final plate on top of the previous one covering it with *one* local ply then one full length ply to finish up with. Make sure that the plates don't move until the layup has cured. If there has been some displacement of the plates during layup carefully reposition them through the laminate before it starts to harden.

Leave to cure, knife trimming and sanding the ends back to the previously cured flanges when appropriate. Also cut open the aileron push-rod hole.

Your wing structure is essentially finished, the tip being the only bit missing but before this is attached you will want the ailerons fitted to ease alignment so these are what to make next.

8. AILERONS

Overview.

The ailerons are made in much the same way as the rudder. The only difference being that the ends are not rounded but have close-out ribs instead. The aileron cores are supplied with the, by now, familiar end pieces with which to make the flanges for the close-outs. Bonded in the root end of each aileron is a plate and bolt with which to attach the actuating push-rod.
Two hinges hold the aileron to the wing, pivoting on its lower surface.
As usual, the construction of only one part is described so a simple doubling up of cloth pieces will enable both ailerons to be made together.

Step 1

Preparation.

The first thing to do is to temporarily attach the end pieces of foam core in their relevant positions with small dabs of 5 minute epoxy.

The upper surface, which has the small trailing edge joggle in it will be laid up first.

Saw away about 5cm (2") from the leading edge of the lower jig block (the one to accept the trailing edge support block) then lay it onto a flat bench, glued down if necessary to make it completely flat.
Gently remove the foam nib from the leading edge then lay the aileron core into the jig block and use ***small*** blobs of 5 minute epoxy, if necessary, to keep it flat too.

Being so long and slender the aileron cores will easily bow and if skin layups are allowed to cure on them in this condition they will not fit your wing properly so take care to ensure, at all stages of their construction, that they don't get out of shape.

Cut lengths of 'uni' to the following dimensions for each aileron:

2 off 150cm (60") long
and several strips of peel ply.

Mark lines on the core at +/- 30° to the leading edge to aid cloth orientation during laying up.

Attach a long strip of peel ply to the trailing edge joggle as in figure 1 using double sided tape.

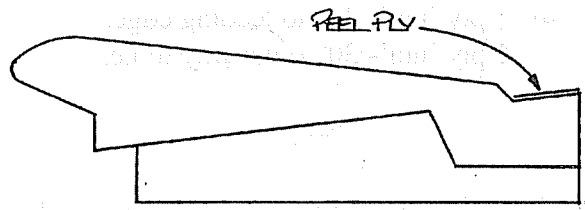


Fig 1. Aileron in trimmed back lower jig block.

Step 2

First Layup.

Micro slurry the foam, keeping it off the peel ply, taking it around the leading edge and back about 2-3cm (1").

Coat the foam now with epoxy then lay the first ply on at 30° to the leading edge, wrapping around the leading edge to within about 1cm (1/2") of the corner. See fig 2.

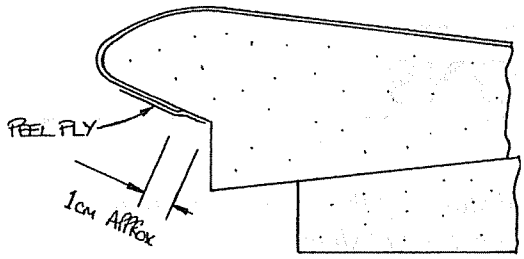


Fig 2 Extent of layup at leading edge..

Squeegee this layer thoroughly before scissor trimming the overhanging edges to within 1cm of the foam then lightly apply a coat of epoxy and the next ply at 30° to the leading edge the other way.

Scissor trim this layer after squeegeeing then apply peel ply to the ends of the fibres at the leading edge and allow to cure.
Knife trim the edges at the appropriate time, sanding them back after full cure.

- **1st layup summary.**

- 1 ply 'uni'- 30° to leading edge.
  1 ply 'uni'- 30° *other way* to l.e.

Step 3

Remove the aileron from its jig block, flip it over and set it flat in the other jig block. Cut away the trailing edge support block and sand the remainder down to blend the main foam surface with the glassfibre trailing edge, tearing off the peel ply when it becomes exposed. See figure 3.

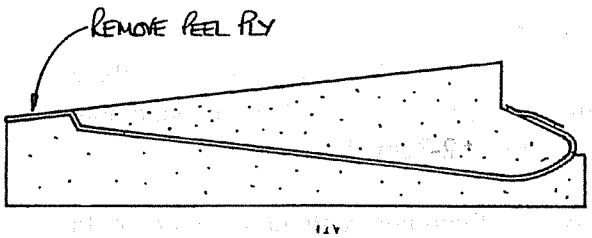


Fig 3. Aileron with trailing edge support block removed.

Cut pieces of 'uni' cloth as follows:

2 off 150cm (60") long.

Mark the foam of the aileron with lines at +/- 30° from the leading edge with which to orientate the cloth.

Step 4

Second Layup.
Micro slurry then epoxy paint the foam ensuring no micro gets onto the glass fibre trailing edge.

Lay the two plies of 'uni' on at +/- 30°, squeegeeing and scissor trimming each in turn then leave to cure knife trimming as required.

- **2nd layup summary.**

- 1 ply 'uni' - 30° to leading edge.
  1 ply 'uni' - 30° *other way* to l.e.

Step 5
After full cure sand the edges to the foam and trailing edges.

Using a hacksaw blade, run it against the leading edge angle as a guide and cut into the foam, up to the skin ***but not into it***, to remove a triangular sectioned strip of foam from the entire aileron length. See figure 4.
Check that sufficient foam is removed for the hinges to fit.

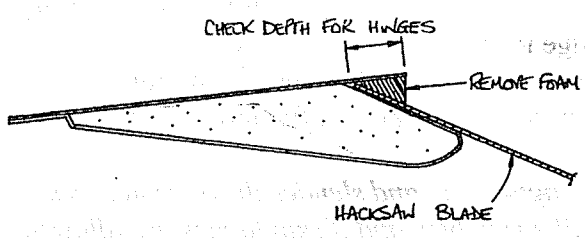


Fig 4. Removing foam under skin to make hinge

Clean off any foam from the newly exposed skin in preparation for the leading edge layup.

Cut strips of 'bid' cloth at +/- 45° to the following dimensions:

2 off full length x 10cm (4") Leading edge.

4 off 20cm x 10cm (8" x 4") Hinge reinforcement.

Roll the long pieces up to help retain their dimensions as much as possible.

Set the ailerons up so that they have their leading edge upwards (figure 5) in blocks of foam with vees cut in them.

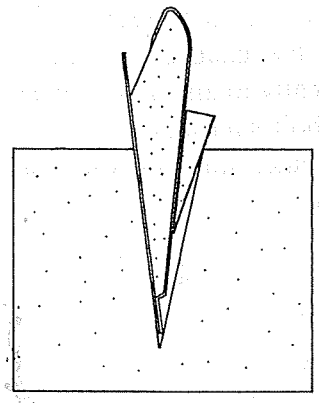


Fig 5.

Step 6

Leading Edge Layup.

Apply micro slurry to the foam making sure it's wiped off the glassfibre flange before layup. Using dry micro make a ***small*** radius at the bottom of the vee. If the radius here ends up too large you'll have problems fitting the hinges later. Its purpose is simply to eliminate air bubbles forming.

Paint all over the layup area with epoxy then roll the first layer of cloth out from one end progressively, stippling it into place as you go. See figure 6.

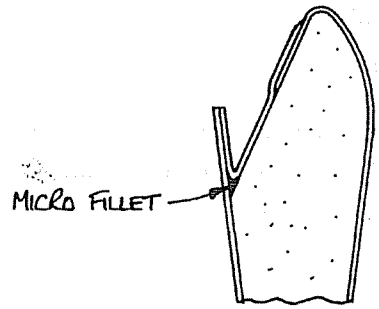


Fig 6. Leading edge layup.

Once thoroughly wetted out apply two hinge reinforcement plies in both of the locations shown in figure 7 then apply the next full ply in a similar manner to the first.

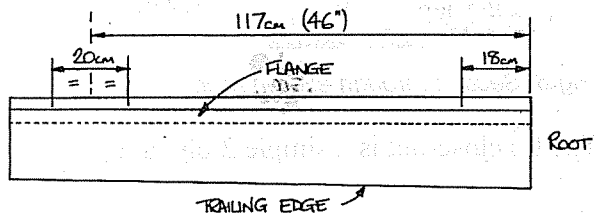


Fig 7. Hinge reinforcement ply locations.

Apply peel ply on the fibre ends of the leading edge and on the flange over the hinge reinforcements.
Leave to cure.

After cure trim and sand the aileron's ends then crack out the foam end core pieces.

- **L.E. layup summary.**

- 'Bid' at +/- 45°
  1 ply - full length
  2 plies - hinge positions
  1 ply - full length.

Step 7

Close-out layups.

Clean the remnants of foam from the insides of the resulting glassfibre flanges in readiness for laying up.

Bonded in each aileron root will be an AN4-10A bolt through an A2 plate with an EUR001 washer as in figure 8.

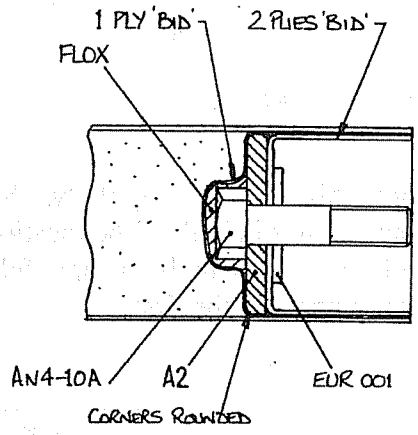


Fig 8. Section through aileron root.

The tip close-out is a simple 2 ply layup.

Cut 5 pieces of 'bid' at +/- 45° to the following dimensions:
30cm x 10cm (12" x 4").
3 off - Root close-out, 2 off - Tip close-out.

Step 8

Root close-out

Before you start this layup you'll need to get together the following;

- A2 plate
  AN4-10A bolt
  EUR001 washer
  AN960-416L washer
  MS21042-4 nut

and make a spacer tube that will allow the bolt through, approximately 1cm (1/2") long, from something like a cheap ball-point pen.

Scuff sand the A2 plate on both sides with 60 grit paper and also the sand the bolt head. A2 should have its two straight edges rounded off on one side slightly to allow cloth to run around it without snagging or cutting it.
While you have the sand paper in your hand roughen up one side only of an EUR001 washer and keep it handy.

With the bolt through the hole in the A2 plate mask its shank and thread to keep epoxy off.

Position the A2 plate and bolt in the end of the aileron's root, as in figure 9, with the bolt 45mm from the leading edge and hollow out the foam locally to allow good clearance around the bolt's head (which will be potted in with flox later) allowing the plate to sit flat on the foam.

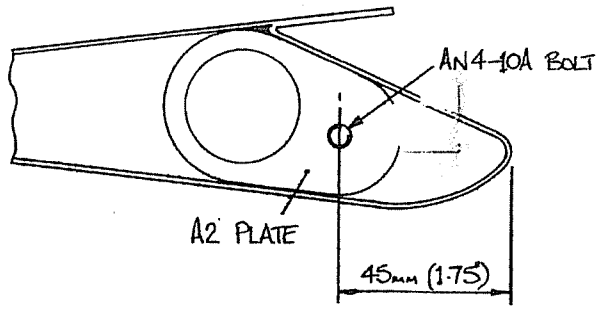


Fig 9. Section through A2 plate in root end.

Micro slurry the foam in the aileron close-out, wiping off any that gets on the glassfibre flanges, then lay in a ply of 'bid' with the fibres at 45° to the chord line and wet it out with a brush, stippling the cloth into the cavity for the bolt head and onto the flanges. Scissor trim the edges.

Lay the A2 plate on a work surface covered with plastic, with the bolt sticking up and lay on a ply of dry 'bid', parting the fibres to

allow the bolt through in a place that will allow complete coverage of the aileron close-out when laid in place, something similar to that in figure 10.

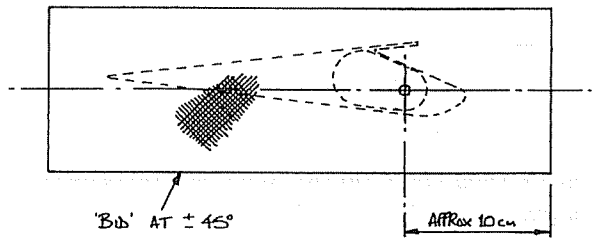


Fig 10. Where to poke the bolt through the cloth.

Wet this ply out with a brush then apply another ply as you did the first. Carefully remove the masking tape from the bolt then place the EUR001 washer over it and down onto the wet glasscloth, rough side down of course. Install the short tube spacer, washer and a standard 1/4 UNF nut, tightening them up so as not to squeeze all the resin out but just to ensure the large washer is down flat. See figure 11.

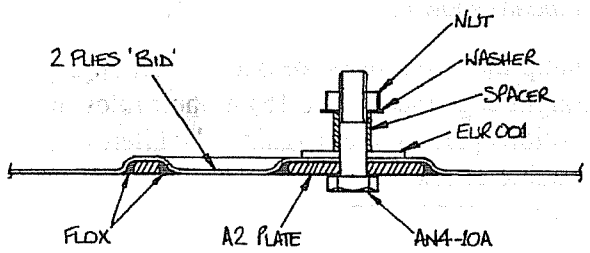


Fig 11. Section through A2 plate ready for installation.

Apply a generous amount of flox to cover the bolt head and scrape some into A2's large hole and all around the edge to form a fillet for the cloth to run down when in place in the aileron.

Place the A2 assembly into the aileron's close-out, stippling the plies into place then, having double checked the dimension in figure 9 and made sure nothing will move, allow to cure before trimming and sanding.

- **Root close-out layup summary.**

- 1 ply 'bid' +/- 45° in root
  A2 plate
  2 plies 'bid' +/- 45° with A2 plate.

Step 9

Tip close-out.

Apply micro slurry as usual to the foam in the aileron's tip then make a small fillet radius in the corners cleaning any excess from the glassfibre flanges before laying on 2 plies of 'bid' at +/-45° to the chord line, wetting out and scissor trimming each in turn.

- **Tip close-out layup summary.**

- 2 plies 'bid' +/- 45°

Step 10

Attaching the hinges.

The attachment of the hinges follows the same principle as that of the rudder and anti-servo tabs.
Two MS20001-5 hinges, one 5" and the other 6" long, are attached to the inside of each aileron flange with flox and pop-rivets.
Four MS21047-3 anchor nuts are pop-riveted to each hinge for AN525-10R8 screws to hold the aileron to the wing. See figure 12.

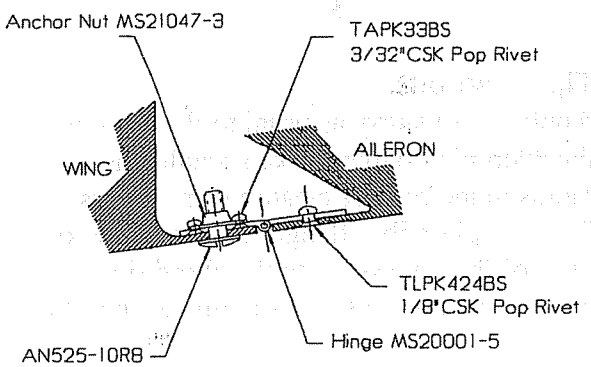


Fig 12. Typical section through aileron hinge.

File the hinges' edges to smooth off any roughness then cut pieces of hinge wire to be about 1cm (1/2") longer than the hinge itself to allow for a bend at each end for safetying. See figure 13.

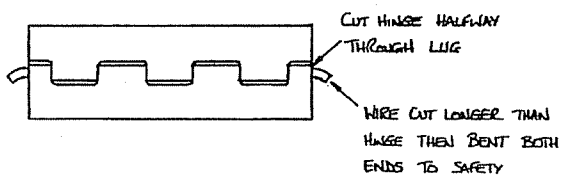


Fig 13. Typical method for safetying hinges.

Mark the areas where the hinges will go onto the aileron flange as in figure 14.

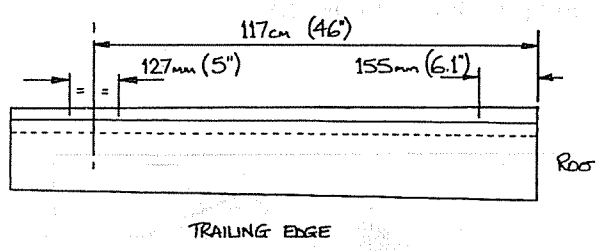


Fig 14. Hinge positions to be marked on aileron flange.

Cut away the flange of the aileron locally to accept the hinge pivot and sand the corners at an angle thus giving clearance for the bent hinge pin ends. See figure 15.
Adjust the cut-outs until the hinges fit correctly.

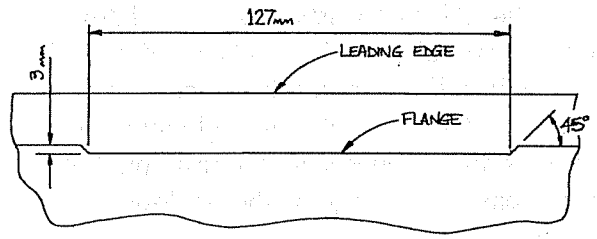


Fig 15. Flange cut back locally for hinge (outboard shown).

Clamp the two hinges for one aileron onto a straight edge (see figure 16) in their relevant positions placing them against the aileron as a double check.

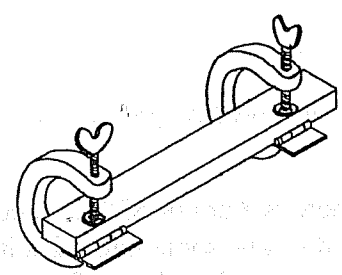


Fig 16. Hinges held in line on straight edge.

Mark the rivet hole centres onto the aileron as laid out in figure 17 then, holding the hinges in place, drill through with a 3.3mm drill placing a cleco in the first few holes to maintain their positions whilst drilling the remaining holes.

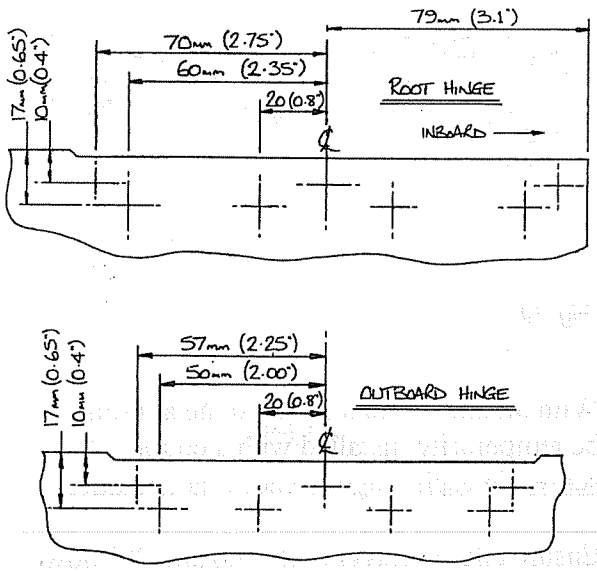


Fig 17 Rivet hole centres in flange (aileron L.E. not shown)

With all holes drilled remove the clecos and deburr each hole, removing all remaining swarf, then scuff sand the hinge flange in preparation for bonding to the aileron. Countersink the flange's holes with a drill bit for the rivets.

Strip off the peel ply from the aileron flange, if you haven't already, then mix up a small quantity of wet flox. Carefully apply a skim of flox to the correct side of the hinge flange to be riveted, making sure not to get any in the joints, (*otherwise your Europa will have a very poor roll rate!*) then offer them up in place with the aileron. Rivet them up, wiping the excess flox off as it oozes out then leave to cure.

Step 11

Fitting the aileron to the wing.

Mark the cut-outs for the hinges on the trailing edge *bottom* skin of the wing as in figure 18.

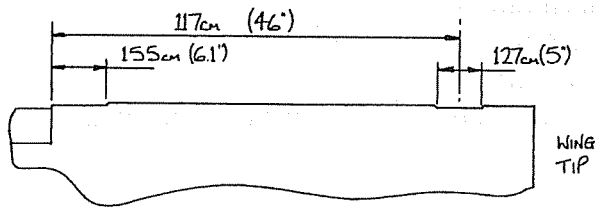


Fig 18. View of wing underside. Adjust dims to suit aileron.

Use the aileron to confirm these positions then cut the slots out, as you did for the aileron itself, adjusting them to accept the hinge pivots and hinge pin ends.

Mark out the hole positions for the screws (see figure 19)but drill only 3.3mm pilot holes through the glassfibre flange to start with.

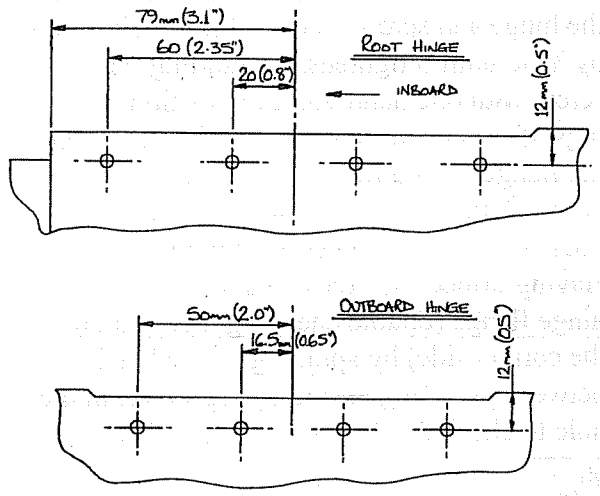


Fig 19. Underside of wing showing hinge screw centres.

Hold the aileron in position with the wing, the gap between the hinge flanges being approximately 1 - 1-1/2mm(1/16"), and drill through the hinge flange with a 1/8" drill in just one place per hinge, initially installing a cleco to keep it in place.

Drill the remaining holes to 1/8", putting clecos in some of them to give extra support, then carefully open them out to 3/16" (4.8mm), taking care to prevent the drill wandering in the glassfibre flange until it has started cutting into the metal of the hinge.

Step 12

Fitting anchor nuts to hinges.

When the push-rod is attached to the aileron it will be impossible to get access to the nuts screwed onto the AN525-10R8 screws holding the aileron on the wing. Likewise, removing the push-rod would entail removal of the flap, and so it goes on. So, MS21047-3 anchor nuts are used to make life easier for you (aren't we kind). These have to be riveted to the hinge flange using two TAPK33BS 3/32" countersunk rivets each.

To attach the anchor nuts to the hinge, place one of the screws through one of the holes in the hinge and screw on one of the anchor nuts by hand until it tightens. By holding the screw with one hand you can position the lugs of the anchor nut and, holding it flat on the flange, drill through their holes with a 3/32" (2.4mm) drill. Try and avoid drilling your fingers in the process, though.
Having drilled the holes countersink the hinge flange (double checking that you do the correct side) by spinning a 3/16" drill between your fingers and trying a rivet in the hole to check for the correct depth. The rivet head should be flush to enable the hinge to lay flat against the wing's flange.

A typical pattern for the nut plates is shown in figure 20.

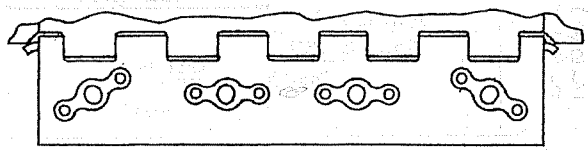


Fig 20.

With all anchor nuts attached the aileron can be temporarily installed with a couple of screws in each hinge to check its operation.

Ensure aileron travel of 25° up and 20° down is available. Trim the wing's top skin flange as required but to a minimum of 6mm (1/4").

Wing tips

With the ailerons fastened to the wings the tip blocks can be attached, shaped and laid up. The aerofoil section has been pre-cut so only the tip curve and corner radii have to be shaped before layup.

Step 1

Attaching the block

Both wing tip blocks are identical so either can be used for either wing.

Hold the tip block in place on the end of the wing and check that there are no large gaps that would need filling.

If the leading edge and trailing edge cores are not quite in line spanwise then shave some off the wing tip block to compensate. You can afford to lose 10 mm from the width of the wing tip block before you will compromise the shape.

Cut a groove in the inboard end of the tip block, long enough to create an air path between the lightening holes adjacent to the spar of the leading and trailing edges.

Set the aileron such that it fairs in with the wing top and bottom surfaces and hold with blobs of hot glue or shims and tape or whatever method you find most simple.

Mix up some dry micro then trowel it on to the exposed foam of the wing tip (no core plugs are required to be inserted).

Squidge the tip block onto the wing's end and hold in place with strips of tape and allow it to cure.

Step 2

Cutting the tip shape

After cure, the shape of the tip curve can be marked on the tip block's top and bottom surfaces according to the co-ordinates set out below. This shape mimics the wing's top surface. See figure 21.

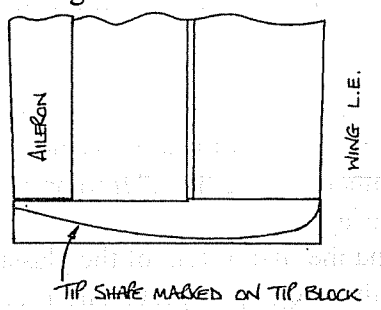


Fig 21. Plan view of wing tip.

Co-ordinates for tip shape.

Chord position from L.E. (mm)	Position from wing end (mm)
L.E.	26
10	43
20	50
30	55
40	59
50	63
60	66
70	69
80	71
90	74
100	76
150	85
200	92
300	101
400	105
500	103
600	94
700	80
800	63
900	47
T.E.	26

Carefully cut the tip curve with a hacksaw blade, watching both top and bottom lines to ensure the blade doesn't run off.

To finish shaping the tip block use a sanding block with about 60 grit paper to round off the edges. The size of radius you make is up to you.

Leave the trailing edge support block intact at this stage.

When you are happy with the shape of your tip set the wing bottom side up ready for layup. Either remove the aileron or mask it up before layup.
Scuff sand the first 3-4cm of the glassfibre skins of the wing tip in preparation for layup.

Step 3

First layup

This first layup will go around 2/3 of the way to the top surface.

Cut pieces of bid at +/- 45° to the following dimensions:

2 off 100cm x 23cm (40" x 9")

and several pieces of peel ply.

Micro slurry the foam, paint the foam surface and the first 3-4 cm of the wing skin with epoxy then lay on the first ply to overlap the skin by 3-4 cm and scissor trim it to 2/3 of the way around. In general terms the cloth doesn't go around onto the top surface.
Pull the cloth as necessary to wrap it around the leading edge.

Wet the first ply out and squeegee it thoroughly then lay on the next ply, arranging it to be about 1 cm short of the first all around to make a gradual transition.

Wet this ply out, squeegee it and peel ply the fibre ends all around before leaving to cure.

After full cure, remove the peel ply, trim the trailing edge and cut off the trailing edge support block, sanding it down to fair in to the trailing edge flange. See figure 22.

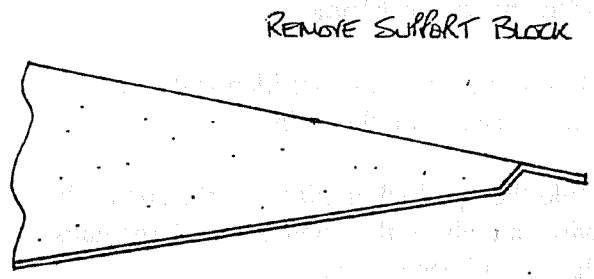


Fig 22. Section through tip at trailing edge.

Step 4

Second layup

This layup covers the remaining core and laps onto the existing skin.

Cut pieces of 'bid' at +/- 45° to the following dimensions

2 off 100cm x 20cm (40" x 8")

and a few pieces of peel ply.

Apply micro slurry to the foam and then paint the foam area with epoxy including about 2-3 cm of the adjacent glass fibre.

Lay the first ply on the foam, scissor trimming to overlap onto the glassfibre skins by about 2-3 cm, except at the trailing edge which will overhang by about 1 cm, then wet it out and squeegee it thoroughly.

Wrap around the leading edge with this and the next ply to end up with all four plies over the corner for resistance against damage to this vulnerable area.

The second ply to go on should be trimmed to be about 1 cm (1/2") shorter than the first one except at the trailing edge which overhangs as does the first.

After wetting out and squeegeeing apply peel ply to the fibres' ends then leave to cure.

After cure, trim the trailing edge and remove the peel ply.

To finish off with, remove the aileron, if you haven't already, then dig out a triangular sectioned shape of foam at the exposed

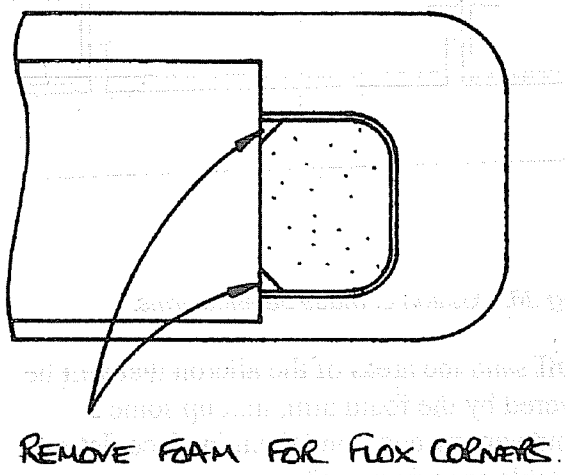


Fig 23. Section through tip trailing edge looking forwards.

trailing edge inboard side of the tip in preparation for a flox corner. See figure 23.

Cut two pieces of 'bid' at +/- 45° sufficiently large to cover the foam and lap onto the trailing edge close-out by about 1 cm.

Scuff sand the trailing edge close-out adjacent to the tip in preparation for bonding.

Mix up sufficient flox to fill the prepared channels and apply it, micro slurry the foam, then position the two plies of 'bid', wetting them out one at a time then leave to cure.

Trim the edges then replace the aileron, sanding its end if necessary to regain the clearance between it and the tip.

Aileron mass balancing

The ailerons are next statically balanced, the purpose of which is to resist an aerodynamic resonance causing the aileron to flutter and result in its catastrophic failure. Lead weights on arms attached to the aileron's leading edge are used to achieve balance.

The lead weights supplied are slightly heavier than required so you can drill holes in them for fine tuning after painting.

Step 1

Preparation

The arms onto which the lead weights are mounted are made from scrap foam and the full size templates, shown at the end of the chapter in figure 24, will need making from card to get their profiles.

Using the templates, make the two 38mm (1.5") wide arms from styrofoam scraps left over from making the flying surfaces. They may need slight adjustment to fit your aileron's leading edge snugly.
Notice that the lead weights are identical and therefore the outboard one will need some material removed to fit the end of its arm as indicated in figure 25.

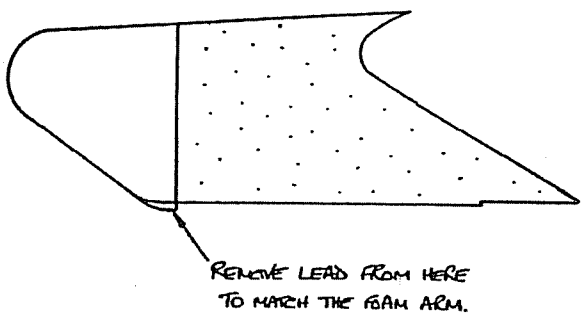


Fig 25. Trimming lead to fit outboard foam arm.

Step 2

Arm and weight attachment

Now lay the aileron on a flat bench with the hinge flange side on the table.

If the hinge is touching the table and lifting the aileron's skin from the surface just support the aileron between the hinges on the corner of the table leaving the hinges overhanging.

The foam arms are to be attached to the aileron's leading edge 20mm (3/4") from the inside edge of the hinges. See figure 26.

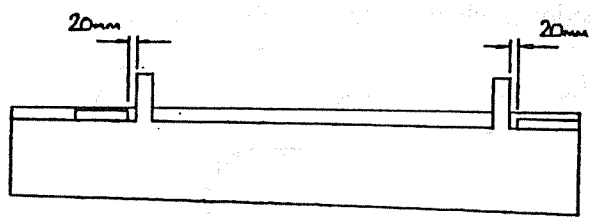


Fig 26. Position of mass balance arms.

Scuff sand the areas of the aileron that will be covered by the foam arm, mix up some 5 minute epoxy and bond them in place flat to the table as in figure 27.

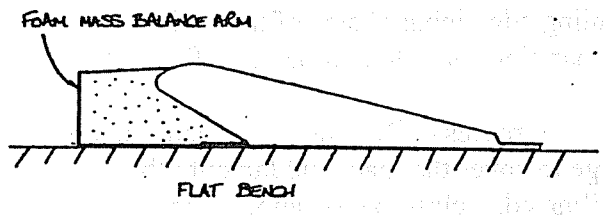


Fig 27. Bonding arm to aileron on a flat surface.

File off any rough edges and scuff sand the flat bonding face of the lead weights then, with the aileron set on edge, leading edge up, temporarily attach one to the end of each foam arm with tape as shown in figure 28.

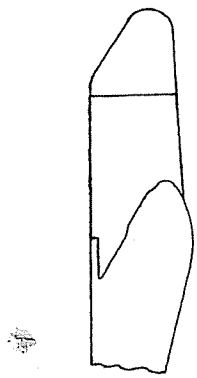


Fig 28. Lead weight bonded to arm.

Note which way the weight is orientated.

Step 3

Wing cut-outs

Before you can re-install the ailerons onto the wings, cutouts in the wing's bottom surface are required.

To ensure sufficient aileron travel, the cut-out in the wing will be made and laid up before the mass balance arms are permanently fixed with glassfibre.

Line the aileron up with the wing and mark the ***bottom skin*** with the outline of the mass balance horns with a clearance of 5mm (3/16") all around.

Cut away the bottom skin to your lines, removing also the portion of the rear close-out.
Dig the foam out down to the underside of the top skin, taking care not to cut or score the skin itself.
Try the aileron in place ensuring that you have the 5mm clearance all around the mass balance horn throughout the aileron's full movement.

Step 4

Wing cut-out layup

With the aileron removed once more, fill the exposed lightening holes with scraps of foam approx 2-3cm (1") long and glue them in with 5 minute epoxy. Use portions of the lightening hole's core if you still have it.

Layup the entire exposed area, including the inside of the top skin, with two plies of 'bid' at +/-45° making flox corners at the skin junctions.

You will have to manipulate the cloth around the corners as you stipple it in adding epoxy as required. Try not to get too much resin into this layup as it is almost impossible to get it out again due to the restricted space.

After cure, trim and sand the excess flush with the skin.

Check that the aileron can travel 22° down minimum (20° will be required after layup). This can be measured as shown in figure 29. *When carrying out this check, tighten fully at least one screw in each hinge.*

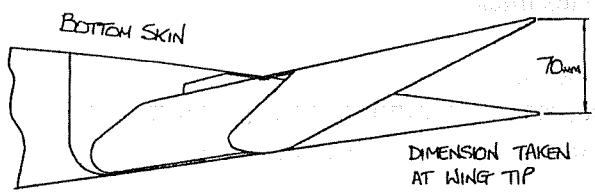


Fig 29. Checking for sufficient aileron travel.

If either of the arms strikes the top skin before the check dimension is obtained, move the weight and trim the foam as required. Trim off the excess lead to blend it in to the foam arm.

Step 5

Preparation

For each mass balance weight, cut pieces of 'uni' to the following dimensions:-

3 off 5 cm x 38cm (2" x 15") with the fibres running lengthwise.

These fibres will run from about 5cm back from the edge of the foam onto the aileron, all the way around the lead weight and back onto the other surface of the aileron, again about 5cm beyond the foam.

Scuff sand with 60 grit paper the areas of aileron which the layup will bond to.

Step 6

Mass balance layup

Lay a piece of plastic sheeting onto a flat surface and paint an area of it with epoxy the size of one of the plies of cloth.

Lay the first ply onto the plastic, which should stay in place on the wet epoxy, then wet it out. Lay on subsequent plies, orientated in the same direction, wetting them out one at a time until the laminate is three plies thick.

The laminate can be easily trimmed with scissors to a width slightly greater than the horn itself and at least 36cm long.

Micro slurry the foam upper and lower surfaces only.

Now lay the wet laminate onto the mass balance horn, remove the plastic and ensure it's properly attached by using a brush or squeegee.

There should be a minimum of 5cm overlap onto the aileron's skin on both upper and lower surfaces as shown in figure 30.

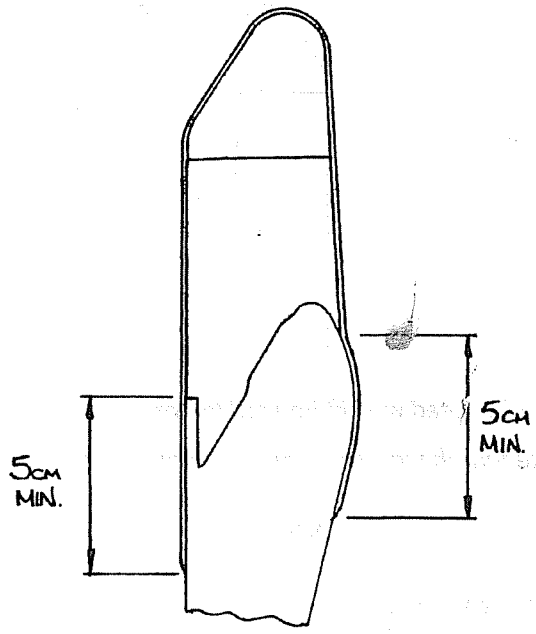


Fig 30. Extent of 'uni' plies onto aileron's skins.

The edges should be left overhanging enough to enable trimming back to the foam and lead after cure and so ensuring a good square edge.

Cover the whole of the wet laminate with peel ply and allow to cure trimming the edges at the knife trim stage.

Remove the peel ply after full cure and sand the edges as required to make them straight and flush with the horn's sides.

Step 7

Side layups

The sides are next laid up with two plies of 'bid' with a flox corner binding them to the 'uni' layup previously made.

Cut the usual 5-6 mm (1/4") triangular channel around the complete periphery of the exposed foam on each side.

Cut 2 pieces of 'bid' at +/-45° to be of sufficient size to cover each side of the mass balance horn and to overlap onto the aileron by at least 1cm.

These side layups can either be made laying on individual plies or laying up the two plies on plastic sheeting and applying them together.

Apply the micro and flox corners to the horns then layup the sides wrapping the plies onto the leading edge of the aileron by a minimum of 1cm. See figure 31.

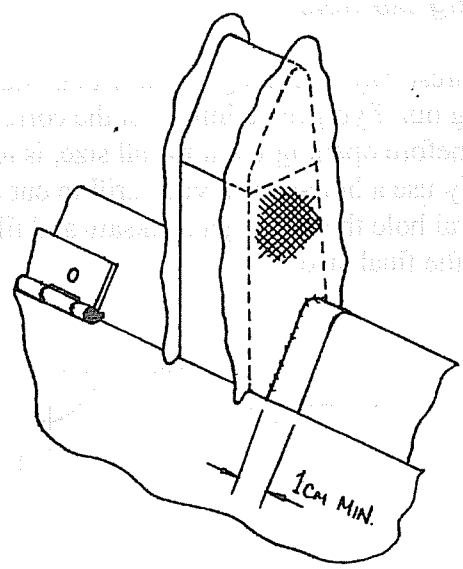


Fig 31. Side layups to lap onto aileron by 1cm minimum.

Step 8

Checking for balance

The final aim is that the aileron, when suspended from the hinges, will lie horizontal through its centreline. This can only be accurately checked after the final paint has been applied.

Before painting, however, to get an idea of balance, suspend the aileron by its hinges. It should hang with the nose of the mass balance horns pointing down at about 45° as in figure 32. In other words the aileron should be over balanced.

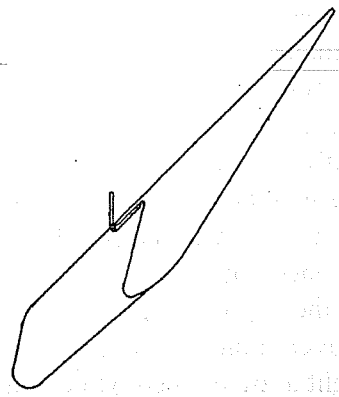


Fig 32. Aileron before finishing and balancing.

After final paint has been applied, to bring the aileron into balance, simply drill into the *side* of the lead with a 1/4" drill to remove sufficient material. Fill the hole(s) with dry micro.
The final balanced state is shown in figure 33.

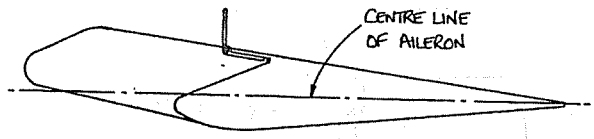


Fig 33. Aileron properly balanced after final painting.

Finally, before refitting the ailerons, drill a small hole through the trailing edge close-out either side of the inboard cut-out to reach the rearmost lightening hole to ensure it vents to atmosphere.

After refitting the aileron to the wing make a final check that at least 20° of down movement can be achieved.
20° equates to 64mm at the tip.

Aileron Bellcrank Access Hole

You've probably been wondering how to get access to the aileron bellcrank, buried in the wing, for attachment of the push-rods.
Well, find a sharp knife as you'll soon be cutting into your lovingly laid up bottom skin to make a hole.
There are many ways you can gain access to the aileron bellcrank for inspection and servicing and the following instructions describe only one of them. A clear window is used in this method so visual checks can be made without removal of a panel.
Of course, once you have cut the access hole and sealed the exposed foam edges with flox, a simple cover could be made using a thin sheet of light alloy painted white and attached to the skin with silicone. The panel can be prised off every year for the inspection and simply re-attached with fresh silicone afterwards.

Step 1

Marking Out

Referring to figure 34, which shows how the access window will look when installed, mark the outline of the aileron bellcrank housing onto the underside of the wing. Sticking masking tape on the skin in the relevant positions first may help you get clear lines.

Use the spar and the 43mm wide trailing edge core, which you can see through the skin, to reference dimensions from.

With the housing size and position established mark lines now to make a rectangle 1cm smaller in both length and width. Finally, mark radii of about 2.5cm at each corner. This outlines your aileron bellcrank access hole.

Step 2

Cutting the hole

The surest way of cutting the hole out, and finding out if you're definitely in the correct place before opening it out to full size, is to initially use a hole-saw in your drill to cut out a central hole then, using a hacksaw and file, cut to the final size.

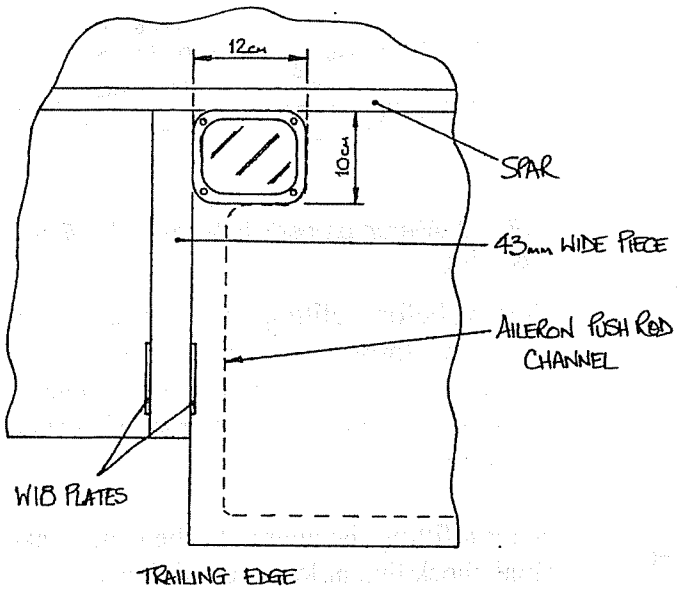


Fig 34. Partial view of wing bottom surface.

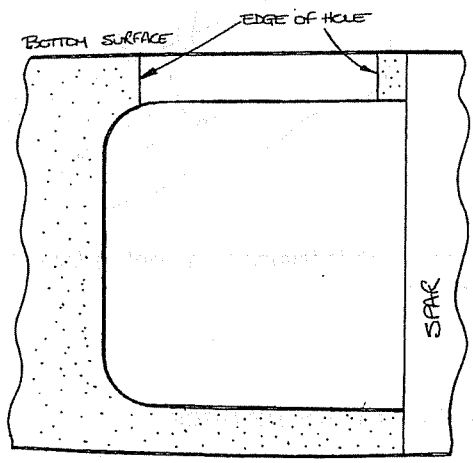


Fig 35. Section through bellcrank housing with hole cut-out.

Step 3

Access window

To make each access window you will need a piece of perspex or lexan 12cm x 10cm (not supplied). The thickness is not critical but 3mm is about ideal. Cut the window to size and round off each corner to a 2.5cm radius. See figure 36. This shape should match the marking on your wing.
Be careful when cutting or filing perspex as it can easily crack, especially if cold.

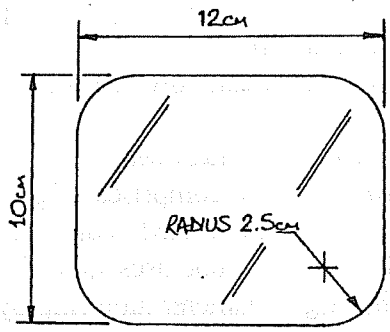


Fig 36. Access panel dimensions.

Step 4

Mounting flange

The flange will match the size of the bellcrank housing, 12cm x 10cm. Use your access window as a template and mark out the flange's outline and position. The apparent mis-matching of corner radii allows sufficient room for an MS21047-3 anchor nut to be positioned at each corner.

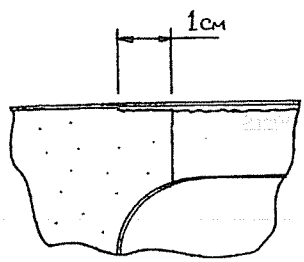


Fig 37. Partial section of hole with flange removed.

With a sharp blade carefully cut along your marked line to just cut through the skin and, by sliding the blade underneath the skin, remove the flange.

Scuff sand one side of the flange for bonding then layup 2 plies of 'bid' onto it, all over, just to thicken it up. This ensures that countersunk holes can be made, for anchor nut rivets, without fear of going right through.

Sand the foam around the hole sufficiently deep until the thickened flange and the perspex window can be put in place and be flush with the wing's skin. See figure 38.

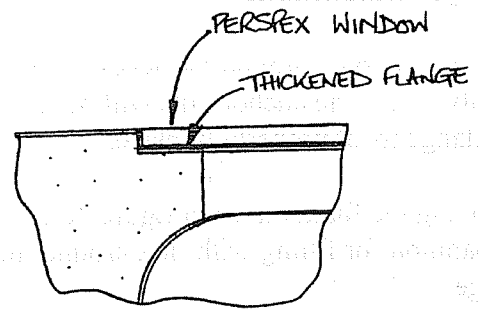


Fig 38. Checking for flange step depth.

Step 5

Attaching the anchor nuts

With the window matched up with the flange mark the hole centres for anchor nuts at each corner and drill through both window and flange with a 5mm drill. See figure 39.

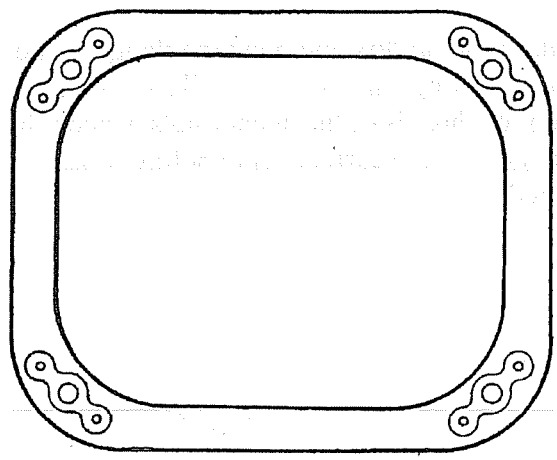


Fig 39. Positions of anchor nuts on flange.

Drill the 3/32" holes for the anchor nuts' rivets (TAPK33BS), holding each anchor nut in position on the flange using one of the AN52510R8 screws to centralise it. Spin a larger drill bit in your fingers to countersink these holes to accept the rivets. Finally, rivet the anchor nuts to the flange.

Step 6

Flange Attachment

Dig out the foam around the access hole locally where the anchor nuts will be to allow the flange to sit properly in place.

Also, dig the foam out as in figure 40 in preparation for filling with flox around the flange.

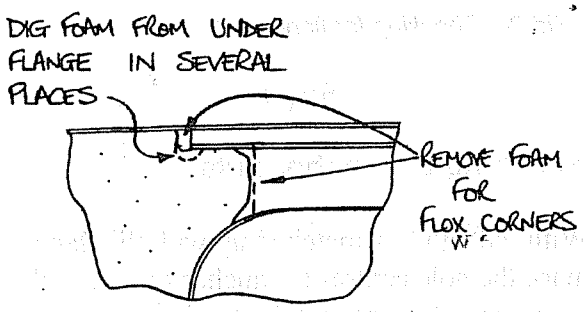


Fig 40. Removal of foam for 'flox corners'.

Mix up some flox and bond the flange to the foam making sure you don't allow any to get into the threads of the anchor nuts. Check the flange is to the correct depth before it has cured off.

Fill the cavities, around the edge of and underneath the flange, with flox to make 'flox corners' then leave the whole lot to cure. See figure 41.

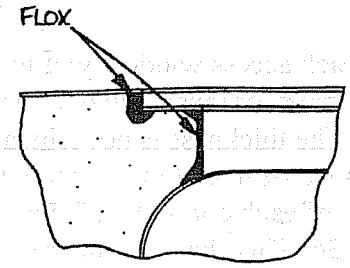


Fig 41. Flox filling foam edges.

After cure smooth off any sharp or rough edges with sand paper.
The access window can now be installed.

Aileron push-rod installation.

Each aileron push-rod comprises a light alloy tube with steel inserts riveted in at both ends. The smaller diameter tube uses solid rivets, whereas the larger diameter tube employs pop rivets.
To make up the push-rods the following will be required:

Aileron link-rod.
1/2" OD light alloy tube
2 AN490HT8P inserts
2 MW4T rod ends
2 AN316-4R nuts
4 AN470-4-10 solid rivets

Lateral push-rod.
1" OD light alloy tube
2 W17 inserts
2 MW4T rod ends
2 AN316-4R nuts
8 TLPD 419 BS pop rivets

Step 13

Aileron link-rod.

To establish the lengths of each link-rod (one is to be longer than the other) set the bellcrank W13 against its stop and the aileron with its trailing edge at 25° up. This angle of up aileron equates to 80mm between the trailing edges of the wing tip and the aileron tip.

Measure the distance between the centre of the pin in the aileron root and the centre of the hole in the short arm of the bellcrank. Subtract 92mm (3.6") from this measurement to obtain the length to cut the tube.

File the ends square then push in one of the AN490HT8P inserts. If you find the fit a little tight remove material from the insert and not the bore of the tube.

With the insert in place drill right through both tube and insert with a 1/8" drill staying as close to the centre line as possible. Place a rivet in the hole to prevent the two parts moving then drill a second hole at 90° to the first as in figure 41.
Carry out the same procedure with the other end making sure all swarf is removed before riveting the inserts in.

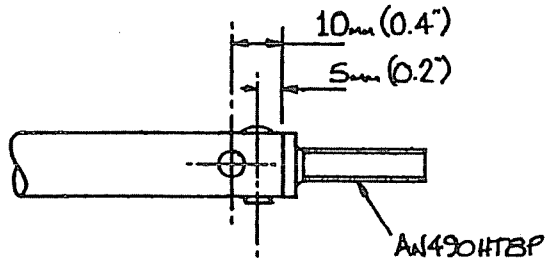


Fig 41. Rivet hole positions in 1/2" dia push-rod.

Step 14

Lateral push-rod.

Cut the 1" tubes to be 192cm (75.6") long and file the ends square.

Push in the W17 inserts, drilling each hole with a 3.3mm drill and placing in a rivet, but not pulling it up, to keep both parts in position whilst drilling the other holes as shown in figure 42.

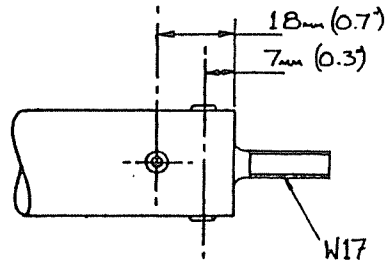


Fig 42. Pop-rivet positions in 1" dia push-rod.

Again, ensure all swarf is removed before final assembly of the inserts.

To finish the push-rods screw on the rod-ends, with a AN316-4R lock-nut, to about 3/4 down the thread adjusting their positions equally to get the final length.

Attach the push-rods to the bellcrank or aileron drive bolt according to the section in figure 43.
You'll have to remove a portion of the flange at the aileron's leading edge to clear the link-rod.

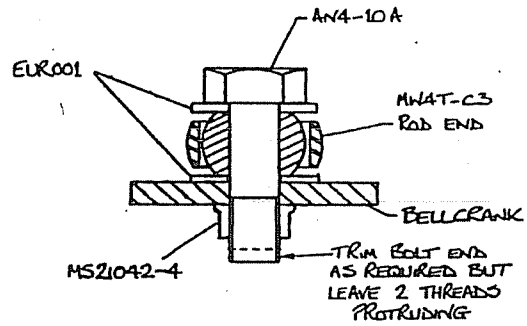


Fig 43. Typical attachment of rod-end to a bellcranck.

It is important not to omit the EUR001 washer as this will prevent the rod-end housing coming adrift in the unlikely event of failure of the ball end. Also shorten the bolt as required to clear the bellcrank bracket.

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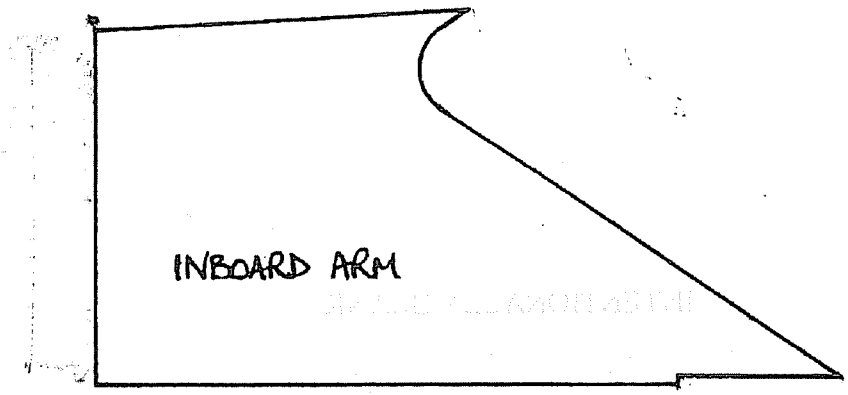

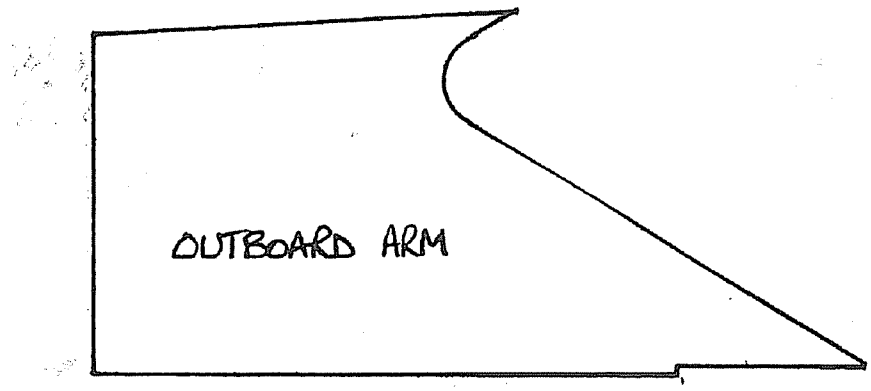

Fig 24. Full size templates for mass balance horn arms.

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9. FLAPS

Overview

Each flap comprises two main cores which are joined together sandwiching a laminate made up from 5mm thick foam with 2 plies of glass fibre each side of it. The flap's skins will be applied, then after cure, the FL1, FL2, and FL3 hinge plates installed, the mid one (FL2) being located in the 5mm foam sandwich piece.
Three small plates (FL7) will also be laminated into the root to provide a hard point for the flap drive pin.

The longer outboard core has a 25mm piece pre-cut at its tip to make a flange with, as does the inboard core. The inboard core also has a 70mm piece pre-cut at its root end which is to be used to extend the flap to conform with the fuselage shape at a later stage. Put this piece in a safe place for now.

Step 1

Joining cores together

Firstly, the supplied 5mm foam needs to be made into a laminate.
Cut two pieces of 'bid' cloth from your scraps slightly larger than the size of the foam piece orientated +/- 45° to the edges.

Apply two plies of the cloth to each side of the foam and wet it out having micro slurried the foam's surface first. Cover both sides with peel ply, then sheets of plastic to prevent epoxy getting everywhere, before weighting it down on a flat surface just enough to keep it flat.

After cure remove the plastic and peel ply, trim the edges to get rid of sharp pieces of glass fibre, then lay the laminate up against the end of one of the flap cores at the joint position, i.e. not the root or tip. Mark the section shape onto the laminate and cut this piece out remembering you'll need two of these, one for each flap. See figure 1.

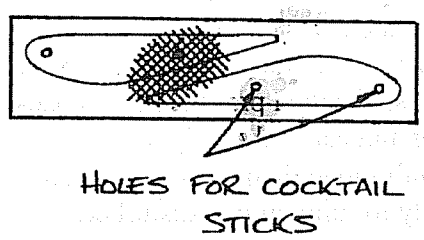


Fig 1. Positions of profiles cut from laminate.

The trailing edge support block shape need not be included, in fact you may cut the last centimetre (1/2") of trailing edge off completely. The gap left here upon joining the flap cores together can be filled with a piece of scrap foam later.

Sand the profiled sandwich lay-up so it's *just* smaller than the foam core's profile. What you want to avoid is a lump in the flap's surface at the joint which will need blending out with filler later. A dip in the surface, although best avoided, is less costly weight wise.

Drill two holes through the profiled laminate, one at the leading edge the other at the trailing edge, to allow short lengths of cocktail stick through, then with the profile in position on one of the core ends, stab the sticks through it into the foam to make locating holes. Do this with the other core also so the profile can be held positively in position.

Set the two flap cores, in their jig blocks to maintain the 1° approx washout, on a flat surface and in position to be joined together, having first placed a strip of plastic down at the join line to act as a release. Sighting along the leading and trailing edges will tell you if they are aligned correctly.
Use a long straight edge to confirm absolute straightness of the two cores in relation to each other.

When you are happy with the cores' alignment mix some wet flox and apply to both sides of the sandwich profile piece. Separate the cores enough to place the sandwich in position, locate it using the cocktail sticks then press the cores back together and carefully weight them down so they don't move then allow the whole assembly to fully cure undisturbed.

Step 2

Bottom skin lay-up.

Preparation

Cut a triangular shaped channel out of the foam each side of the 5mm rib to a depth of 5-6mm for a flox joint to be made between the rib and skin.

The first skin to be laid up is the bottom skin so set the jointed cores in their jig blocks with the trailing edge support block downwards, as in figure 2, having cut the jig block back along the leading edge about 7 or 8cm thus giving access underneath.

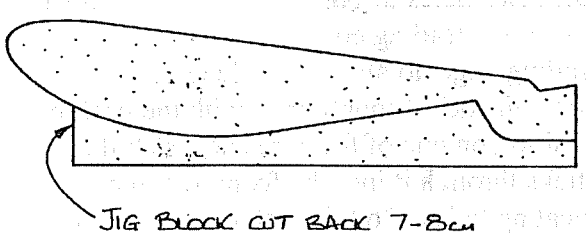


Fig 2. Flap core in jig block.

Bond the jig blocks to the bench with 5 minute epoxy to keep them flat and do likewise with the core to the jig blocks, remembering to use small blobs. Attach also the 25mm pieces to the main cores in their relevant locations.

Remove the foam flashing around the leading edge to make it nicely rounded, brushing any bits off the core afterwards.

Mark the core's foam surface with lines at 30° each way to the leading edge for ply orientation during lay-up.

Attach peel ply to the trailing edge joggle, as in figure 3, with double sided tape.

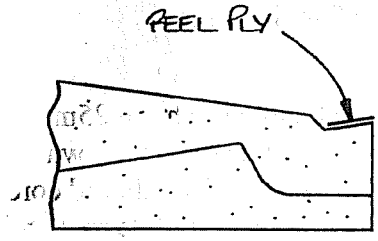


Fig 3. Flap core trailing edge detail.

Cut a piece of 'uni' to the following length:

1 off 2.5m (98") x full width.
and several pieces of peel ply for the leading edge.

Step 3

Skin lay-up

Fill the grooves each side of the rib with flox and underneath about 5cm back from the leading edge. Micro slurry the foam, keeping it off the peel ply then, having painted the foam surface and peel ply with epoxy, lay on the first ply at 30° to the leading edge

Figure 4 shows a method of laying on the cloth, using the 'off-cut' to provide the second ply.

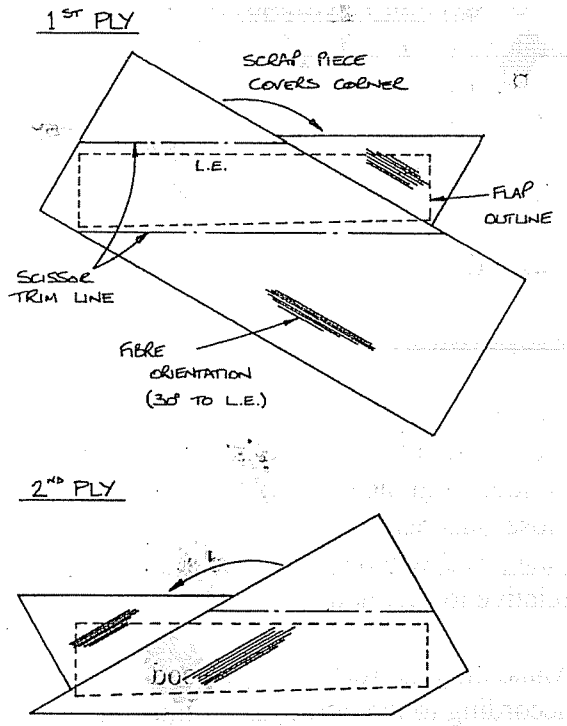


Fig 4. Positioning 'uni' cloth for skin lay-up.

The first ply wraps around the leading edge and back approximately 3-4cm. See figure 5.

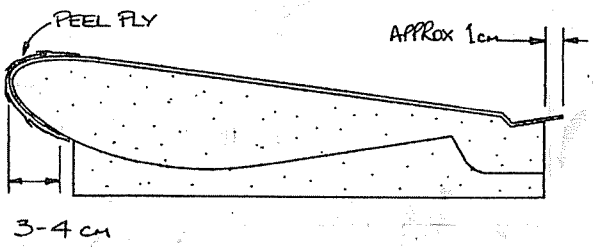


Fig 5. Bottom skin lay-up.

Squeegee the first ply, wetting it out properly and scissor trimming the edges to within 1cm of the core before laying on the second one at 30° *the other way* to the leading edge. This ply should be trimmed to be about 1cm shorter than the first ply at the leading edge to feather it down to the foam.

Apply peel ply over the fibre ends at the leading edge and all around the leading edge as shown in figure 5 then leave to cure, knife trimming at the appropriate time.

- **First lay-up summary.**

- 1 ply 30° to leading edge
  1 ply 30° *other way* to leading edge.

-oOOo-

Step 4

Top skin lay-up

Preparation

Retrieve the top surface jig blocks, cut the leading edge back as you did the others and set them in line on your flat bench. Remove the flap from its jig blocks, flip it over and set it up as before in the other jig blocks, making sure everything is straight.

Remove the peel ply and saw off the trailing edge support block, sanding the foam to blend the top surface with the trailing edge flange.

Carefully sand the glass fibre at the leading edge to remove any bumps and to help feather the glass to the foam core. Take special care not to sand into the foam, of course. See figure 6.

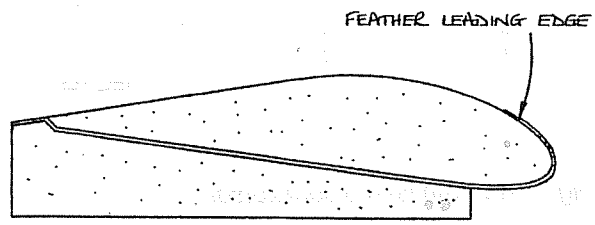


Fig 6. Flap core ready for top skin lay-up.

Continue the groove each side of the rib for flox where the trailing edge support block was and mark the core's surface with orientation lines at 30° each way to the leading edge.

Cut a piece of 'uni' to the following length:

1 off 2.5m (98") x full width
and several strips of peel ply.

Step 5

Skin lay-up

Fill the rib's grooves with flox then micro slurry the foam, keeping it off the glass fibre at the leading and trailing edges then paint the surface with epoxy.

Lay on the first ply at 30° to the leading edge in a similar fashion to the bottom skin, wet out and squeegee it then scissor trim 2-3cm back from the leading edge underside and about 1cm beyond the trailing edge and at each end.
Lay on the second ply at 30° the other way to the leading edge trimming this one about 1cm short of the first at the leading edge. See figure 7.

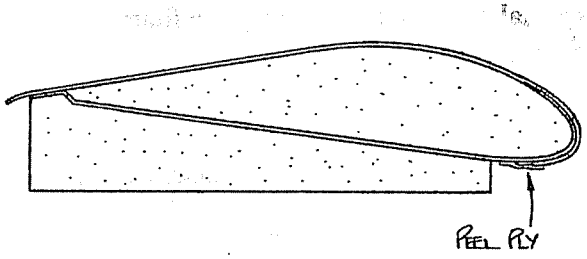


Fig 7. Top skin lay-up completed.

Peel ply the fibre ends at the leading edge then leave to cure, knife trimming as required.

- **Second Layup Summary**

- 1 ply 30° to leading edge
  1 ply 30° *other way* to leading edge

Step 6

Installing Hinge Plates

Preparation

Two jigs are required to position one each of the FL1 and FL3 hinge plates which are to be bonded onto the root and tip of the flap close-outs respectively. The centre hinge plate, FL2 will be positioned separately relative to FL1 and FL3.

Make the jigs from 1/2" plywood or similar according to the drawings in figure 8.

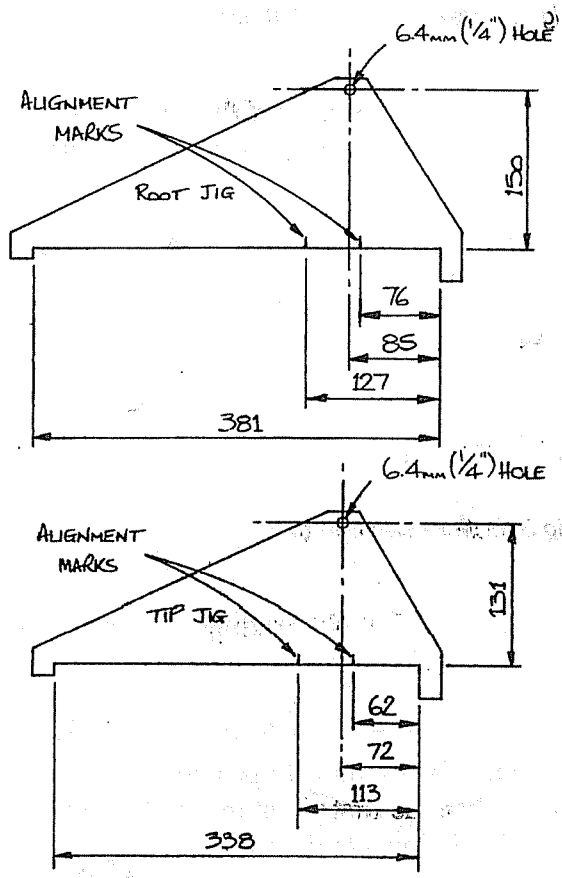


Fig 8. Flap plate positioning jigs.

Later illustrations show how these jigs are used.

Crack out the 25mm foam end pieces then position the jigs as shown in figure 9 to transfer the alignment marks from the jig to the glass fibre flange. These mark the length of the slots which need to be cut into the flange to allow the flap plates through. The slot itself should be made to allow the hinge plate to sit flat on the foam core end, allowing a little extra for two plies of 'bid' behind it.

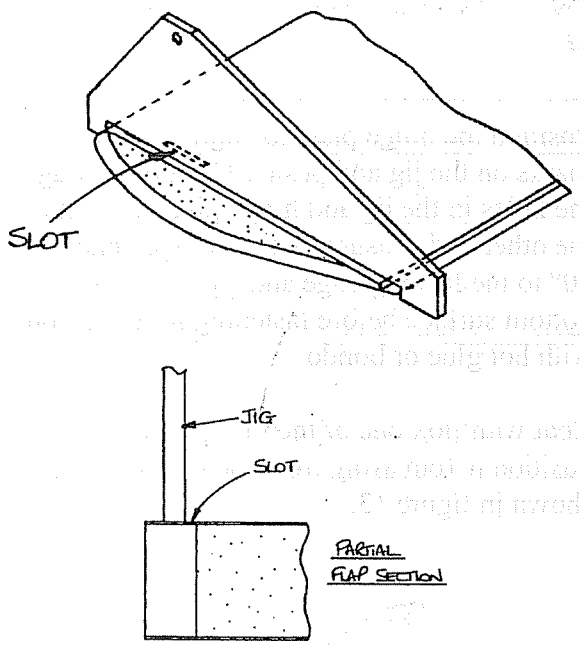


Fig 9. Typical jig position.

Mark the position for the 'middle' hinge plate, which will be situated in the rib, by using a straight edge to join the fore and aft alignment marks, respectively, from the flap's root and tip.
Cut away the skin with a sharp knife first then, using a drill, rout the 5mm foam out full depth until you touch the top skin. See fig. 10. Take care when making this slot that you don't cut through the glass fibre skin of the 5mm laminate or, more importantly, the top skin.

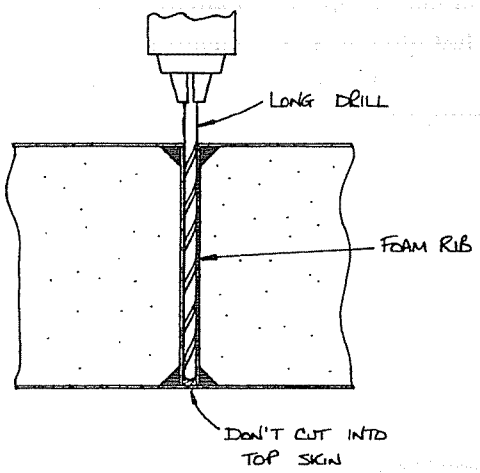


Fig 10. Section through flap at rib area.

Try the flap hinges in their relevant slots to check that they fit.

Step 7

Close-out Layups

Preparation

Cut pieces of 'bid' cloth at +/-45° to the following dimensions:

6 off 50cm x 12cm (20" x 5") - 3 each root and tip.
4 off 25cm x 12cm (10" x 5") - 3 local plies root, 1 local ply tip.

Mask the FL1 and FL3 plates with tape to cover the area that will protrude from the wing to keep it clean leaving the pivot hole uncovered.
Bond an FL9 bush into each of the hinge plates using Loctite 638 bearing retainer then scuff sand the area of the plates to be bonded with 60 grit paper.

Abrade also three of the FL7 plates in preparation for bonding. These plates provide a mounting pad for the flap operating pin.

Attach the jigs to the underside of the flap with hot glue or bondo ensuring they are at 90° to the skin and 90° to the leading edge. See figure 11.

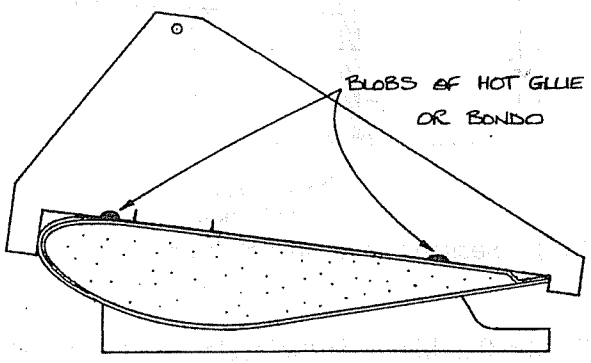


Fig 11. Jig temporarily attached to flap.

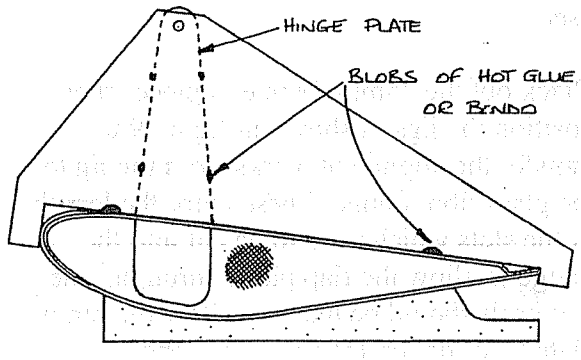


Fig 12. Flap hinge plate temporarily attached to jig.

Position the hinge plate to align with the marks on the jig and push a 1/4" bolt through the holes in the jig and hinge plate to locate the other end. Ensure that the hinge plate is at 90° to the leading edge and square to the bottom surface before fastening it in position with hot glue or bondo.

Coat with flox one of the FL7 plates and position it 1cm away from the FL1 plate as shown in figure 13.

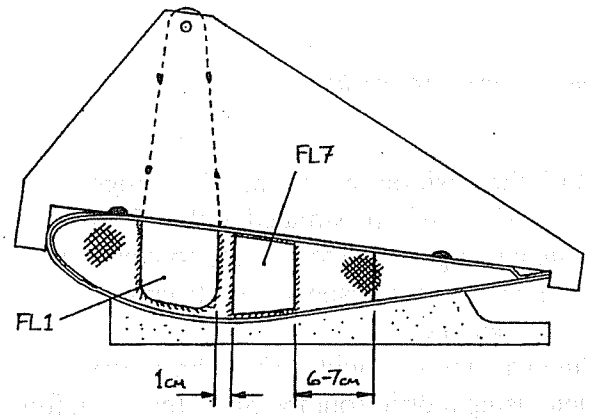


Fig 13. Position of FL7 plates.

Step 8

Root close-out lay-up

Micro slurry the foam of the close-out, wiping off any stray micro from the glass fibre flanges.

Lay in two plies of 'bid' at +/- 45° to the chord line wetting each out in turn and scissor trimming to within 1cm of the flanges.

Slit the cloth where the slot is to allow the hinge plate through.

Trowel on some flox to the hinge plate's unmasked end, then insert it through the slot and lay it against the wet plies in the close-out. Make flox fillets around all the edges and the hole to stop bubbles forming underneath the subsequent plies. See fig. 12.

Coat the metal of both FL1 and FL7 with flox then lay on a shorter, local ply running from the leading edge to at least 7-8cm (3") aft of the FL7 plate.

Lay another flox coated FL7 plate directly over the first. Flox the exposed surface of the plate and form a fillet around its edges then lay on and wet out another local ply trimming it about 1cm shorter than the previous one.

Do the same with the last FL7 (3 in all) then finally add the last full length ply, scissor trim and allow to cure, knife trimming as required.

¤ **Root close-out lay-up summary**

¤ 2 overall plies 'bid' +/-45°
FL1 and FL7 plates with flox
1 local ply 'bid' +/-45°
FL7 plate with flox
1 local ply 'bid' +/-45°
FL7 plate with flox
1 local ply +/-45°
1 overall ply 'bid' +/-45°

-oOOo-

Step 9

Tip close-out lay-up

Having micro slurried the foam at the tip, lay in and wet out 2 plies of 'bid' at +/- 45° to the chord line running them onto the flanges as in the root and scissor trim them to approximately 1cm overhang.

Slit the cloth where the slot is to allow the hinge plate through.

Trowel on some flox to the FL3 hinge plate's exposed end then insert it through the slot and lay it against the wet plies in the close-out. Make flox fillets around all the edges and the hole to stop bubbles forming underneath the subsequent plies.

Position the hinge plate to align with the the marks on the jig and push a 1/4" bolt through the holes in the jig and hinge plate to locate the other end. Ensure that the hinge plate is at 90° to the leading edge and square to the bottom surface before fastening it in position with hot glue or bondo.

Coat the metal of the FL3 with flox making a fillet around its edges then lay on a shorter, local ply running from the leading edge to at least 7-8cm (3") aft of the hinge plate's aft edge. Wet out and trim this ply then lay on a final full length ply to finish with. Leave to cure.

¤ **Tip close-out lay-up summary**

¤ 2 plies 'bid' overall +/-45°.
FL3 plate
1 local ply 'bid' +/-45°
1 ply 'bid' overall +/-45°

-oOOo-

Step 10

With both FL1 and FL3 installed and fully cured remove the jigs with a sharp tap.

Try the FL2 hinge plate in its slot and thread a piece of string through all the hinge plates' pivot holes. Place shims (e.g. pieces of mixing stick) in the holes of the two end hinge plates and under the string to position it in the hole's centre then pull the string tight. Check that the FL2 hinge plate will position such that it lines up with the other two and that the string runs through the centre of its hole. See figure 14.

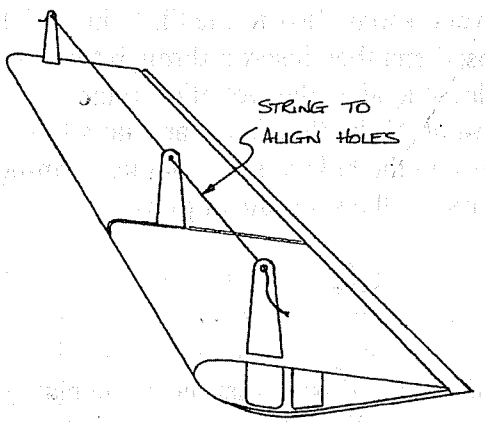


Fig 14. Aligning FL2 hinge plate with FL1 and FL3.

When you are happy that the FL2 can be positioned properly, squeeze some flox into the slot first of all, coat the plate, then pot it in place lining it up with the FL1 and FL3 plates by eye and checking again that all the holes line up by means of the string.

Support the FL2 plate with pieces of wood hot glued to it then allow to cure undisturbed ensuring nothing can move when it's left alone.

The flap structure is now complete and is ready for installation onto the wing.

Flap Attachment

Step 11

To enable setting the flap up accurately for hinge attachment a template is required which is easily made. This template will also be used for setting the wing's incidence later so don't use it for firewood or give it away immediately after the end of this chapter.

The wing will be set up upside down to give access to the hinges but initially the template has to be fastened to the upper surface.

The template is best made from a piece of faced board similar to that used for the wing's straight edge. These boards have good straight edges from which to work.

You will require a piece about 145cm x 20cm (57" x 8") in size and thick enough so you can balance a level on its edge for incidence setting, say 12mm (1/2").

Setting the datum line about 1cm from one edge mark the co-ordinates set out below onto the board as in fig. 15 then, having joined the dots with a smooth curve, cut out the profile, leaving a step with which to locate the flap's trailing edge. The section between chord positions 300mm and 800mm can be cut back a little as the main reference areas are the leading and trailing edges.

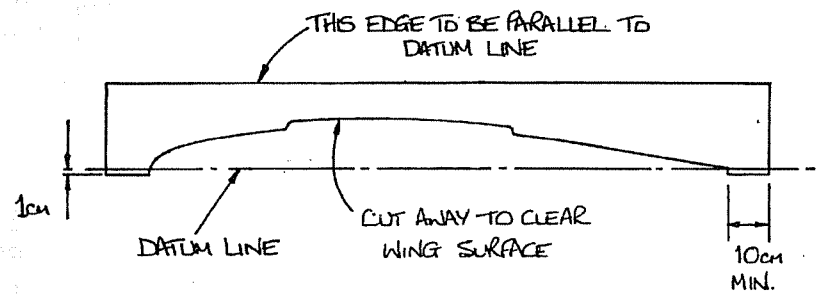


Fig 15. Flap setting template.

Co-ordinates for template.

Chord position from L.E. (mm)	mm from datum line
L.E.	0
10	22
20	29
30	34.5
40	39
50	43
100	58.5
200	77
300	90
31.5 800	77.5
35.433 900	62
39.37 1000	45
43.31 1100	28.5
47.25 1200	12
50. 1270	0

Set the template onto the wing's upper surface, lined up with the *leading edge* root, and bond in place with blobs of bondo in two or three places to make it secure.
Of course, don't make it so secure that you won't be able to remove it later!

Step 12

Now turn the wing over so that the lower surface is uppermost and wedge it with blocks of foam to keep it steady.

Try to fit the flap into the wing's trailing edge close-out. Don't expect it to fit at first as the bottom flange of the wing close-out is too long at this stage and will need trimming back to allow the flap to enter properly.
The flap's leading edge should not be pushed hard up against the wing's close-out but its trailing edge should be located by the template's trailing edge step.

Trim the wing's bottom skin flange back, a little at a time, until the flap can sit properly in the template.

The flap's outboard trailing edge should be lined up with the aileron's trailing edge (set in its neutral position) both fore and aft and up and down.

Also, the flap's outboard hinge arm (FL3) should be midway between the two W18 plates set into the wing at this location.

The end of the flap should be clear of the wing structure and aileron root by 3-5mm. Trim the end of the flap, if required, to achieve this, not the wing or aileron.

Once in position, hold the flap in place by placing a few blobs of bondo between the close-out flanges of the wing and the flap's skin.

Step 13

With the flap secure, assemble the flap connectors W19 (inboard) and W20 (middle) to their respective hinge arms set into the flap. Refer to the sectional drawing in figure 16.

Figures 16 and 18 shown in the text are reproduced in a larger size and with more detail at the end of this chapter.

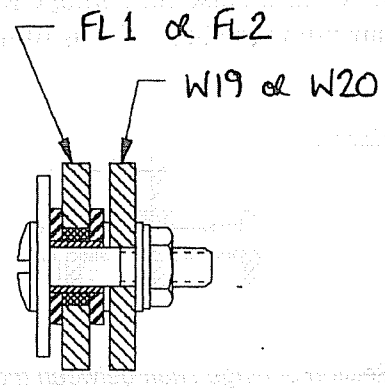


Fig 16. Section through inboard and mid flap hinges.

The principle of these hinges is that the FL10 spacer acts as the bearing surface on which the FL9 bush will run and also prevents over enthusiastic tightening of the nut and screw thus causing the hinges to lock up

The outboard hinge will also house the outrigger retraction mechanism but for now only partial assembly is required.

Referring to the sectional drawing in figure 17 assemble the two W21 plates with the OR6 and OR7 blocks between them using four AN525 10R32 screws with AN960-10L washers under the MS21042-3 nuts.

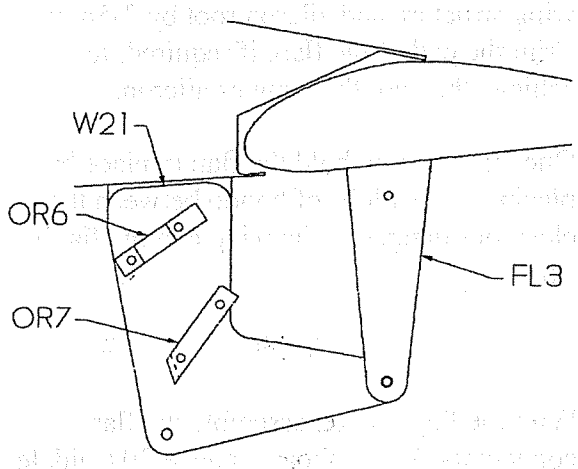


Fig 17. Outboard flap hinge / outrigger assembly.

Make up the hinge shaft around the flap's outboard hinge arm as shown in the sectional drawing in figure 18. Although it's not required yet install also the spring OR11 to save dismantling the hinge for its fitment later.

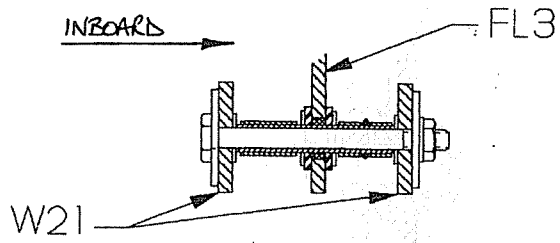


Fig 18. Section of hinge shaft between the W21 plates.

Now swing all hinge connectors over so they rest on the wing next to the W18 plates (set into the wing). The paired W21's will go between the two W18's and W19 and W20 should be positioned to the same side of the W18s as they are on the flap hinge arms.

Step 14

You'll notice that one of the screws through the W21s interferes with the W18s so file them locally to allow a clearance as shown in figure 19.

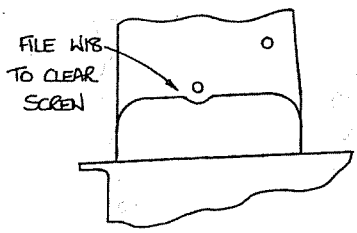


Fig 19. Detail of W18 plate filed to clear screw of W21.

Step 15

Due to the angle of the wing's trailing edge root the W19 inboard hinge connector will not fit properly against its W18 plate. This is catered for by bending W19 slightly as described next.

With W19 touching the wing, place a straight edge against the W18 plate and, sighting down the side of W19 mark the point on W19 at which the straight edge intersects it. See fig 20.

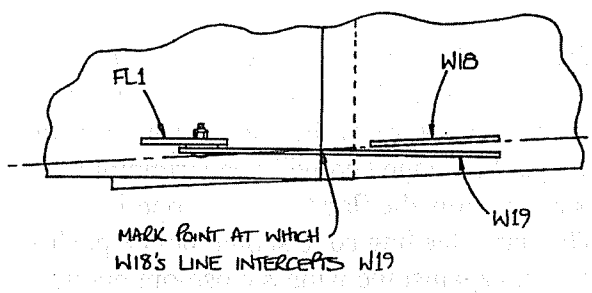


Fig 20. Marking W19 for the bend.

Mark a line on the side of W19, 90° to the flap's bottom skin, to run through your mark. This will be your bend line. (see figure 21).

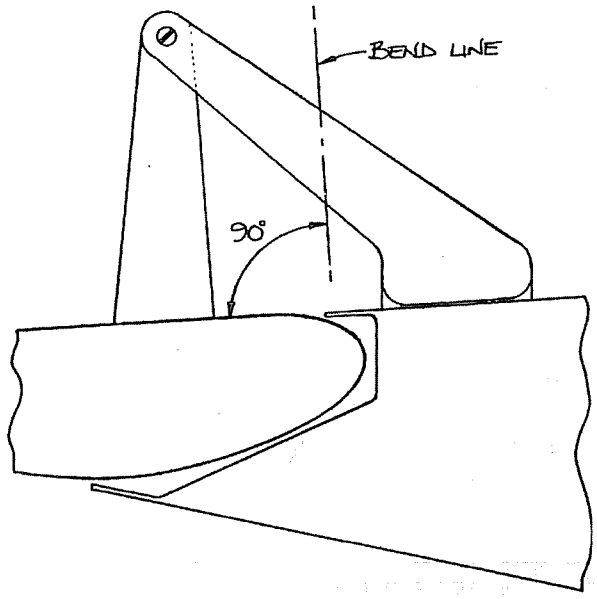


Fig 21. Bend line on W19 at 90° to flap underside.

Remove W19 and carefully clamp it in a vice, with soft jaws to prevent surface damage, so that it can be bent along the line.

Take care when bending W19 that you bend it *in the correct direction* and that you don't over bend it and therefore have to bend it back. A small over-bend will not cause a problem but excessive bending back and forth will weaken the metal.

Re-mount W19 then securely clamp the hinge connectors to the W18 plates with G-clamps then crack off the template and break the bondo blobs holding the flap. The flap can now be checked for correct operation before fitting permanently.

Step 16

Flap Connector Attachment

Mark the hole centres on the W18 plates for the attachment screws as in figures 22 and 23.

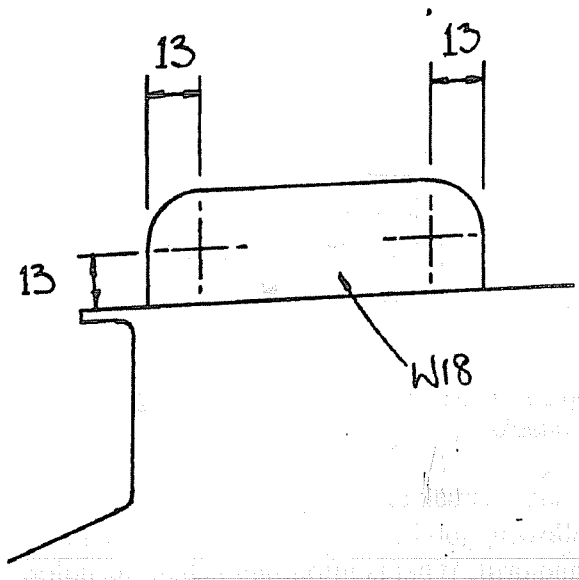


Fig 22. Hole centres (inboard and mid hinge connectors).

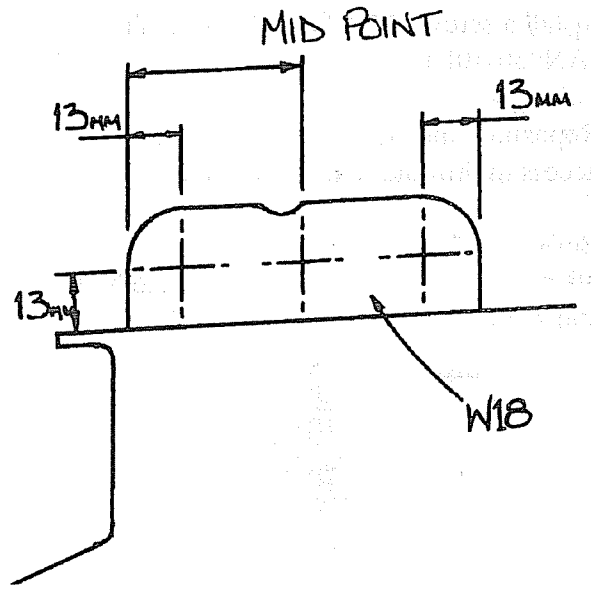


Fig 23. Hole centres for the outboard hinge connectors.

Note:

If you find that the hinge connector arms do not fall precisely in line with the W18 plates make sure the two holes near the edges are no closer than 10mm to the edges of either W18 or the hinge connector.

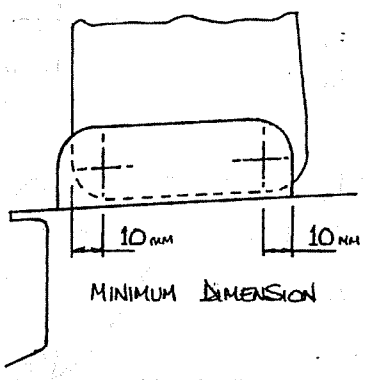


Fig 24. Hole centre with misaligned hinge connector.

A small chuck angle drill will be best for the following job but you can also use a small hand drill. What is important is that the holes you drill are square to the W18 plates.

Drill the holes 4.8mm (3/16") diameter, where the clamps are not in the way, and install a screw (AN525 10R10), washer (AN960-10L) and nut (MS21042-3) in each hole.
Reposition the clamps, one at a time, to give access to drill the remaining holes.

Before finally screwing the flap connectors up, separate the parts and remove the burrs and swarf around the holes.

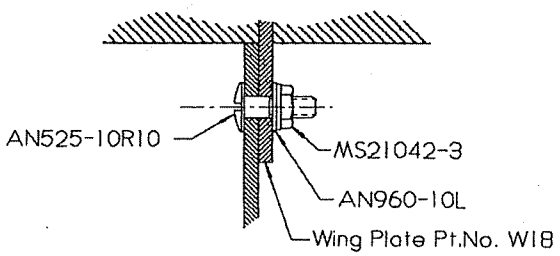


Fig 25. Section of attachment of hinge connectors to W18s.

Step 17

Outrigger assembly

The assembly of the outrigger retraction mechanism components is depicted in the drawing in figure 26. The view shown is that of the port side outrigger mechanism looking towards the fuselage from the outboard end of the wing.

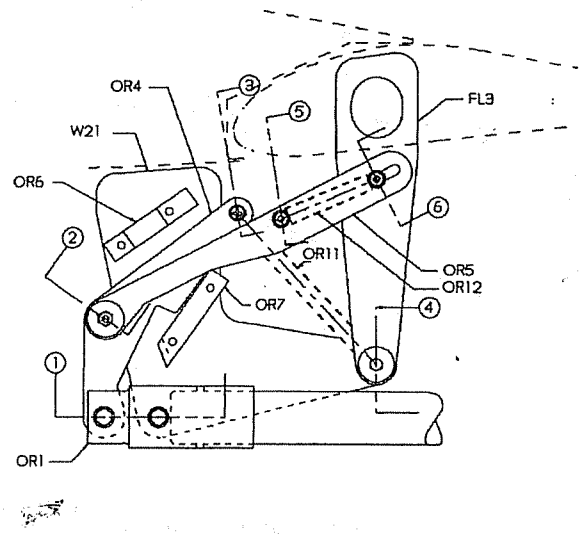


Fig 26. Section of outrigger retraction mechanism.

Note:

Larger scale detail drawings of the outrigger retraction mechanism and sections through various places are to be found at the end of this chapter. Use these, along with the following text, to complete the assembly.

Before final assembly is carried out, a certain amount of filing of OR4 will be required to ensure there is no play in the outrigger leg whilst extended.

Assemble OR1 and OR4 together as detailed in section 1 and figure 26.

Note: *There are two washers under the head of the AN4-11 bolt which connects OR1 and OR4. Also, two washers are required at OR1's pivot, on the opposite side. This is important to ensure good clearance between the AN4-11 bolt and the W21 plate. See section 1.*

It's important also that you select the correct OR4 arm for the relevant side. The two are different to each other in that the countersunk hole is handed. The countersunk side should face outboard.

Using the AN4-21 bolt, install OR1 between the W21 plates mounted on the wing, with OR4 slotted between the blocks OR6 and OR7. *There's no need to use the washers at this stage as you'll probably remove the sub-assembly several times to file OR4.* Rotate OR1 to the extended position (refer to figure 27) and check if OR4 will latch over OR7. File the step of OR4 a little at a time until it can latch the mechanism securely. If too much material is removed you'll end up with play in the outrigger which will cause wear at all the rotating joints.

Completing the mechanism's assembly should be quite straightforward, however it may be advantageous to leave connecting OR5 to the flap hinge arm, FL3, until last.

The sub-assembly of OR1, OR4 and OR5 can be carried out on the bench before installing into the main assembly.

Attach the short spring, OR12, to OR5 (section 5) then slot the two connected arms, OR4 and OR5, between the two blocks spacing the W21 plates (figure 26) and attach OR1 by its pivot bolt (section 1) ensuring it is free to rotate once the nut has been tightened.

Next, connect the longer spring, OR11 (which should already be installed on the hinge shaft) to OR4. See section 3.

To link up the final part of the retraction mechanism place the bolt and spacer through OR5's slot (section 6), place the spring over the spacer then pull the bolt to locate it through the hole in the flap hinge arm, FL3. Tighten the nut and washer against the spacer.

Operating the flap will now drive the outrigger retraction mechanism.
Don't be alarmed by the loud clatter when the latch arm drops into place, this is normal. Grease the latch arm and block before operating the mechanism too many times.

Step 18

Setting up the retraction mechanism

To function correctly, the flap should move through 27°, causing the outrigger to extend and latch by at least its 25° position. The remaining flap movement will not affect the outrigger mechanism due to the slot in OR5.

Checking the required flap angles is most easily done using an inclinometer, a device that enables accurate angular measurements to be made. Alternatively, the following method may be used.

Setting flap angle.

Locate your flap setting template back into its original position on the wing but with the flap extended so it's not prevented from moving by the trailing edge step.
Mark a line 51mm back from the trailing edge step then, from the datum line and at 90° to it, measure 134mm towards the flap. This position in space is where the flap's root trailing edge should be at 25°. The outrigger

mechanism should be fully latched with the flap in this position, in other words OR4 should be fully down against the light alloy block OR7 as in figure 27.

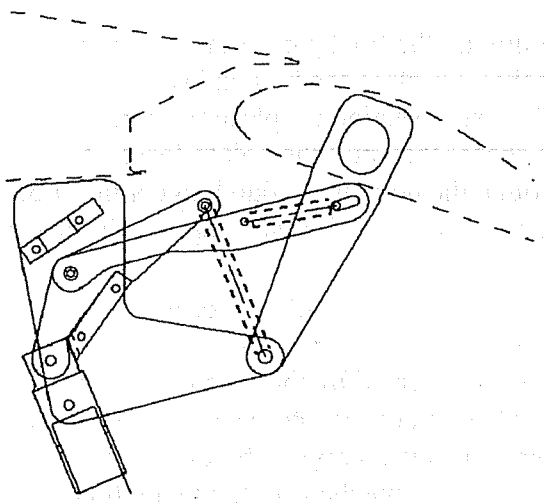


Fig 27. Outrigger fully latched at 25° flap.

To prevent unintentional retraction of the outrigger due to vibration causing the flap to move, the flap will be set to extend to 27°, this extra movement being catered for by the slot in OR5.

To establish where the flap's trailing edge should be at the 27° setting, mark your template 53mm aft of its trailing edge step then, again at 90° to the datum, measure 146mm towards the flap.

With the bolt through the outboard flap hinge arm FL3 and 1/3 to 1/2 way along the slot in OR5, any vibration of the flap at this setting will not effect the outrigger mechanism.

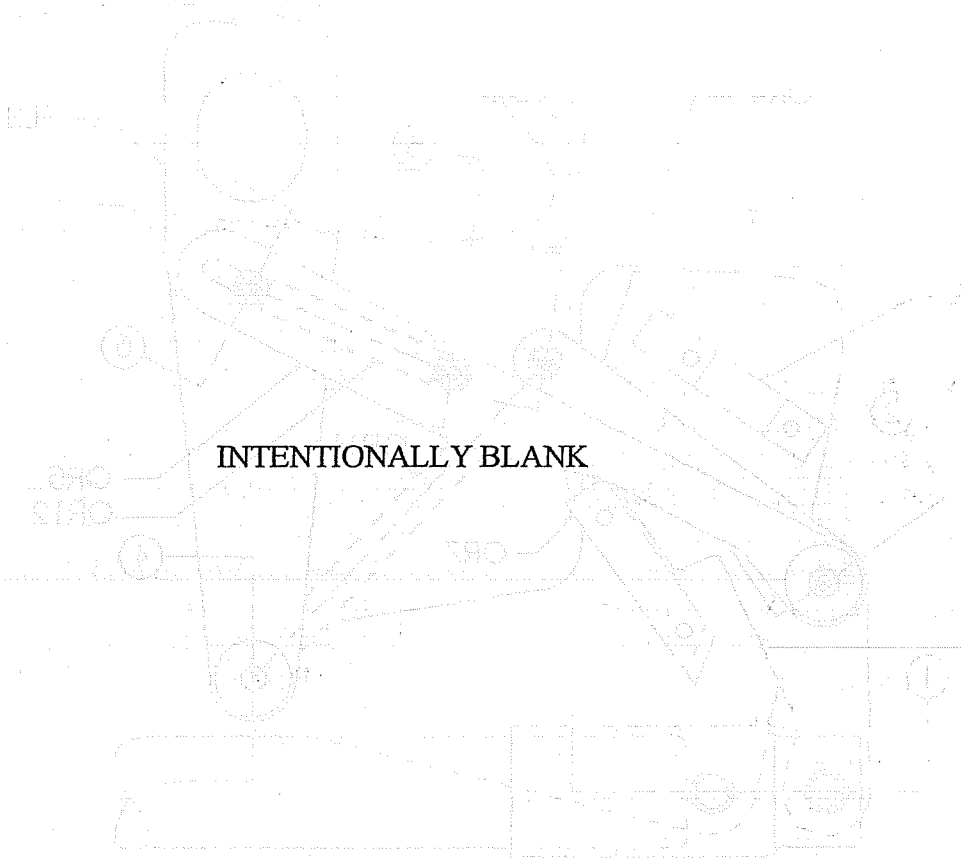
The final step in assembly is to add the leg, wheel and fork.
The wheel assembly comprises the wheel, a roller bearing, a spacer, and the nut and bolt.

Pack the bearing liberally with grease and insert it into the wheel followed by the spacer.

Install this assembly onto the wheel fork, OR3, and bolt up with the bolt and stiffnut.

Remove the outrigger retract mechanism socket OR1 and push the Nylon 66 outrigger leg OR2 into it and drill half-way through the leg with a 4.8mm (3/16") drill using the hole in OR1 as a guide. Aim as squarely as possible towards the hole on the opposite side. Now drill from the opposite side and you should find the existing hole quite easily. Run the drill through, if necessary, to enable the AN525-10R30 bolt through, securing it with an AN960-10L washer and an MS21042-3 nut.

Replace OR1 onto the retraction mechanism and slide the wheel fork OR3 onto the leg then, with the outrigger extended, sight down the side of the wheel to check its alignment to the W21 plates which are aligned fore and aft. When you are happy that the fork is in alignment with the W21 plates, drill through the leg with a 4.8mm (3/16") drill using the hole in the fork as a guide.
Drill this hole in two stages as you did at the other end of the leg and install the AN525-10R28 screw with an AN960-10L washer under the MS21042-3 nut.



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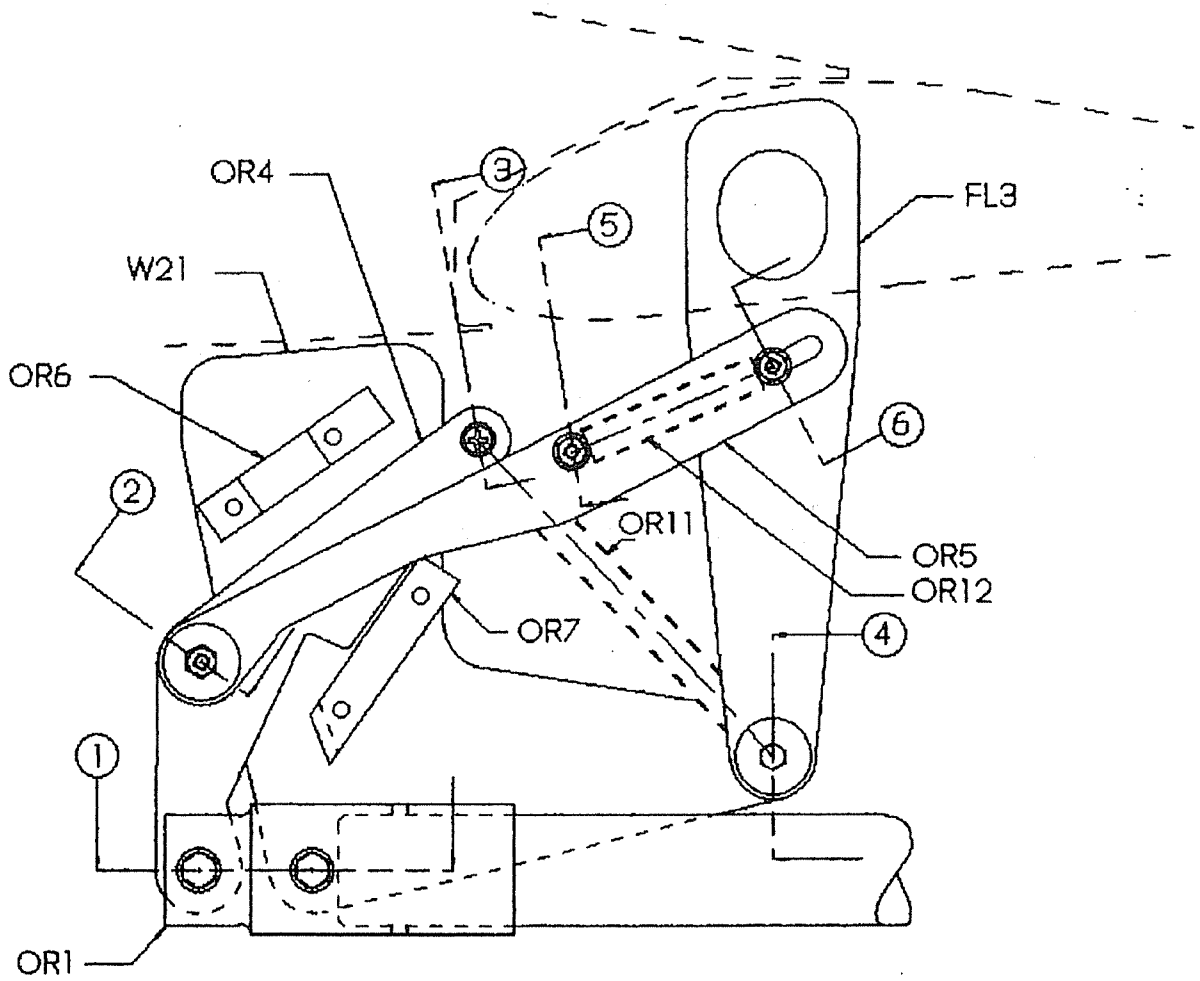
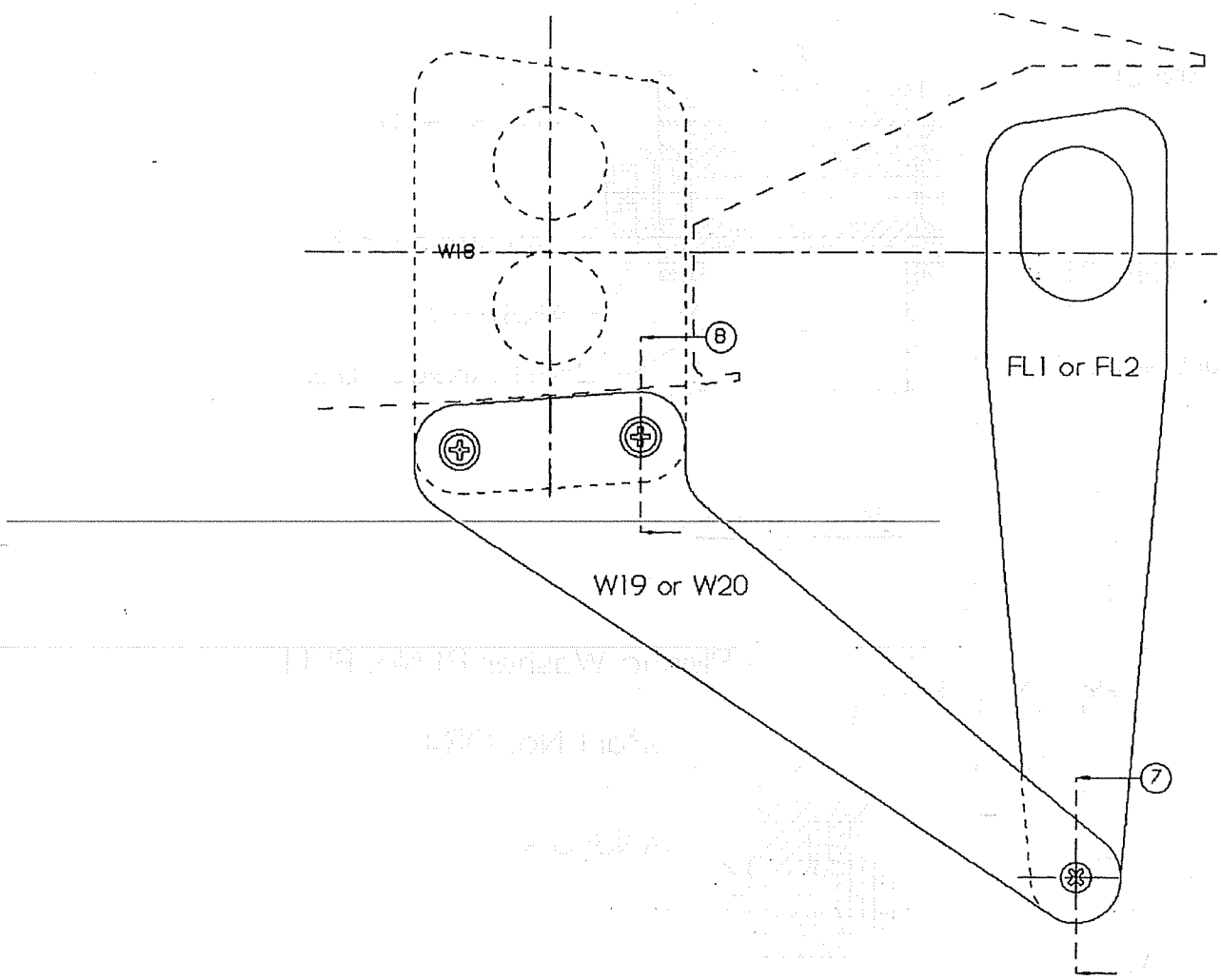
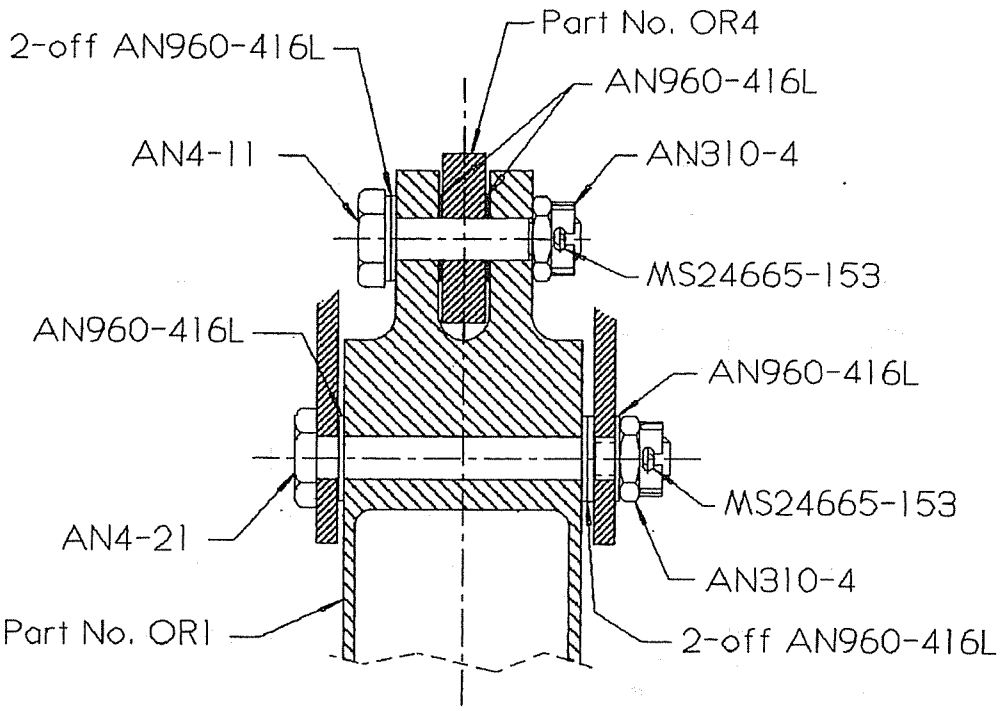


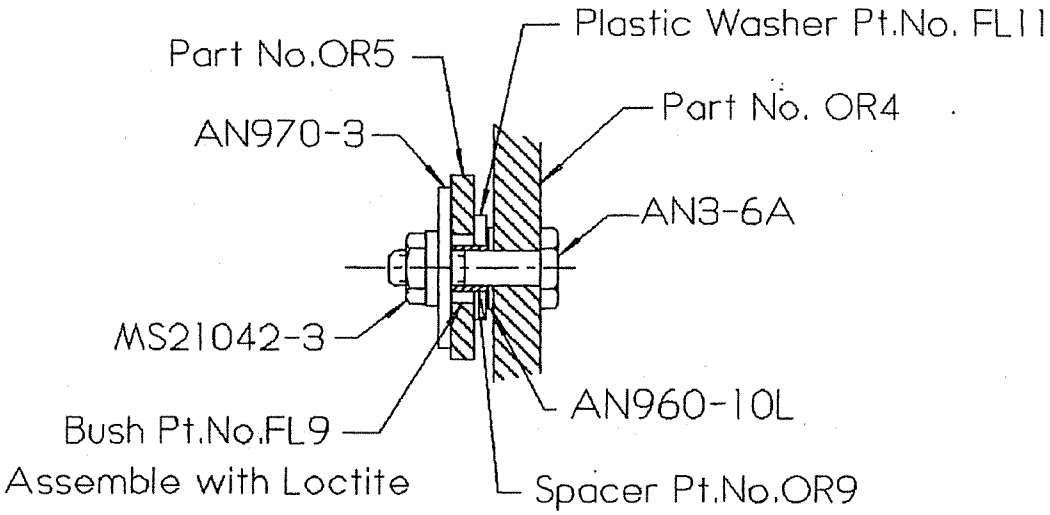
Outrigger mechanism showing section view locations.



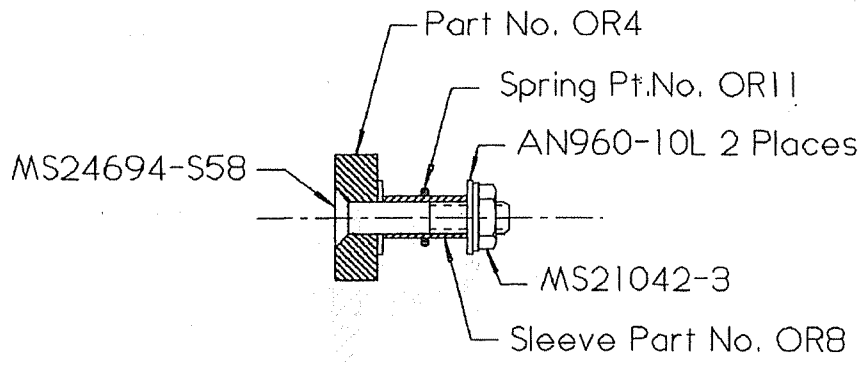
Inboard and mid flap hinges with section locations.



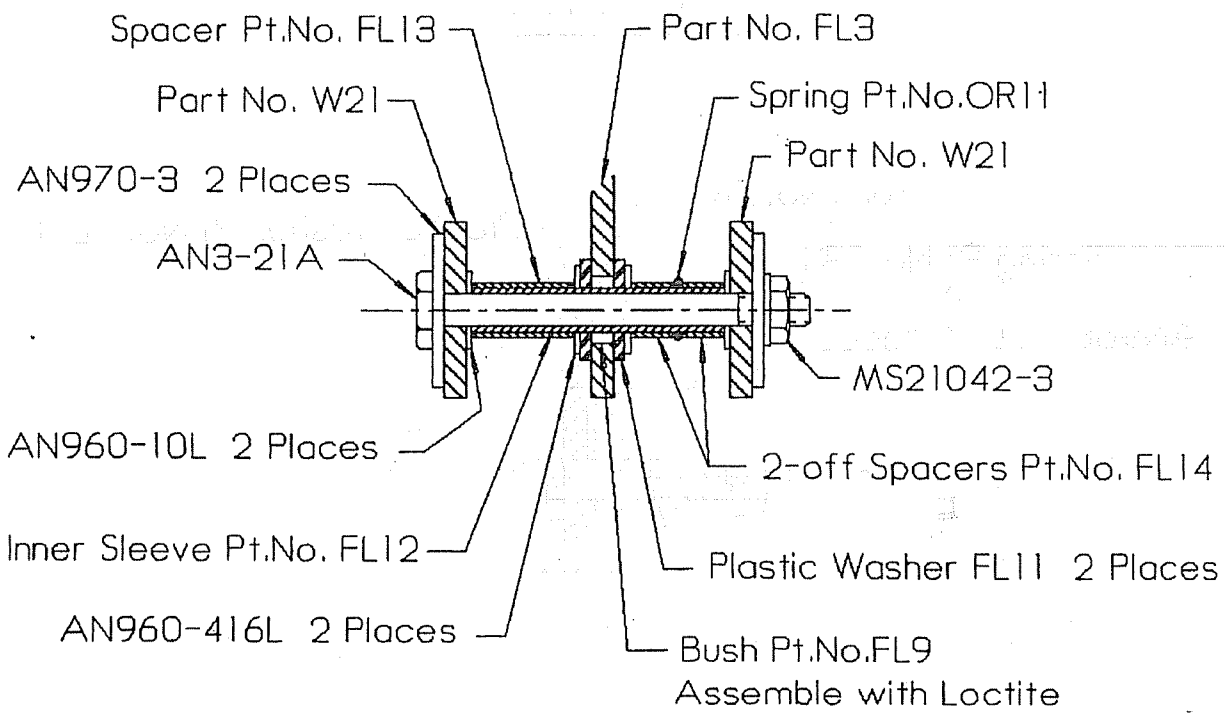
Section 1



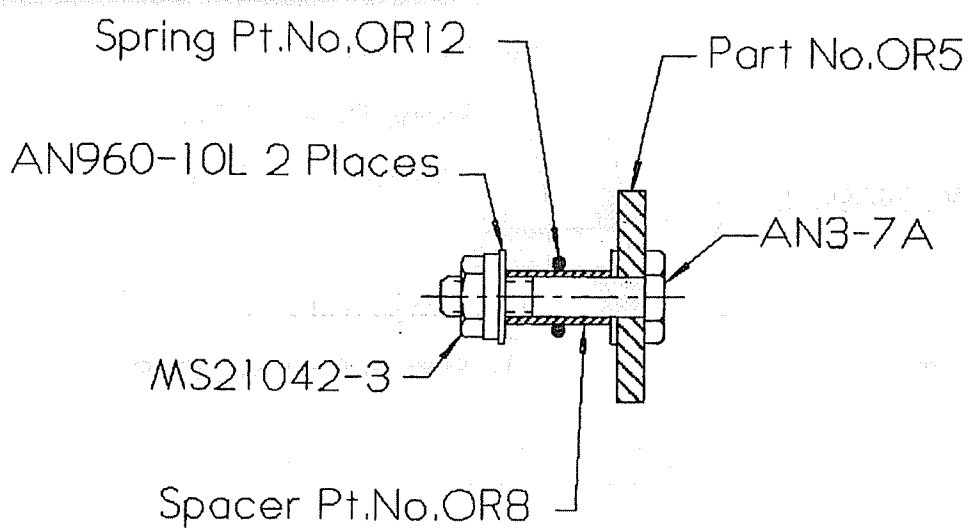
Section 2



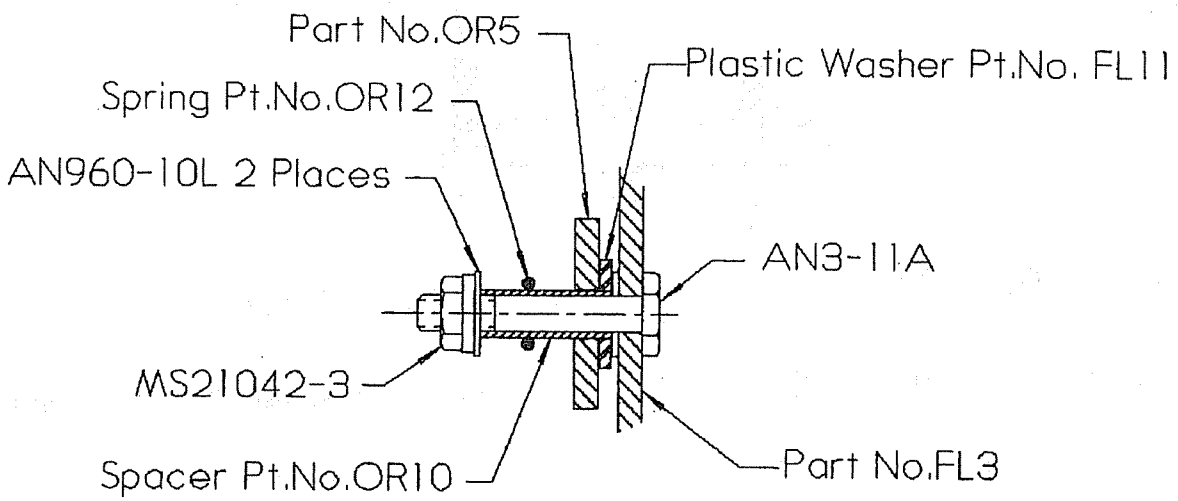
Section 3



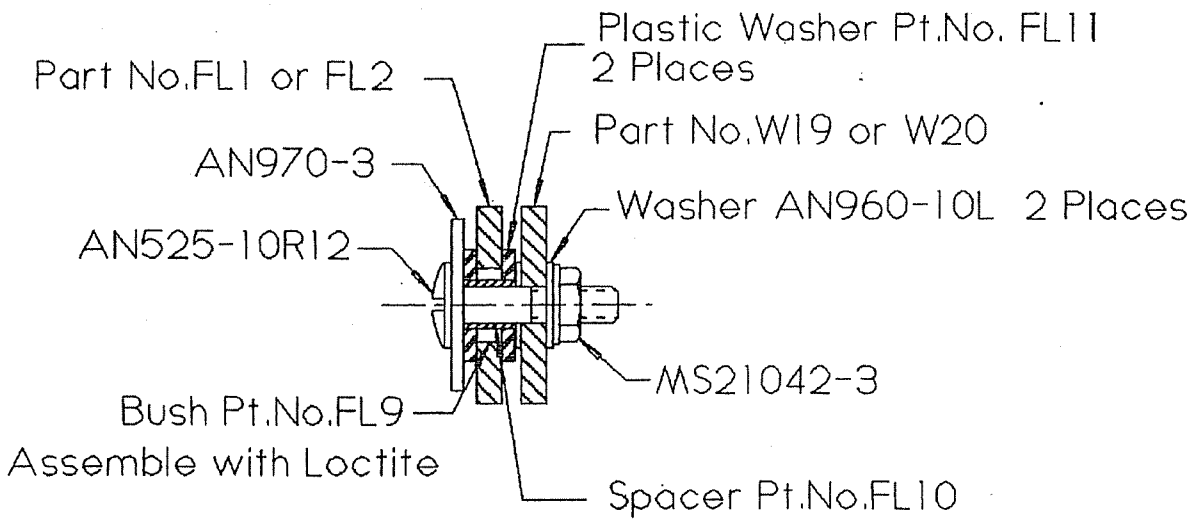
Section 4



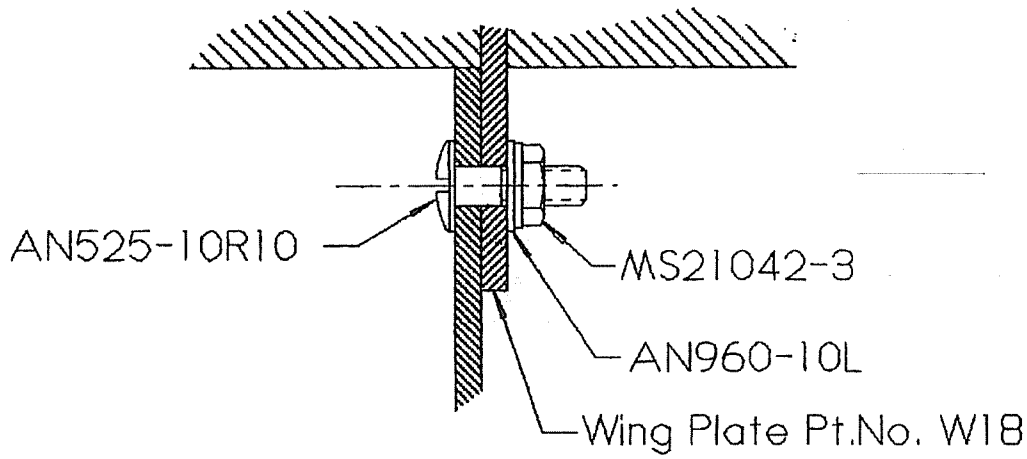
Section 5



Section 6



Section 7



Section 8