# Europa motor glider - introduction

## Overview

This manual details the build of the motor glider version of the Europa where it differs from the Europa XS.

The manual should be read in conjunction with the appropriate Europa XS manual.

Chapters 7, 8 and 9 are in place of the equivalent chapters in the XS manuals, and the remaining chapters are to be added in the appropriate places in the XS manuals.

## Classic Europa - important notes

1. The position of the forward wing-to-fuselage pin on the wing, and socket on the fuselage, of the classic Europa is different from that of the XS Europa.

It is not possible to position this fitting safely on the motor glider wing to suit the existing position on classic Europas.

To enable the motor glider wing to be fitted to classic Europas the forward fitting must be repositioned on the classic wing and the fuselage.

Detailed instructions on carrying out this work will be provided on application to the factory.

2. It is a mandatory requirement for fitting the motor glider wings to classic Europas that Mod 52, (the weight upgrade to 1370 lb maximum gross weight) is incorporated.

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# 6. Airbrakes (motor glider)

## Overview

The airbrakes are made in much the same way as the rudder. The main difference being that the ends are not rounded off but have close-out in two pieces each side, an inner and an outer.

The airbrake cores are supplied with the, by now familiar, pre-cut end pieces with which to make the flanges for the close-outs. A plywood insert is to be incorporated on to which you will mount the actuating brackets.

A single, almost full length, hinge holds the airbrake 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 airbrakes to be made together.

The airbrake is quite thin, and in the early stages of laminating can easily be distorted, so careful checking is necessary as you go along.

## Step 1

## Preparation

Place the inner and outer airbrake cores in their lower casings on a flat bench. Remove the top casings and set aside for later use.

Temporarily attach the pre-cut close-out flange end pieces in their relevant positions with small dabs of rapid epoxy.

Discard the crescent shaped foam strips, and remove the cores from the casings. With a hacksaw blade or sharp knife, remove the 20 mm vertical flashing in front of the leading edge from the lower casing, and replace the cores in the lower casings. See figure 1.

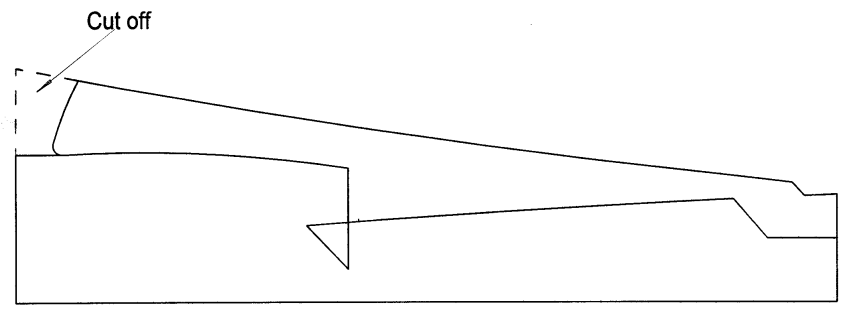


*Fig 1. Airbrake core in modified lower casing.*

Cut the 3 mm ply supplied (identified as Ply-13 in the bill of materials) to the dimensions shown in figure 2.

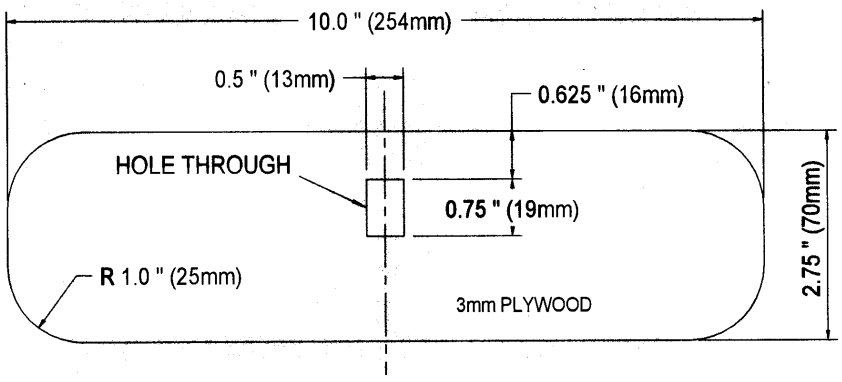


*Fig 2. Control horn reinforcement insert.*

Now butt the cores in their casings together, and align the centreline of the plywood insert with the joint of the inner and outer cores, with the forward edge of the plywood 0.85" (22mm) aft of the leading edge of the core. The ply should be orientated with the rectangular hole towards the leading edge - see figure 3. Mark the ply for orientation for future reference. Trace around the plywood with a felt tip pen.

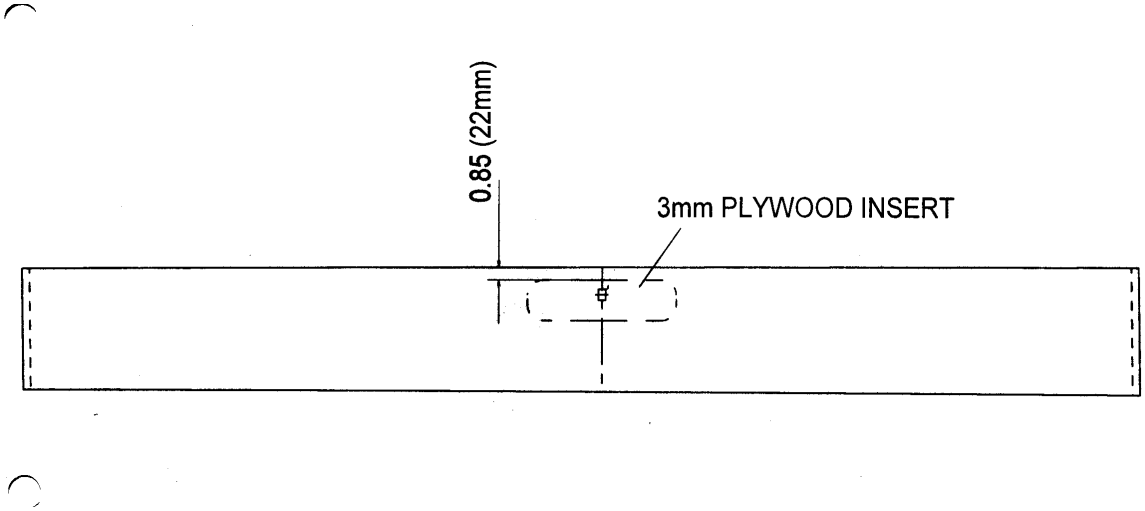


*Fig 3. Plywood positioned in airbrake core.*

Carefully rebate approx 4mm deep into the foam cores, inside the marked lines, so that the plywood will drop into place and be slightly below the surface. Scuff sand the ply faces with 80 grit paper.

Recheck the plywood orientation that there is no possibility of bonding it in the wrong way round. Check that the core has no twist along the length, or misalignment between the cores, and that the leading and trailing edges are in line. If necessary adjust with shims between the casings and the bench to achieve this.

Temporarily bond the lower casings to the bench with small dabs of rapid epoxy.

## Bonding cores together

When set, apply a strip of 2" (50mm) wide parcel tape over the join in the casings, to act as a release agent if any resin leaks through when bonding the two cores together. Replace the two cores in the lower casings, along with the plywood pad and the two ½" (13mm) end pieces in a 'dry run'.

When you are happy that everything fits together correctly remove the cores from the casing. Mix a small amount of dry micro, and carefully wipe a smear onto the adjoining ends of the cores, keeping just inside the edges.

Apply several small dabs of rapid epoxy to the leading and trailing edges of the upper surface of the lower casing. Position the two cores together into the lower casings, pushing them firmly together. Weight the cores down with suitable weights (small sandbags or weights with scrap foam under)to prevent denting the foam core.

## Plywood insert

Check again that there is no distortion along the length of the airbrake.

Apply micro into the rebate, wet the lower surface of the plywood insert with a coat of resin, and push it into the rebate until it is level with the foam surface.

Wipe any excess resin from around the edge of the plywood insert, cover it with plastic sheet, weigh it down with a scrap piece of flat board slightly large than the plywood to compress/level the insert in the core.

Checking again that there is no distortion, leave to fully cure.

After curing remove the weights and board, which should reveal a smooth flat surface with no noticeable step between the two foam cores and the plywood pad.

The rectangular hole(which will later provide clearance from the operating pushrod's rod-end bearing) in the plywood needs to be filled level, so cut a piece of scrap foam about 12mm (½") thick to fit into it, and stick into the hole with a dab of rapid epoxy. When this is set, cut off the excess foam and sand it flush with the plywood.

Mark lines on the foam core at +30° and -30° to the leading edge, which will provide guide lines for laying up the unidirectional cloth.

Using double sided tape, stick strips of peel ply to the trailing edge joggle, and to the two ½" end pieces. This will provide a clean surface on the lower surface of the layup for subsequent glass to glass bonds.

Using masking tape or parcel tape, mask the leading edge 'nose' from just below the upper surface down onto the lower casing, to prevent resin dripping down the leading edge which would otherwise bond the cores to the lower casings - see figure 4.

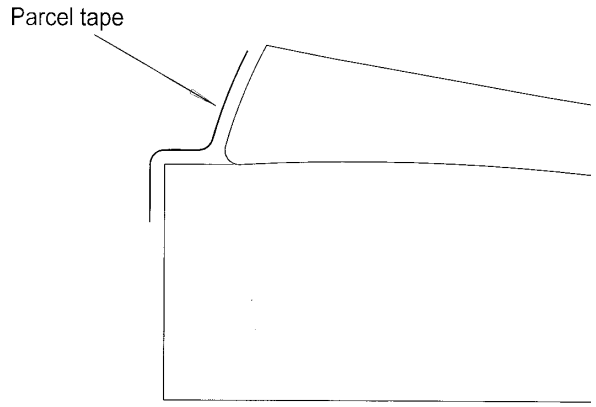


*Fig 4. Parcel tape around leading edge.*

Cut lengths of 'uni' to the following dimensions for each airbrake: 2 x 183 cm (72") long.

**Step 2**

**First lay-up**

Micro slurry the foam surface, keeping off the peel ply and also off the plywood insert. Fill any dents or cavities around the plywood with dry micro, again taking care not to contaminate the plywood insert. Wet the plywood insert, and the rest of the foam including the peel ply covered areas with epoxy and lay up the two plies of 'uni' - one at 30° to the leading edge and one at 30° the other way, using the lines you previously marked on the foam as a guide - see figure 5. You will find that the cloth is not wide enough, so scissor trim the excess and use the triangular piece as shown in figure 5. **Butt** the pieces together, do not overlap them.

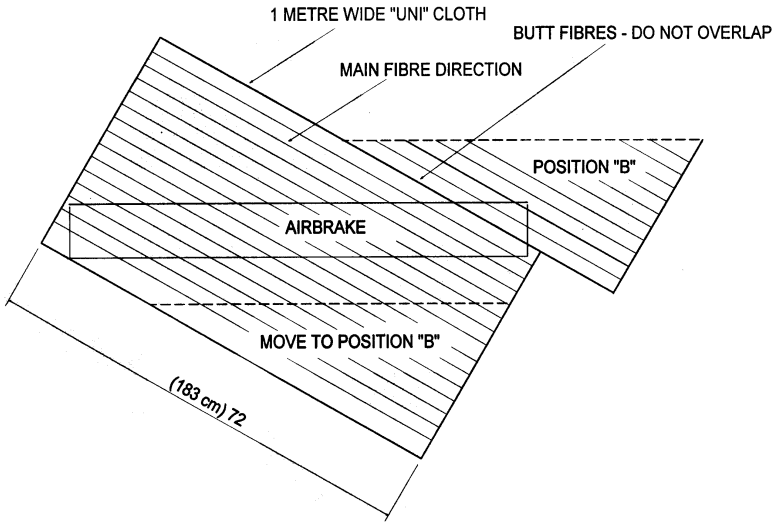


*Fig 5. 'Uni' lay-up - first ply.*

Scissor trim to within 10 mm (3/8”) of the core and allow to cure.

## Preparation for second lay-up

After cure, trim the skin back to the foam and carefully sand the edges with a sanding block with 80 grit paper.

Gently ease the core out of the lower casing, and move the lower casings from the bench. Retrieve the upper casings that you set aside earlier, and lay these on to the bench to receive the airbrake cores, which will now sit upside down in them.

At the trailing edge you will see that there is a large support block which kept the trailing edge stiff whilst you laid up the upper skin. This is now to be removed. Apply tape to 755 to 100 mm (3” to 4”) to the surface forward of the support block (to protect the surface) and remove the block with a hacksaw blade. Sand away what remains with a block with 80 grit paper until you expose the peel ply on the trailing edge joggle.

Remove the peel ply and the adhesive tape, and if necessary blend the surface into the joggle. Remove the masking tape, and again blend out any step with 80 grit paper on a sanding block - see figure 6.

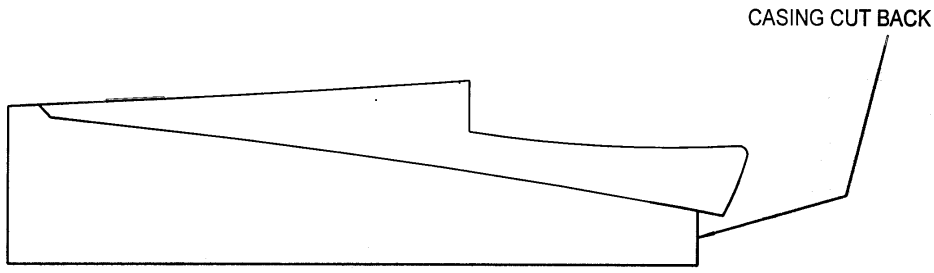


*Fig 6. Removal of support block.*

Cut away about 12 mm (½”) of the forward edge of the lower casing.

Now insert the core into the casing, and check again for any twist, shimming under the casing if required. When you are happy that there is no twist, temporarily bond the case to the bench and the core to the case with small dabs of rapid epoxy, apply weights ensuring that they do not cause any distortion, and leave to cure.

Mark lines at ±30°to the leading edge of the rearmost section of the airbrake, as you did earlier, to act as a guide when laying up.

Mask off the forward part of the surface from the leading edge 'nose' to the top of the vertical step, to prevent resin drips from contaminating the surface- see figure 7.

Remove all traces of foam dust from the core surface. Using double sided tape, cover the 12 mm (½") ends with peel ply only over the foam, do not take the peel ply all the way to the trailing edge. Also run a 15 mm (3/4") strip of peel ply along the leading edge of the rearmost section - see figure 7.

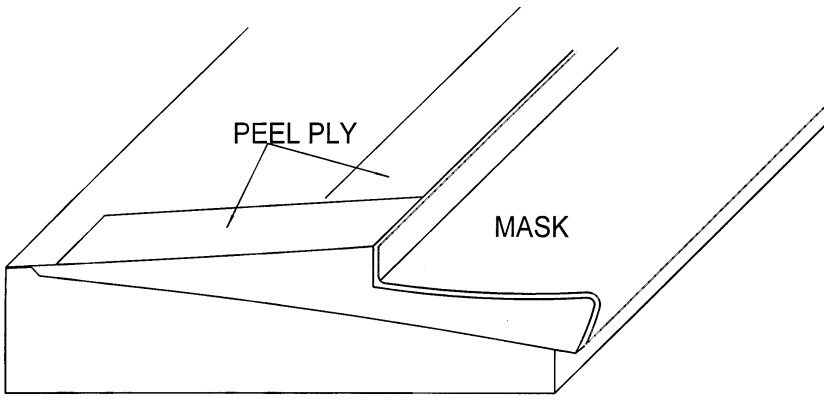


*Fig 7. Masking and peel ply on lower surface.*

Cut two pieces of 'uni' 183 cm (72") long.

## Step 3

### Second lay-up

Micro slurry over the blue foam. Do not contaminate the areas that are peel plied, or the 22mm wide glass area at the trailing edge with micro. Fill any dents with dry micro, then wet the glass trailing edge, taking care not to drag the micro slurry off the foam. Lay up the two plies of 'uni' at ±30° to the leading edge. Scissor trim to within 10 mm (3/8") and allow to fully cure.

When the second lay-up has fully cured, trim the glass back to the foam at the forward edge, and the two ends, and back to the first lay-up on the trailing edge. Sand the edges smooth with 80 grit paper.

## Hinge flange and closing lay-up

Remove the masking tape from the forward area, and re-cover with fresh masking tape to protect the foam from the next sanding operation, which is required to prepare the hinge flange. Cut a wooden sanding block "finger" from a piece of plywood or reasonably hard timber approximately 3/4" (19mm) thick, to the shape shown full size in figure 8.

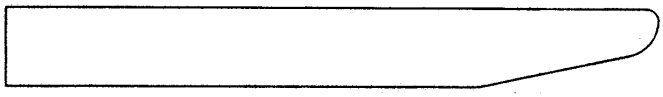

*Fig 8. Sanding "finger".*

Fix some 80 grit paper to the tip and very gently sand underneath the forward edge of the second lay-up until you have exposed all of the peel ply along the forward edge. Remove the peel ply and fully blend the underside of the skin around and into the forward area of the surface - see figure 9.

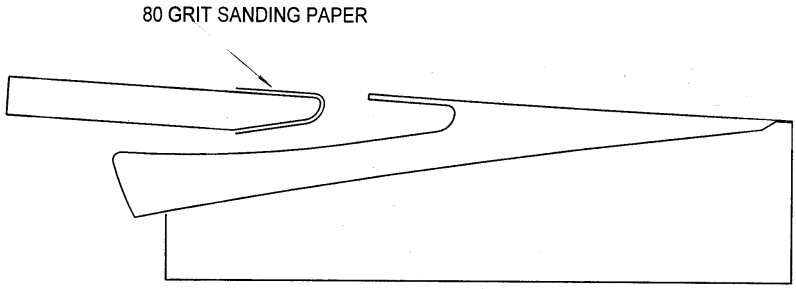


*Fig 9.Sanding rebate with "finger".*

There must be a minimum depth of 23 mm (0.9") on the cantilevered flange to allow for the next lay-ups and fitting of the hinge.

Remove the masking tape from the forward area and blend any mismatch out. On the very forward edge where the first lay-up ends you will need to cut out a 6 mm (1/4") cavity for a flox corner. This flox corner gives a load path between the upper and leading edge skins, and will also allow for it to be radiused later. - see figure 10.

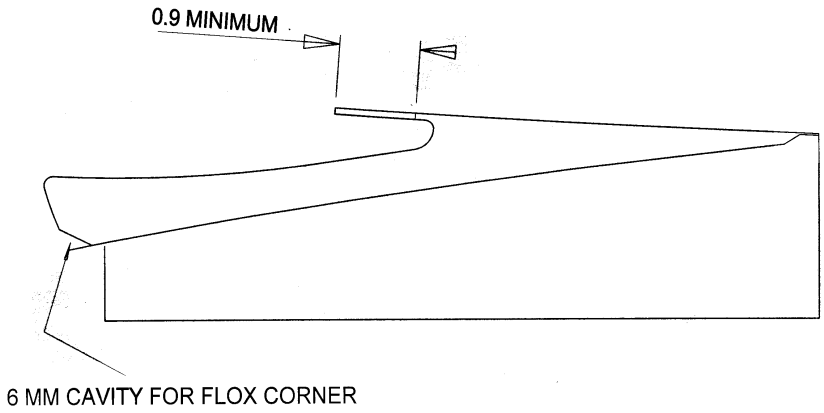


*Fig 10. Flox corner cavity.*

You will now need to dig out some of the foam on the lower forward face to expose part of the plywood pad which you bonded in earlier. Working from the core join line you will expose 3" (75mm) of plywood -1 ½" (37mm) each side of the join line - and fore and aft to expose the 2.75" (70mm) width of the plywood. Remove the foam to give a smooth transition from the foam surface into the plywood insert as shown in figure 11.

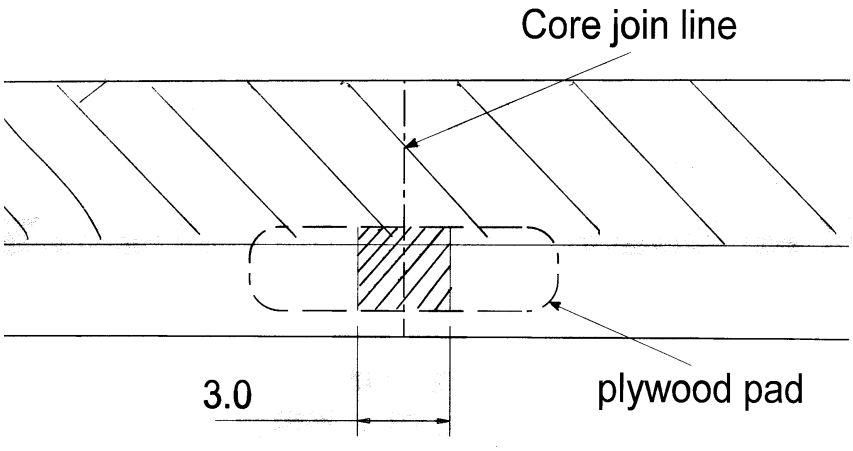


*Fig 11. Underside view of airbrake.*

The side of this rebate should have a gentle transition from the ply into the foam surface. See figures 12 and 13.

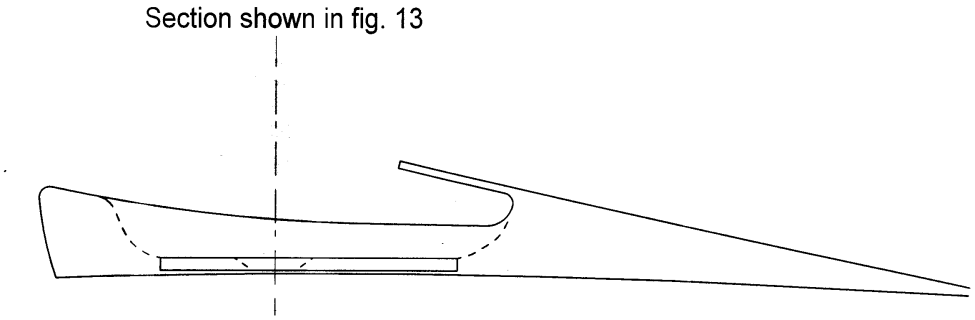


*Fig 12. Removing foam from plywood insert.*

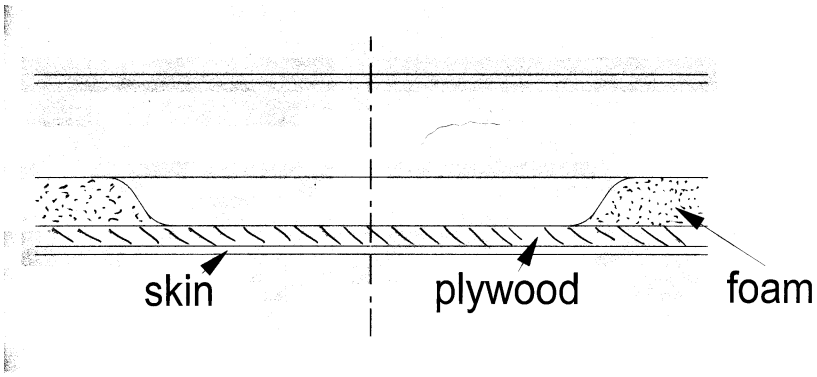


*Fig 13. Cutting away foam to the plywood insert.*

On the leading edge at the join line you will need to sand a round slot to allow clearance for the actuating pushrod coming out of the trailing edge of the wing to reach the control horn that will be attached to the centre of the plywood insert.

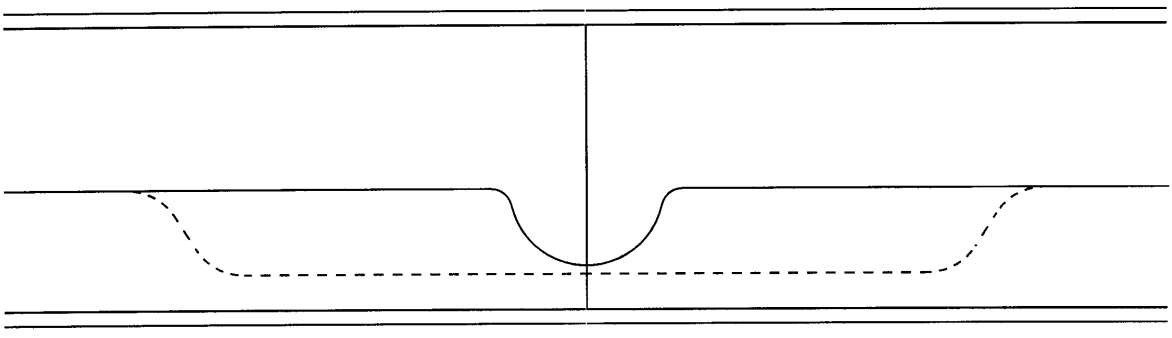

*Fig 14. Slot for pushrod shown from leading edge.*

Fully remove **all** the micro from the plywood insert. Dig out the plug of foam in the rectangular hole and chamfer the edges at 45°. Vacuum away all the foam dust and chips from the core surface.

Cut 4 lengths of 'bid' at ±45° 180 mm (7") wide x full length.

Apply peel ply to the foam areas of the 12 mm (½") end pieces - do not peel ply onto the glassed area of the end pieces.

Support the airbrake - leading edge up, in foam blocks with wedges, and mask off all the surfaces which have already been glassed, with tape and plastic sheeting.

### Third lay-up

Mix up some micro-slurry and seal all the blue foam, taking care not to contaminate any of the glass or plywood areas. Thicken up the slurry with more micro to make a paste. Fill any dents or chunks, again taking care not to contaminate the plywood.

Mix up some flox and trowel this into the leading edge cavity, keeping it clear of any micro - make the smallest possible flox fillet around the edges of the rectangular hole in the plywood to transition the cloth onto the glass.

Whilst you have the flox you can use it to repair any small areas of damage on the plywood insert.

Brush a coat of resin over the entire surface, including the peel plied area - taking care not to wipe micro onto the glassed areas.

Lay-up a ply of 'bid' at ±45° to overhang the leading edge, going all the way around the surface onto the hinge flange. Rolling up the 7"(18cm) wide strips and unrolling them along the surface should help prevent the cloth from distorting too much. The cloth will not be long enough to cover the full length, so you will have to overlap at least 40mm (1 ½") - not a butt joint as with 'uni', but a full 1 ½" overlap. Fully wet out and squeegee, ensuring that there are no bubbles in the micro. Trim the cloth to 10 mm (3/8").

Now lay-up a second full ply, starting from the other end so that the joins do not occur in the same position. Ensure that there are no bubbles in the rectangular hole.

Finally layup two plies of 'bid' at ±45° to reinforce the entire hinge flange. These plies should cover the hinge flange, go into the Vee, and run about 50mm (2") onto the airbrake. Make the second ply slightly narrower than the first to avoid a sudden change of thickness - see figure 15.

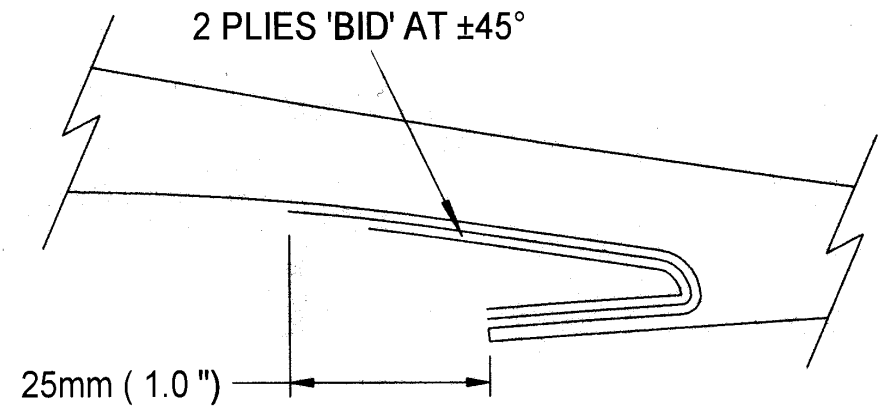


*Fig 15. Hinge flange reinforcement.*

If you wish you can peel ply the hinge area around onto the foam, trim to 10mm (3/8”) and allow to cure.

When cured, break out the 12mm (½”) end pieces, remove all the peel ply and lay-up 2 layers of ‘bid’ at ±45° to form the end rib close out, using the same procedures as carried out for the ailerons. Stagger where the layers finish to provide a gradual transition.

Finally, sand the entire length of the upper leading edge corner with a 3mm (1/8”) radius.

Using the joint line between the two airbrake cores as your centreline and the square hole in the plywood insert as a guide, cut two slots for the brackets through the upper skin. The slots should be as narrow as possible to retain as much of the original structure as you can, but at the same time to allow the brackets through with a small amount of adjustment prior to bonding.

# 7. Ailerons (motor glider)

## Overview.

The ailerons are made in much the same way as the airbrakes. Bonded in the root end of each aileron is a plate and bolt with which to attach the actuating push-rod**.** Three 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 close out flange end pieces in their relevant positions with small dabs of rapid epoxy.

The inner and outer sections will next be joined together and aileron cores treated as one component. The cores are cut so that they mate correctly when they are put together with the upper surfaces on top - this way any small variations in the casing thickness will not have any effect. Set the two cores together in their lower casings and check that leading and trailing edges are continuous from one core to the next. Once you are happy with the mating faces remove the cores from the lower casings, apply rapid epoxy to their mating faces and reset them, in the lower casings. From now on they may be regarded as one single core.

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

Saw away about 5 cm (2") from the leading edge of the lower casing (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. Lay the aileron core into the casing and use ***small*** blobs of rapid epoxy, if necessary, to keep it flat too. Check that there is no twist along its length before proceeding - there is no washout on the motor glider wing.

*Being so long and slender the aileron cores will easily bow and if skin lay-ups 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 190 cm (75") long, and several strips of peel ply.

Mark lines on the core at +/- $30^{o}$ 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. Peel ply also the tip and root flange cores.

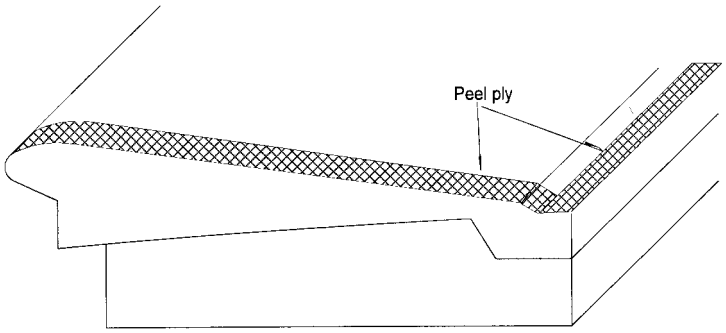


*Fig 1. Aileron in trimmed lower jig block.*

**Step 2**

## First lay-up

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

Coat the foam now with epoxy then lay the first ply on at $30^{o}$ to the leading edge, wrapping around the leading edge to within about 1 cm (½") of the corner. See figure 2.

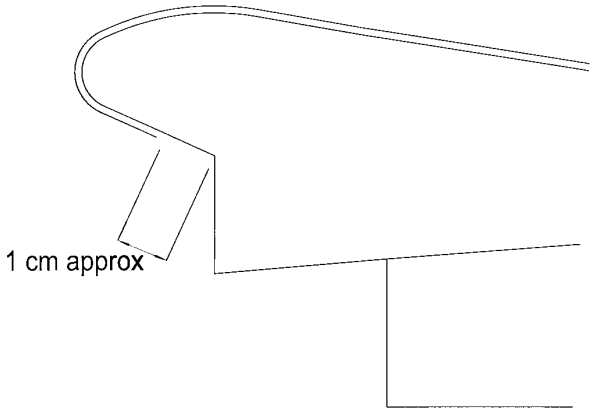


*Fig 2. Extent of lay-up at leading edge.*

You will find that the cloth is not wide enough to cover the whole surface, so scissor trim the excess off and use the triangular 'scrap', see figure 3. **Butt** the 'scrap' piece to the main ply, do not overlap.

Squeegee this layer thoroughly along the line of the fibres before scissor trimming the overhanging edges to within 1 cm of the foam then lightly apply a coat of epoxy and the next ply at $30^{o}$ to the leading edge *the other way.* You will need to butt a 'scrap' piece as you did before.

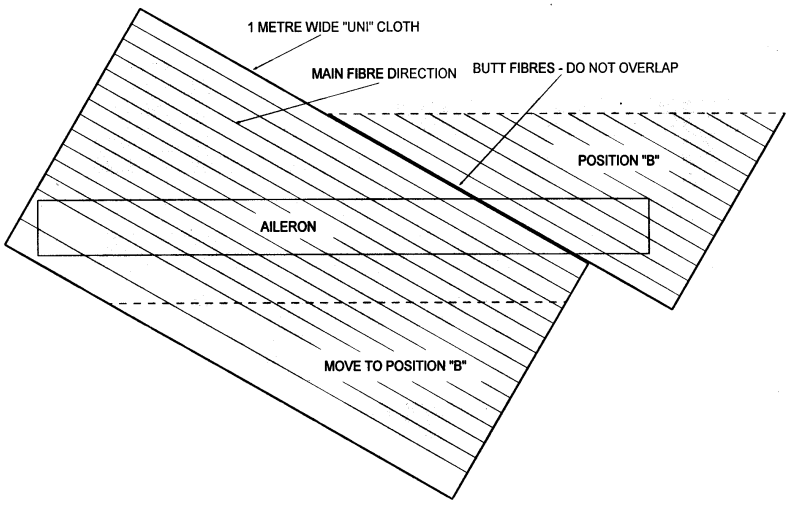


*Fig 3. "Uni" layup.*

Scissor trim this layer after squeegeeing then apply peel ply to the ends of the fibres at the leading edge and allow to cure - see figure 4.

Knife trim the edges at the appropriate time, sanding them back after full cure.

**1st lay-up 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. Apply a layer of masking tape to the skin 75mm - 100mm (3" - 4") forward of the trailing edge support block, to protect the surface. 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 5.

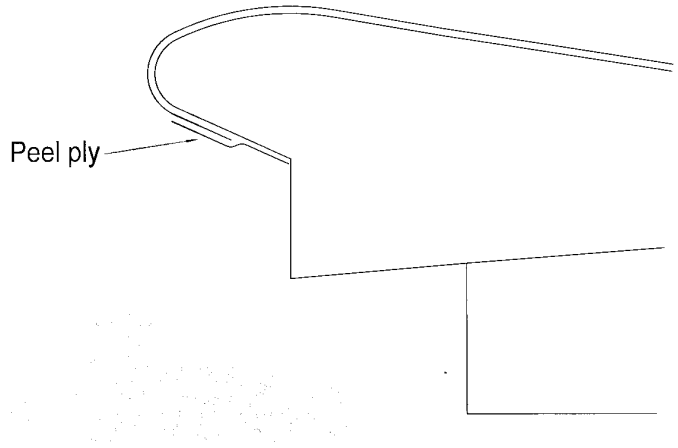


*Fig 4. Peel ply at leading edge.*

Apply a 19mm (3/4") strip of peel ply to the leading edge, using double sided adhesive tape, and on to the foam area of the tip and root flange cares, **not** on to the glass trailing edge area - see figure 6.

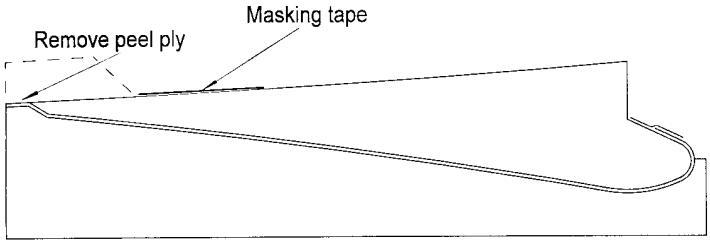


*Fig 5. Aileron with trailing edge support block removed.*

Cut pieces of 'uni' cloth as follows: 2 off 190 cm (75") long

Mark the foam of the aileron with lines at +/- 30$^{o}$ from the leading edge with which to orientate the cloth.

**Step 4**

## Second lay-up

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

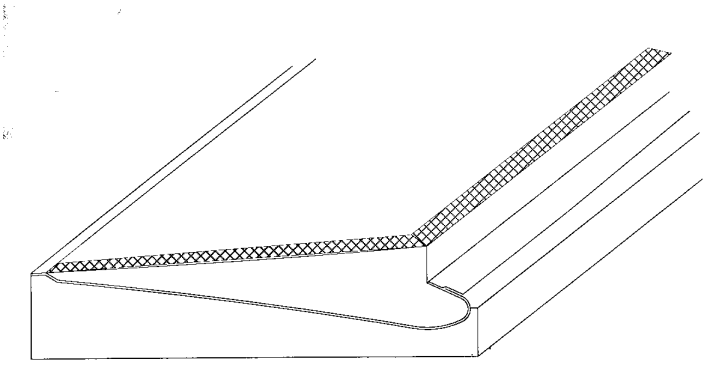

*Fig 6. Application of peel ply.*

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 lay-up 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 7. Check that sufficient foam is removed for the hinges to fit, allowing approximately 5 mm (3/16") for the radius of the close-out lay-up (refer to figure 9). Remove the leading edge peel ply in preparation for the leading edge lay-up.

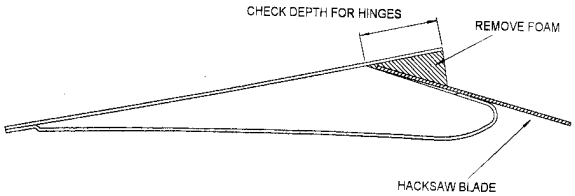


*Fig 7. Removing foam under skin for hinge.*

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

3 off full length x 10 cm (4") Leading edge (leave the ends at 45°)
6 off 18 cm x 10 cm ( 7" 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 8) in blocks of foam with vees cut in them.

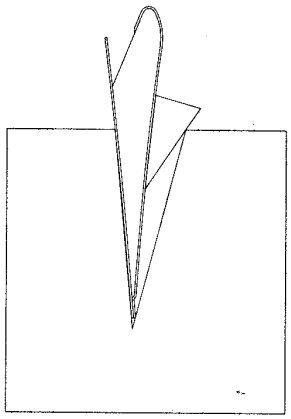

*Fig 8. Aileron set in foam "V" blocks.*

**Step 6**

## Leading edge lay-up

Apply micro slurry to the foam making sure it's wiped off the glassfibre flange before lay-up. 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 lay-up area with epoxy then roll the first layer of cloth out from one end progressively, stippling it into place as you go. See figure 9. The cloth will not run the full length of the aileron, so join with one of the other pieces, overlapping 37mm (1 ½") on to the first piece. Keep the excess cloth to one side.

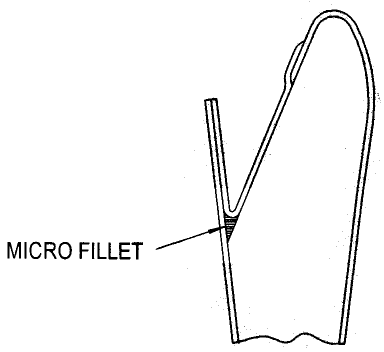


*Fig 9. Leading edge lay-up.*

Once thoroughly wetted out apply two hinge reinforcement plies in each of the three locations shown in figure 10 then apply the next full ply in a similar manner to the first, starting from the opposite end to the first (so that the join is in a different position), again with a 37mm (1 ½") overlap, using the offcut from the first layer (overlap with the 45° end).

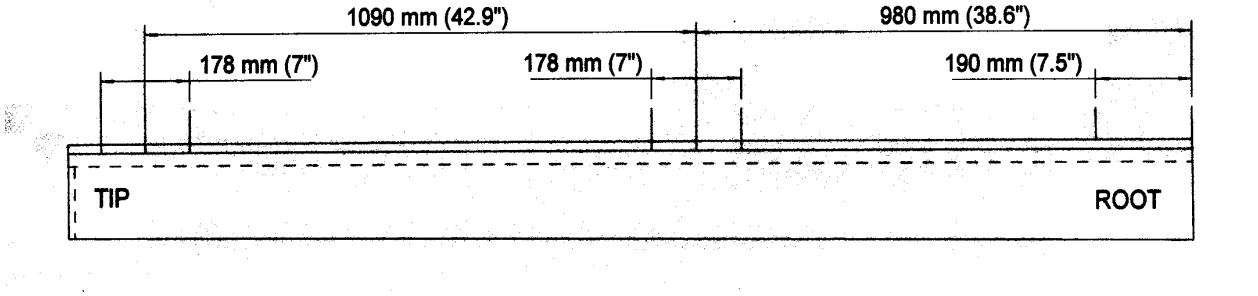


*Fig 10. Hinge reinforcement ply locations*

Apply peel ply on the fibre ends of the leading edge and on the flange over the hinge reinforcements - see figure 11. Leave to cure. After cure trim and sand the aileron's ends then crack out the foam end core pieces.

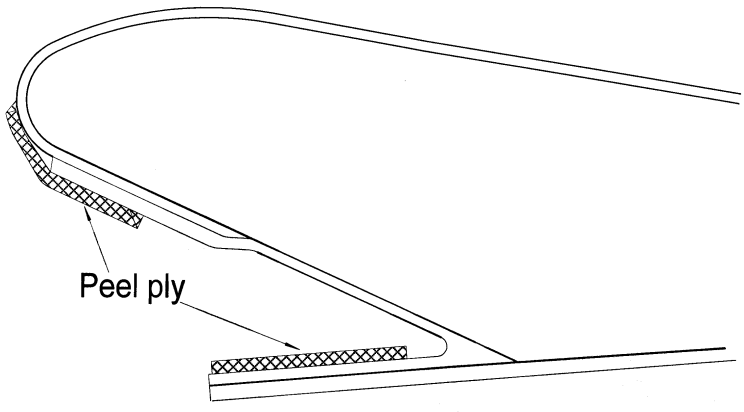


*Fig 11. Detail of peel ply position.*

**L.E. lay-up summary.**

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

**Step 7**

## Close-out lay-ups

Clean the remnants of foam from the insides of the resulting glassfibre flanges in readiness for laying up, remove the peel ply, and on the root close-out only make a cut out on the leading edge only for a flox corner - see figures 12 and 13. This will be needed for strength, since in this area a large part of the leading edge will be removed later to provide clearance for the aileron push-rod.

Bonded in each aileron root will be an AN4-10A bolt through a GA02 plate with an EUR001 washer as in figure 12.

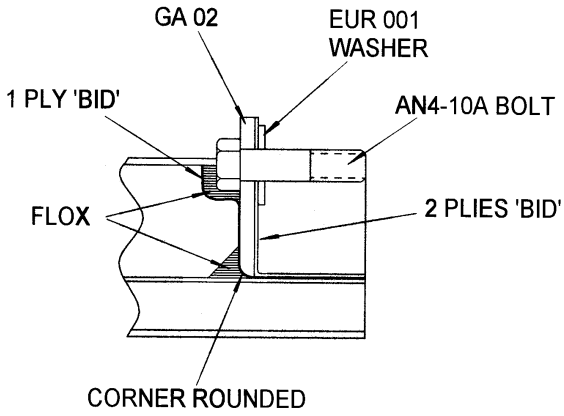


*Fig 12. Section through aileron root.*

The tip close-out is a simple 2 ply lay-up.

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

**Step 8**

## Root close-out

Before you start this lay-up you'll need to get together the following;

GA02 plate, AN4-10A bolt, EUR001 washer, AN960-416L washer, AN316-4R nut, and FL13 spacer.

File the flat sides and the large radius of the GA02 plate as necessary so that it sits in the position shown in figure 13. Scuff sand the GA02 plate on both sides with 60 grit paper and also sand the bolt head. GA02 should have its lower straight edge 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.

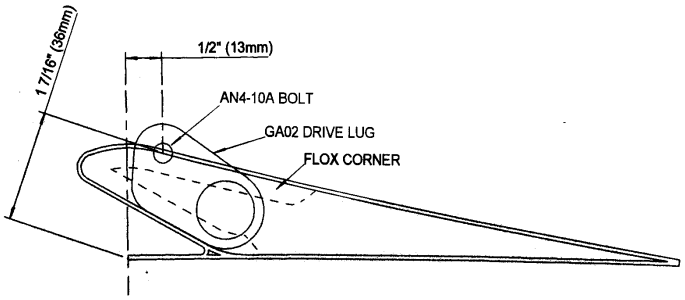


*Fig 13. Section through GA02 plate in root end.*

With the bolt through the hole in the GA02 plate mask its shank and thread to keep epoxy off. Position the GA02 plate and bolt in the end of the aileron's root, as in figure 13, 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. Double check that the distance from the bolt hole centre to the end of the leading edge flange is the same on both ailerons.

Micro slurry the foam in the aileron close-out, wiping off any that gets on the glassfibre flanges, then apply flox into the leading edge groove you made earlier. Next, 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 GA02 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 14.

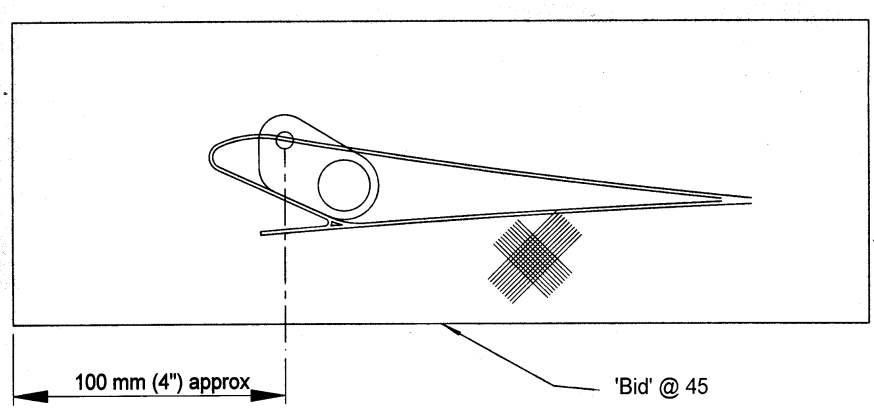


*Fig 14. Where to poke the bolt through the cloth.*

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. Temporarily install the lightly greased FL13 spacer, washer and AN316-4R 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 15.

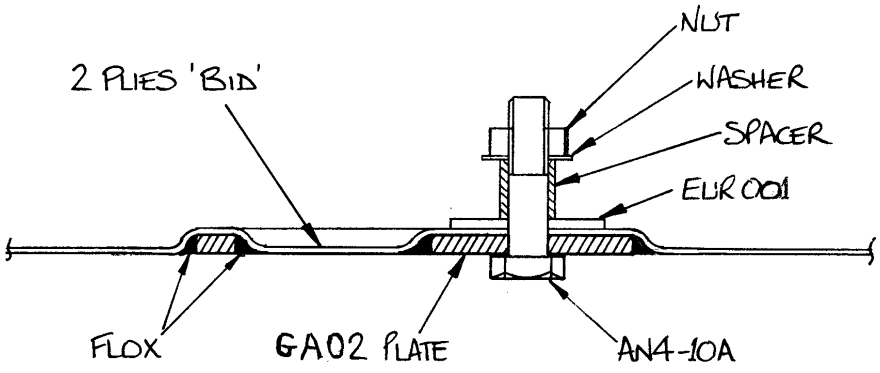


*Fig 15. Section through GA02 plate ready for installation.*

Apply a generous amount of flox to cover the bolt head and scrape some into GA02'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 GA02 assembly into the aileron's close-out, stippling the plies into place then, having double checked the dimensions in figure 13 and made sure nothing will move, stand the aileron on its tip end and allow to cure. Where the GA02 plate sticks above the surface of the aileron, on the bolt head side, apply a fillet of lox covering the bolt head and running down on to the surface over a length of approximately 12mm (½"). Cover this fillet with 2 layers of 'bid' to give added support to the GA02 plate and to streamline the area. Allow to cure before trimming and sanding.

**Root close-out lay-up summary.**

1 ply 'bid' +/- 45° in root
GA02 plate
2 plies 'bid' +/- 45° over GA02 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 lay-up 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. Three 4" long MS20001-5 hinges are attached to the inside of each aileron flange with flox and pop-rivets. See figure 16.

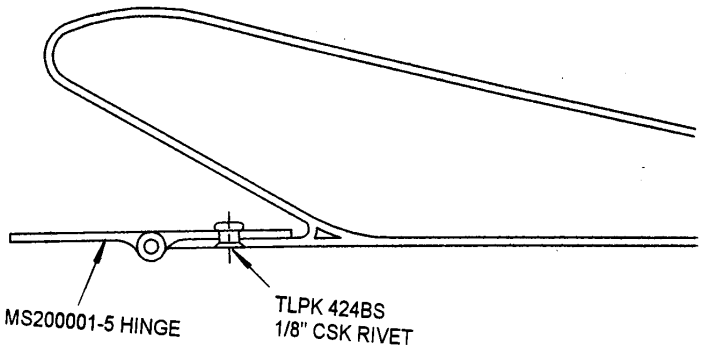


*Fig 16. Typical section through aileron hinge.*

File the hinges' edges to smooth off any roughness then cut pieces of hinge wire to be about 1 cm (½") longer than the hinge itself to allow for a bend at each end for safetying. See figure 17.

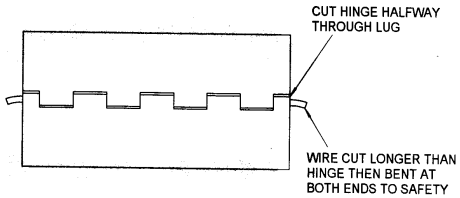


*Fig 17. Typical method for safetying hinges.*

To do the safetying put the hinge vertically in a vice, gripping only the lower 6mm (1/4"). Using a straight block of wood to support the wire, bend the wire through about 30° -40°.

Lightly lubricate the wire with thin oil (3 in 1 or similar) and insert it into the hinge. Grip the remaining 6mm (1/4") or so of hinge wire in the vice, again vertical, with the previously folded wire end pointing towards you.

Orientate the hinge with the spine towards you and the hinge flanges away, (making a "Vee"). Put a piece of wood into the Vee and holding the wood and hinge firmly, pull towards you, again to about 30° - 40°. This completes the safetying of the hinge.

Mark the areas where the hinges will go onto the aileron flange as in figure 18.

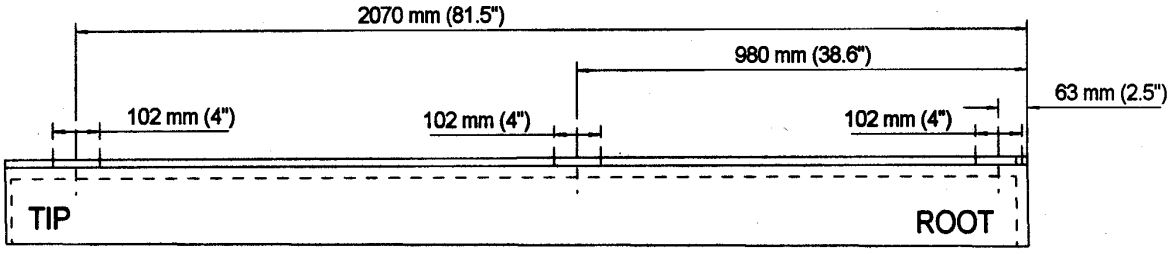


*Fig 18. Hinge positions to be marked on aileron flange.*

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 19.

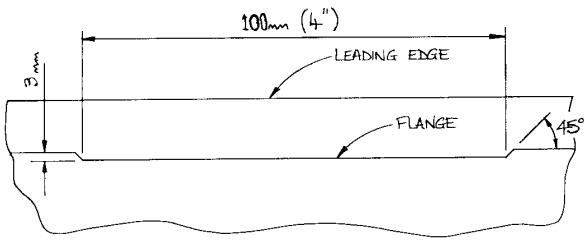


*Fig 19. Flange cut back locally for hinge.*

Adjust the cut-outs until the hinges fit correctly.

Clamp the hinges for one aileron onto a straight edge (see figure 20) in their relevant positions placing them against the aileron as a double check.

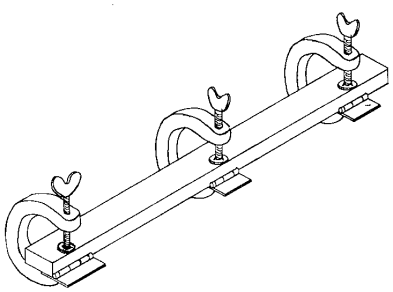

*Fig20. Hinges held in line on straight edge.*

Mark the rivet hole centres onto the aileron as laid out in figure 21 then, holding the hinges in place, drill through with a 3.3 mm drill placing a Cleco in the first few holes to maintain their positions whilst drilling the remaining holes. Ensure when doing this operation that the distance from the hinge pin to the AN4-10A bolt is exactly the same for each aileron - refer back to figure 13. Note that the 17mm and 10mm dimensions are from the leading edge of the hinge flange, not the edge of the hinge cut-out.

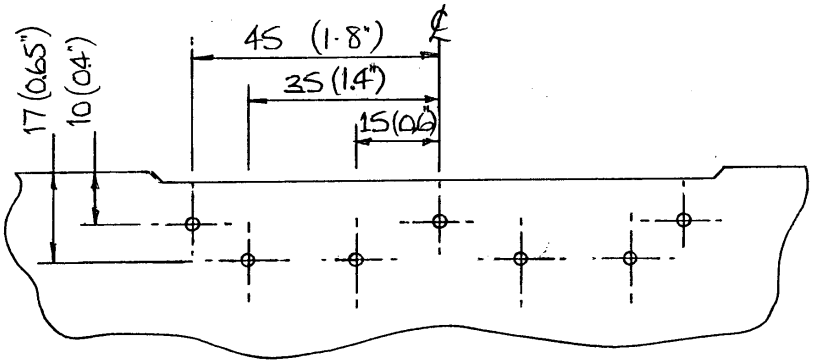


*Fig 21. Rivet hole centres in flange - aileron L.E. Not shown*

With all holes drilled remove the clecos and deburr each hole, removing all remaining swarf, then degrease and scuff sand the hinge flange in preparation for bonding to the aileron. Countersink the flange's holes with a drill bit for the rivets. Use a drill bit between your fingers, countersinking only as far as necessary to enable the rivet to sit flush.

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, then offer them up in place with the aileron. Rivet them up, using TLPK424BS rivets, wiping the excess flox off as it oozes out then leave to cure.

## 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 13**

## Preparation

The arms onto which the lead weights are mounted are made from pre-cut foam, which is supplied as a 9" wide block.

Cut the blocks provided into three 3" wide pieces. They may need slight adjustment to fit your aileron's leading edge snugly. Trim the lead as necessary to fit the end of the arm as indicated in figure 22.

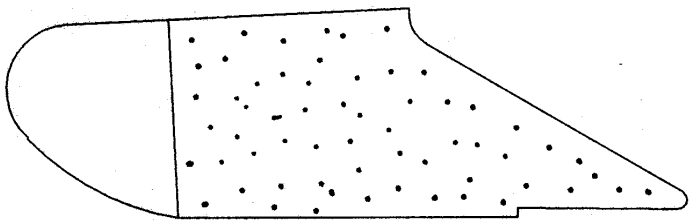

*Fig 22. Lead fitted to match arm.*

**Step 14**

## 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 20 mm (3/4") from the **inside** edge of the two outer hinges, and 20mm (3/4") from the **outside** edge of the inner hinges. See figure 23.

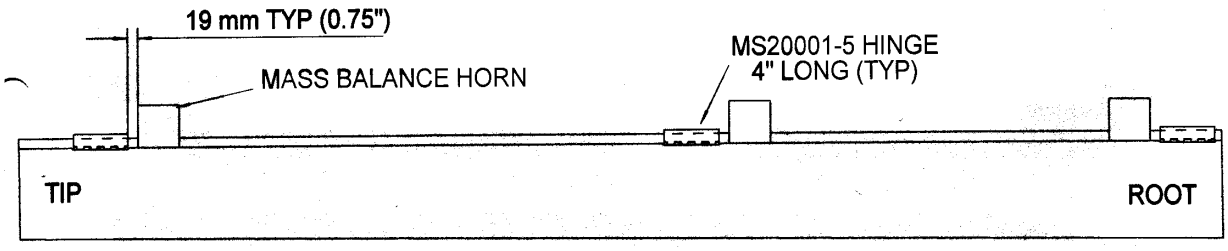


*Fig 23. Position of mass balance arms.*

Scuff sand the areas of the aileron that will be covered by the foam arm, mix up some rapid epoxy and bond them in place flat to the table as in figure 24.

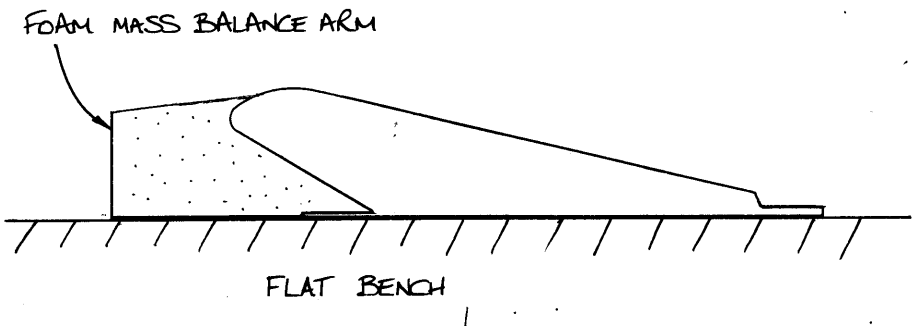


*Fig 24. Bonding arm to aileron on a flat surface.*

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 25.

.

*Fig 25. Lead weight temporarily fixed to arm with tape.*

**Step 15**

## Preparation

Prior to laying up the mass balance horn securing straps it would be prudent to check that full aileron deflection can be achieved first. A chamfer at the end of the lead weight may be necessary. Check aileron deflections on the completed wings before coming back to this chapter to permanently attach the mass balance horns.

Bond the lead weights to the foam horns with rapid Araldite.

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

3 off 8.5cm x 38cm (3.5" x 15") with the fibres running lengthwise.

These fibres will run from about 5 cm (2") 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 5 cm (2") beyond the foam.

Scuff sand with 60 grit paper the areas of aileron which the lay-up will bond to. Also scuff sand the surface of the lead **just before the layup.** With a hacksaw put a number of saw cuts across the lead, approximately 1mm (.040") deep every 10mm (3/8") or so, to provide a "key" for the resin to bond to.

**Step 16**

## Mass balance lay-up

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 squeegeeing each ply in the direction of the fibres to eliminate any trapped air..

The laminate can be easily trimmed with scissors to a width slightly greater than the horn itself and at least 36 cm (14") long.

Micro slurry the foam upper and lower surfaces only. Skim a wettish flox over the lead to fill the saw cuts. 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.

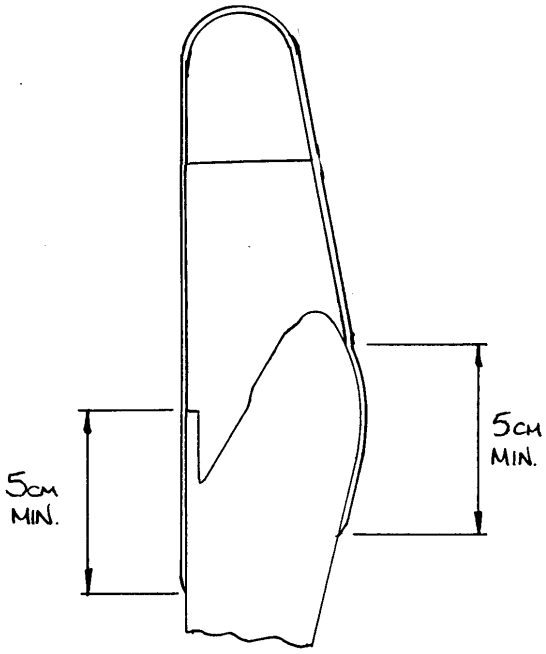


*Fig 26. Extent of 'uni' plies onto aileron skins.*

There should be a minimum of 5 cm (2") overlap onto the aileron's skin on both upper and lower surfaces as shown in figure 26. 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 17**

## Side lay-ups

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

Cut a 5-6 mm (1/4") triangular channel around the complete periphery of the exposed foam on each side to enable a flox corner to be made.

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 1 cm (½"). These side lay-ups can either be made laying on individual plies or laying up the two plies on plastic sheeting and applying them together. Scuff sand and saw cut the lead as previously.

Apply the micro and flox corners to the horns, and skim flox over the lead, then lay-up the sides wrapping the plies onto the leading edge of the aileron by a minimum of 1 cm (½"). See figure 27.

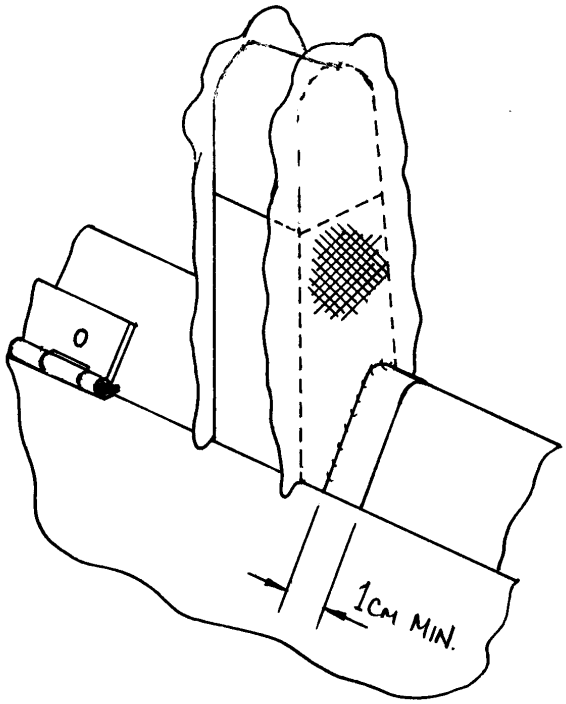


*Fig 27. Side lay-ups to lap onto aileron by 1 cm minimum.*

**Step 18**

## 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 28. In other words the aileron should be over balanced.

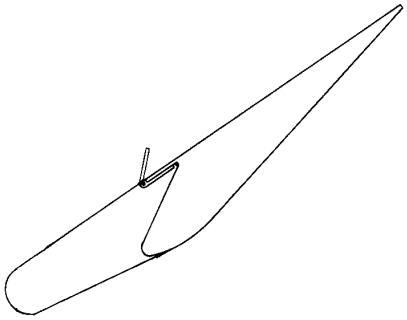

*Fig 28. Aileron before finishing and balancing.*

After final paint has been applied, to bring the aileron into balance, simply drill into the side of the lead with a 1/4", 3/8" or ½" drill to remove sufficient material. Care should be taken when drilling to prevent the 'bid' layup being pulled away from the lead. Drilling through a thin piece of plywood held firmly against the surface will reduce the chance of this happening. Fill the hole(s) with a foam plug and dry micro. The final balanced state is shown in figure 29.

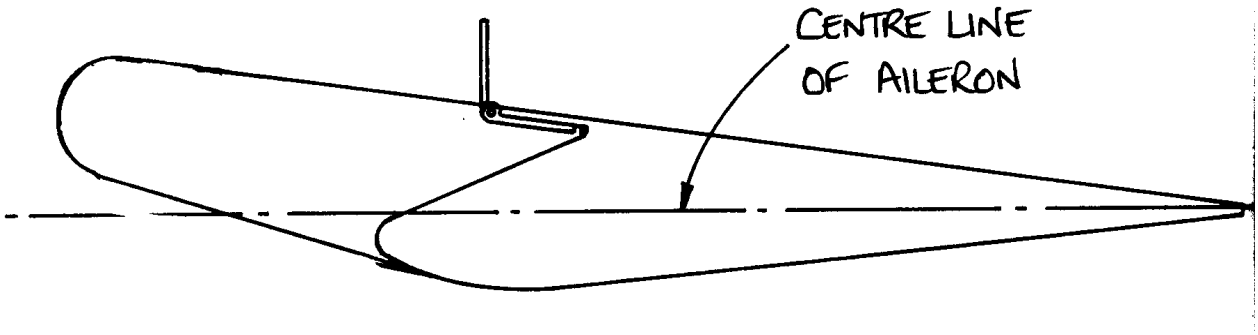


*Fig 29. Aileron properly balanced after final painting.*

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# 8. Wings (motor glider)

## Introduction

The motor glider wings are delivered in two sections : inboard and outboard.

The inboard section comprises a pre-moulded upper skin and lower leading edge skin into which are already bonded the main spar and ribs. A separate pre-moulded lower trailing edge skin is also provided, as are stiffeners for the airbrake cut-out.

The outboard section comprises similar pre-moulded skins to the inboard section, a spar extension, ribs and aileron close-out moulding.

The building work required comprises reinforcing some rib-to-skin and spar-to-skin joints with 'bid', fitting the outrigger mounting plates (monowheel version only), assembling and installing the aileron and airbrake control systems and, in the port wing, the pitot static system.

Some of the metal parts supplied which have been cut out from metal sheet material may require their edges to be smoothed off with a file. Take care that no scratches are left on the metal surface or edges, except where scuff sanding in preparation for bonding is necessary, as these could otherwise lead to cracking after a while in service. If you have to do any marking of aluminium parts, don't use a scriber or even a lead pencil. Carbon from pencils has been known to lead to cracks developing. Some parts may have a protective coating of plastic on them which needs removal before installation.

It is advisable to protect your metal parts from corrosion. Anodizing is suitable for light ally parts, as is painting them with zinc chromate. If you decide to have the parts anodized, specify that you want them chromic anodized to DEF STAN 03-24 (sealed). However, if the anodized part is required to be subsequently bonded or painted, specify unsealed. Don't use sulphuric or hard anodizing. Alternatively there is a process called "Alodine", which is carried out at home, and involves pre-cleaning followed by the Alodine treatment itself; this gives a protection similar to anodizing.

Remember, keeping your working area clean and tidy especially just before lay-up, will give you the best chance of making a neat job of your aircraft components.

Please note that these instructions include cloth cutting dimensions and quantities for the building of *one wing* at a time.

## Reinforcement lay-ups

Looking into the open area of the inner wing panel you will notice that flanges at the ribs and the airbrake trailing edge sub-spar have been bonded to the inner skin with epoxy adhesive (Araldite 420), making a L shaped bond.

Additional lay-ups consisting of two plies of 'bid' at ±45°are to be applied to the other side of the ribs from the moulded flange to effectively convert the 'L' shape into an inverted 'T'

The ribs concerned **do not include the root rib** - counting outboard the next 5 ribs will need to be scuff sanded for 25mm (1") on both the rib and inner wing skin and spar. The next pair of ribs counting outboard are where the outrigger leg attachment plates are mounted. All of the surfaces of both ribs on the non-flange sides, and the area of the inner skin between these two ribs will need to be scuff sanded, and finally the next 2 outboard ribs will need to be scuffed on the non-flange side for 25mm (1"), along with 25mm (1") on the adjacent inner skin.

The joint of the wing spar to the inner skins also requires two plies of 'bid' so the area of spar up against the inner skins, and the skins themselves needs scuff sanding for 25mm (1") on both. Also scuff sand the aft face of the airbrake sub spar and adjacent area for 25mm (1").

When all the areas have been scuff sanded (which entails sanding gently with 80 grit paper to just remove the shine of the moulded finish), vacuum all dust away. Carbon / epoxy dust can be a skin irritant, so you should ensure that gloves / masks, etc. are worn for this operation. Carbon dust is also electrically conductive, do not use electrical machines of any sort for sanding.

To recap: you will be bonding the moulded / non flange side of the 5 inner ribs and the two outermost ribs to the inner skins and the spar, the spar to the inner skins both top and bottom, and the airbrake sub-spar to the inner skins.

The most effective way of applying these tapes is to lay up two layers of 'bid' at ±45° on to a layer of polythene sheet with epoxy, and squeegee the cloth until the correct resin/cloth ratio is achieved. Cut through the two plies of cloth and polythene sheet in 50mm (2") wide strips. Wet out the area of structure to receive these tapes with epoxy, and make a small flox fillet of 6mm (1/4") radius in the corners of the two surfaces.

Picking up the polythene/2 'bid' tapes as one, transfer it to the wing, folding it lengthwise and push it into the corner. Removing the polythene - keeping the cloth in place with a brush as the polythene comes away. Further brushwork/ squeegeing will be required to remove any trapped air from the laminate.

**Note:** The section which follows applies only to monowheel Europas. If your Europa is a trigear version, you will need to apply tapes to the two trailing edge ribs set close to each other midway along the airbrake section. These tapes should be fitted in the same way as the other ribs described earlier.

## Outrigger mounting plates (monowheel only)

The two outrigger mounting plates GOR13 are to be bonded to the recesses of the two trailing edge ribs which are set close to each other mid way along the airbrake section of the wing. The part of these plates with the three holes in will protrude through the lower skin and slots will need to be cut in the inboard 1/4 panel for these prior to their fitting. See figure 1.

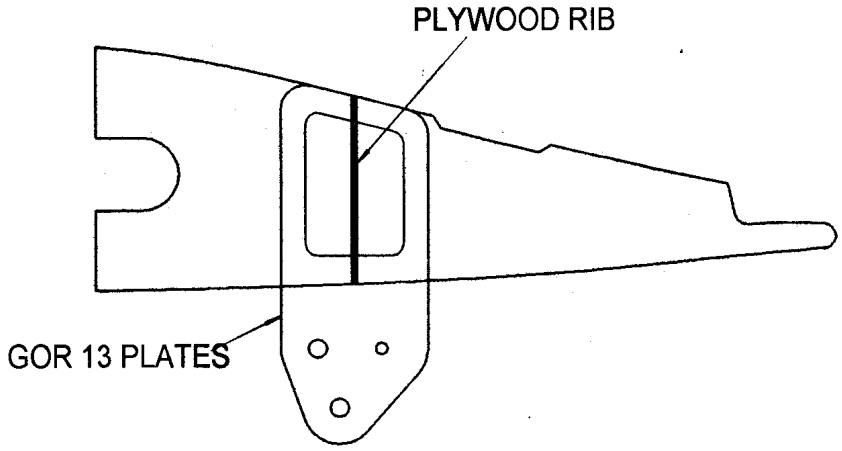



*Fig 1. Outrigger mounting plate.*

Mask off the portion of the GOR13 plates that will protrude though the lower panel. Scuff sand the portion of the GOR13 plates which will be bonded.

To ensure that the two plates remain in alignment with each other, and are at the correct distance apart from each other whilst they are bonded into place, temporarily assemble them with two flanged bushes GOR14 each and the outrigger upper fitting GOR15, using an AN4-21 bolt through the upper hole, and the pip pin BLS4R18N to align them.

Cut 12 pieces of 'bid' 18cm (7") x 18cm (7"), all at ± 45°, and also make a 3mm thick plywood rib 92mm (3 5/8") x 38mm (1 7/8") in size.

Using Araldite 420 mixed with flox, bond the two GOR13 plates into position with the ribs. Remove most of the adhesive from within the window in the plates, but scrape it to form a fillet all around, which will help the glassfibre reinforcement to transition down onto the rib. Lapping at least 5cm (2") all around and onto the upper skin between the ribs, layup 3 plies of 'bid' over the plates and trim them to align with the rib flange. (Don't use a knife which would score the metal plate).

With a generous bead of Araldite 420/flox on the two long edges and one short edge of the plywood rib, position the rib between the two plates - see figure 1. Make sure that the adhesive is not scraped away when installing the rib, and add some to form a generous fillet on both sides. Finally, layup 3 plies onto the plywood rib and around onto the previous layups, ensuring that the edges run beyond the plates each side. Try not to get these layups too resin rich, mopping up excess resin before it gels. Allow the entire assembly to cure after first checking that the positions of the plates are as required.

## Bellcrank access holes

To allow access to the bellcranks for inspection and maintenance, access holes need to be made in the bottom wing skin. You will find that a portion of the skin underneath each bellcrank has been recessed inwards to provide for the panel to be flush. To make each panel you will need a piece of lexan or perspex 3mm (1/8") thick (not supplied).

You may use other materials if you wish; the panel need not be transparent. Cut and shape it to match the recess in the wing skin. Using your 54mm (2 1/8") diameter hole saw, cut through the corners of the recessed area first, then cut between the four holes open the access hole.

Tape it temporarily into position and drill 4 holes, one in each corner, through the panel and wing with a 5mm drill. See figure 2.

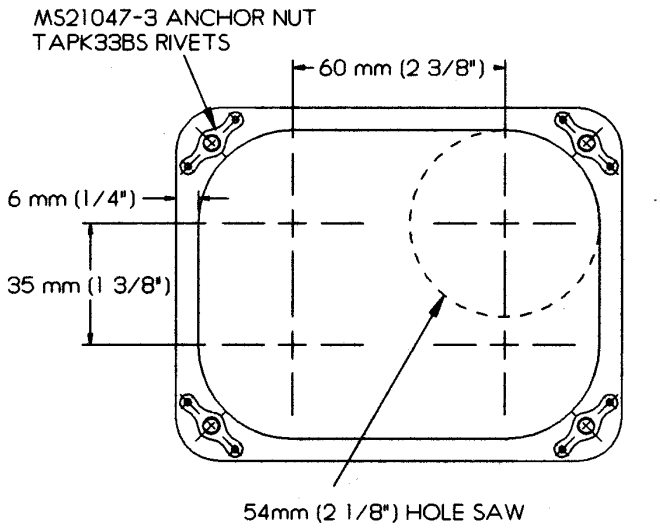



*Fig 2. Access hole.*

Remove the panel and place MS21047-3 anchor nuts as shown, holding them in place with AN525-10R8 bolts. Drill 2.8mm (3/32") holes for the anchor nut TAPK33BS rivets. Spin a larger drill bit in your fingers to countersink these holes to accept the rivets. Finally, rivet the anchor nuts to the inside of the flange.

IMPORTANT NOTE: as the motor glider wings have been designed to be retro-fitted to a completed Europa, certain stages of the wing build will require the fuselage to be used for jigging purposes before the wing build itself can be finished. If you have not yet completed the fuselage, please move on to chapter 10 of the main manual and only return to this section after the fuselage upper moulding has been bonded on (chapter 23).

## Rigging wings to fuselage - spar bush installation

The wings are located in the fuselage by two ½" diameter pins through the seat back. The pin on the port side is a ball detent pip pin, part no S08; the starboard side is part no S07/3. For the next operation you will be using EUR047 bolts - **these must NOT be used for flight.**

The hole in the spar tip is formed during the manufacturing process, and requires gentle relieving with a piece of rolled up 80 grit abrasive paper to allow the GS12 / GS13 spar bush assembly to fit snugly and to provide a scuffed surface for bonding. Ease the two holes out until the GS12/ GS13 bushes will fit. Temporarily fit in place with adhesive tape. The GS12 is inserted into the forward face of the spar, the GS13 the aft face.

Because of the tolerance variation during the building process, and to cater for those people retrofitting motor glider wings to an existing aircraft, you will now be custom fitting your wings to the fuselage. The S01/6 bushes will need to be installed into the cockpit module if you have not already done this, as detailed in chapter 14, except that you will be bonding the bushes into the seat back without the spar as a reference. Do not fit the S02 cup at this time if it is a new installation.

Support the fuselage and level it in roll axis using the EUR047 bolts inserted into the S01 bushes and a spirit level (or do yourself a big favour and get a Smart digital level and reset to 0.0° across the two bolts).

Install the port wing and insert the EUR047 bolt in the starboard side S01into the GS12/GS13 bush assembly fitted to the tip of the port wing spar. For retrofitted motor glider wings, gentle easing of the S02 rigging cup may be necessary to allow for the flange of the GS12/GS13 to enter. For new installations wedge the spar tip fully forward , and tie the wing forward at the wing root to ensure the spar is up against the port S01 bush.

The total dihedral of the wings is 4.8° measured on the top wing skin (it is 5° through the wing spar centreline).

You will need to support the outboard end of the port wing with a trestle, suitably padded to prevent skin damage.

If you are using a Smart digital level, place a straight edge approx. 1 metre (3 ft. Long) long on the scribed line on the upper skin, which is the position of the forward face of the spar, and checking that the reference across the seat back S01 bushes is still 0°, adjust the trestle until you have 2.4° on the upper surface.

Make up an incidence board using templates BL29 out of 19mm (3/4") board - see Annex F. The other templates will be used later for making wing supports. Place this on the wing just outboard of the kink near the wing root. Set the level to 0° on the port side door sill, which is the aircraft water line reference, and with the board on the wing skin, set the incidence to +2°, this means that the chord line of the wing, the line from the leading edge to trailing edge, is higher at the leading edge. Keep rechecking both the dihedral and the incidence until both are correct.

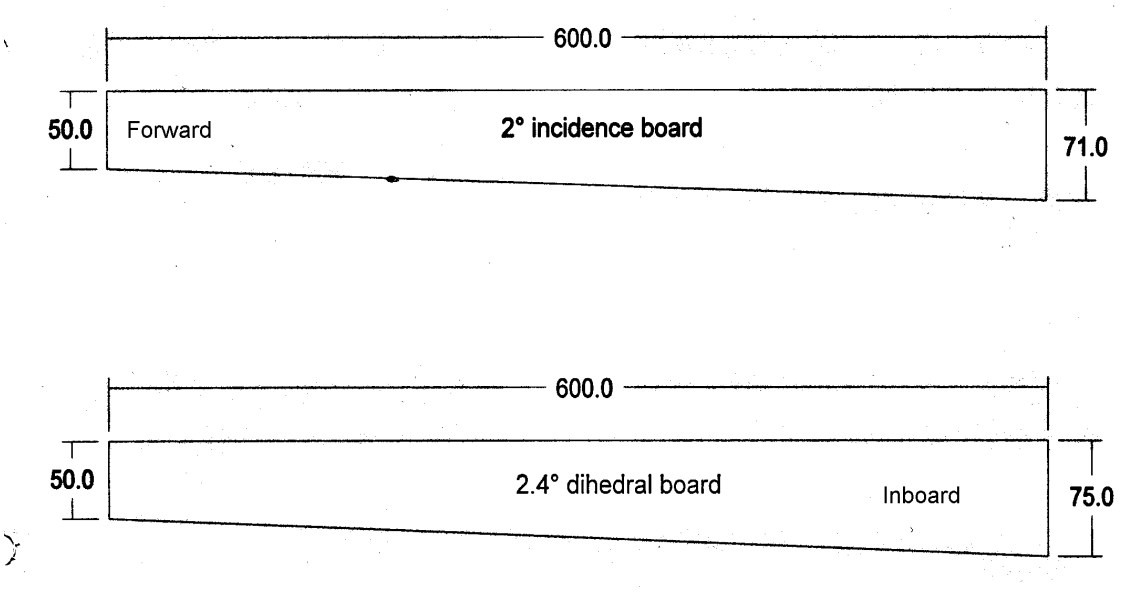



*Fig 3. Incidence and dihedral boards*

If you are using a bubble spirit level, you will need to ensure that the fuselage is level in both pitch and roll, and you will need to make two further incidence boards to the dimensions shown in figure 3 - they can be made from 19mm (3/4") thick MDF or plywood. These are not required if you are using a digital level.

When you have the wing set up with the correct angle of incidence and dihedral, you are ready to drill the second hole in the wing spar, through the port seat back S01 bush.

*To recap - you have levelled the aircraft in pitch and roll, you have the port wing on the aircraft, pinned through the starboard S01 bush (with the S02 rigging cup slipped over the end of the spar on a new installation) using a EUR047 bolt. The free end of the spar is wedged forward on a new installation, the wing root is pulled forward so the spar is in contact with the port side S01 bush. The wing incidence is set at +2°, the dihedral at 2.4° measured on the upper wing skin.*

Without disturbing anything, remove the EUR047 bolt from the port S01 bush (which was there to level the fuselage) and insert a drill guide GDG05. Now gently drill, using the guide, into the spar with a 1/4" drill, gently breaking out of the rear f ace of the spar.

Remove the wing from the fuselage and enlarge the hole with a 20mm hole saw, drilling halfway through from each side. Using the rolled up 80 grit abrasive paper, ease the bore of this hole until the GS12/GS13 bush assembly is a snug push fit.

You now have the port wing with two bushes temporarily fitted and the starboard wing with one bush. Mate the two wings as they would be on the aircraft, on trestles with suitable padding, with the starboard spar aft of the port spar, and with a EUR047 bolt through the root end bush of the port wing and the tip end bush of the starboard wing. Use scrap pieces of wood with a ½" hole in to pack out the length of the EUR047 bolt and run the ½"UNF nut finger tight plus ½ turn onto the bolt.

You now need to set the total dihedral of the pair of wings to 4.8°, measured on the upper wing skin.

If you are using the smart digital level, you can just zero the level on one wing, and then adjust the angle of the other to 4.8° by raising the trestle as necessary. If you are using a bubble spirit level you will need to level the bush centres in the port wing so that with the aid of your dihedral level board, each wing can be set at 2.4°.

When you have the wings at the correct dihedral, you must check the relative incidence of the two wings, using the incidence level board, again setting the wings to get them level with a bubble spirit level or zeroing the Smart level on one and checking the other. Adjust as necessary - you may have to slacken off the nut a little to achieve the correct relative incidence. Clamp the two spars together with wooden pads under the clamps, and again check both sets of angles.

Using the drilling guide GDG05 inserted into the tip end bush of the port spar, drill through the starboard wing with a 1/4" drill.

De-rig the wings and open out the hole with a 20mm hole saw. Ease out the hole with your rolled up 80 grit paper until the GS12/GS13 bush assembly is a snug push fit.

Now is the time for a 'dry run'. Assemble the two wings with EUR047 bolts, and check that you can get the two wings at the same incidence again. Have the wings supported on trestles with suitable padding to protect the skins. Split the wings again.

Using cellophane packing tape, mask off the faces on the spars in all 8 areas around the GS12/GS13 bushes and prise out the bushes. To ensure a good bond the bushes will need to be prepared; scuff sand the area of the flanges that will be in contact with the spar using 80 grit abrasive paper, and remove all traces of oil, fingerprints, etc. from all surfaces. An old toothbrush with lacquer thinners/acetone/MEK, etc. is good for this.

The spar face inside the masked area which will make contact with the bush also needs to be scuff sanded.

Mix up a small amount of Araldite 420. As a reminder the ratio is 10 parts of resin (the yellow part) to 4 parts of hardener (the blue part) **by weight.** 28 grams total is sufficient for this operation. Fully mix the two components until you have the uniform green colour.

Paint a thin layer of unthickened Araldite 420 into the bores of the spar holes, which will be quickly absorbed into the plywood and exposed fibres, and apply a thin coat on to the plain smooth section of the GS12 bush - see figure 4.

Thicken up the Araldite 420 with cotton flock until you have a mixture that will just not run off the mixing stick when inverted.

Apply this mixture to the bond areas of the flange, over the knurled section of the bushes, and fill any cavities which may be in the bore of the tip end bush hole, and insert the bushes into the spar. The GS12 is fitted into the forward face of both spars, and the GS13 to the rear face. Push firmly together and remove any excess adhesive from around the flange, and from inside the bore.

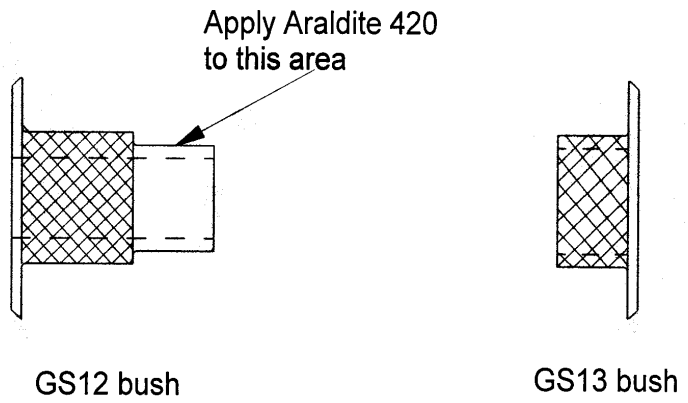



*Fig 4. GS12 and GS13 bush.*

To prevent inadvertent bonding together of the two wings you will need to apply a thin film of grease to the outer face of the flanges, and to the EUR047 bolts, nuts, etc.

Reinstall the EUR047 bolts with the packing as used in the dry run, again ensuring that all parts have some form of release applied to them (parcel tape, grease, etc.) and tighten the nut finger tight plus ½ turn.

Re-check the relative incidence of the two wings with the incidence board/level, and having shimmed everything firmly so that no movement will occur, and removed any excess adhesive from around the bush flanges, and if necessary having re-tightened the ½" nut gently, leave the complete assembly to cure fully.

After curing remove the EUR047 bolts/nuts and the two wings should part, leaving you with the wings with matched bushes.

If you have used too much adhesive and/or not enough release material when bonding in your bushes - and the wings are permanently glued together - do not call Europa - try the local counselling service!

## Aileron controls

### Aileron outboard bellcrank

Make up the aileron outboard bellcrank assembly (part nos. W11, W12, W13, W14 and W15 as in figures 5 and 6). If you intend to paint these, do this before assembly.

Initially attach a BC4W10 bearing to a W13 bellcrank with six TLPD435BS rivets, noting that these sub-assemblies are handed port and starboard. Now attach the bracket assembly to the rear face of the spar onto the outboard set of four bolts which are already positioned, using MS21042-3 nuts and AN960-10L washers.

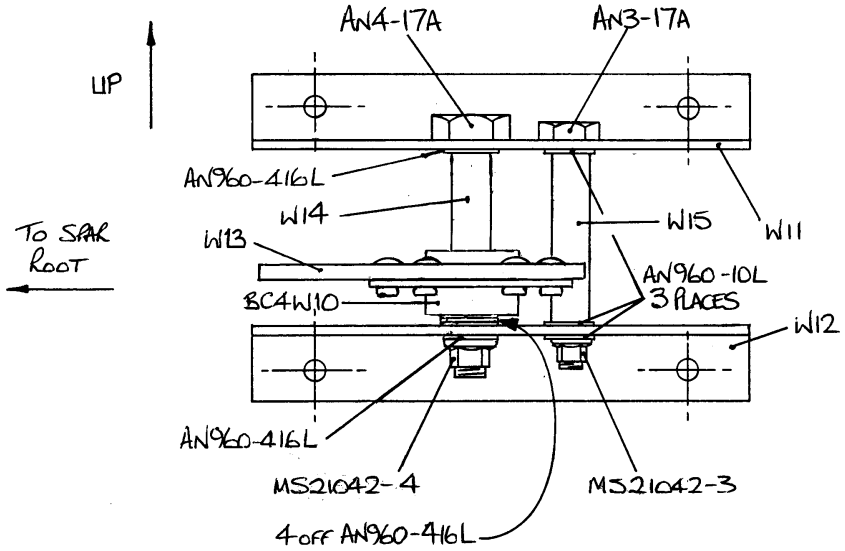



*Fig 5. Aileron bellcrank assembly looking at T.E. as installed (stbd).*

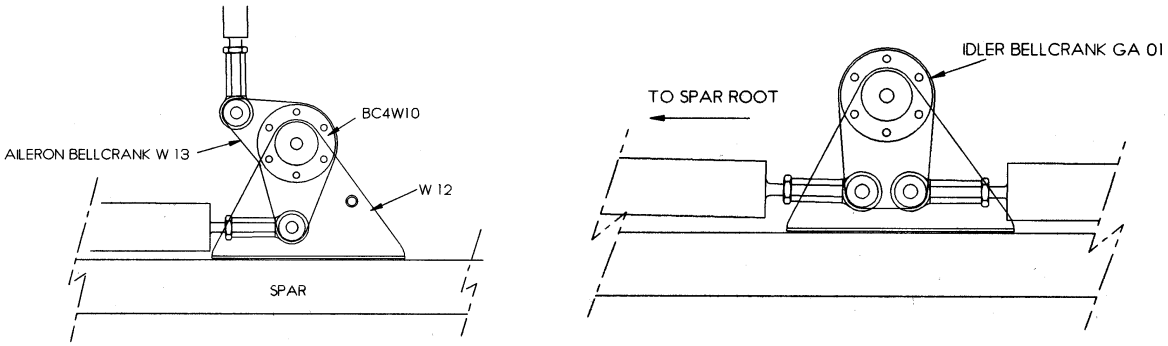



*Fig 6. Aileron and idler bellcranks on stbd spar.*

## Aileron idler bellcrank

The idler bellcrank is made up in similar fashion to the outboard bellcrank. The shape of the bellcrank GA01 and the omission of the W15 stop and its associated nut and bolt and washers are the only differences. Bolt this bellcrank onto the inboard set of four bolts on the rear face of the spar.

Attach two rod-end bearings to the bellcranks as shown in figure 7.

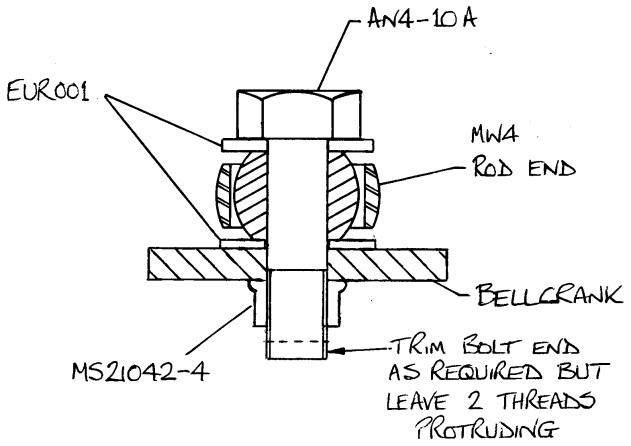



*Fig 7. Attachment of rod-end bearing to the bellcrank*

## Lateral push-rods

Cut the 1" o.d. Light alloy tube (part no TU1) to end up with lengths of 1727mm (68") and 1760mm (69 1/4"), and file the ends square. Mark the positions for the rivets according to figure 8. Push in a W17 insert and drill each hole with a 3.3mm drill, inserting a TLPD419BS rivet to act as a spigot before drilling the next hole. After drilling, remove the W17, clear out all swarf, replace the W17 and pull up the rivets. Do this operation for both ends of the lateral push-rods. The outer push-rod is the shorter one.

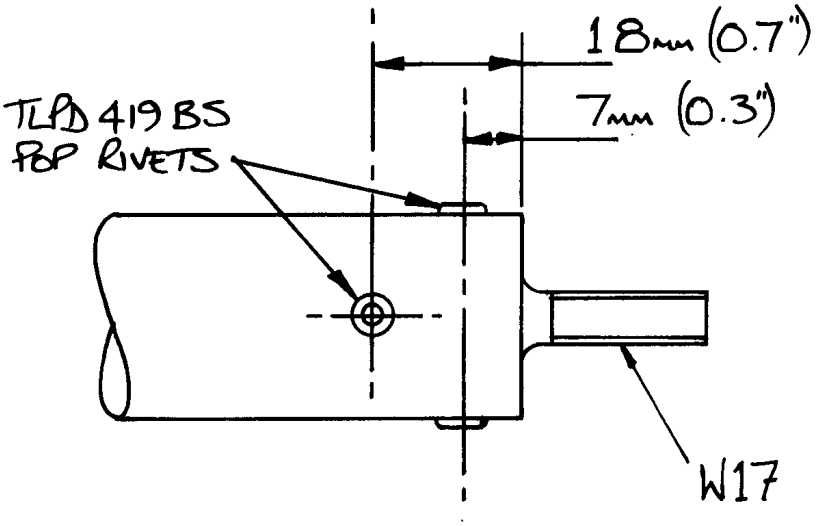



*Fig 8. Pop rivet positions in lateral push-rod.*

## Aileron quick-connect bellcrank

Before riveting the bearings to the W16 bellcranks mark out and file away a portion of the flange as shown in figure 9.

This will enable the bellcrank to pass the pivot bolt of the mating fuselage bellcrank during rigging and derigging.

The two bellcranks W16P and W16S require BC4W10 bellcrank bearings riveted to them. Each bearing is attached to the outside of the 'L' shaped bellcrank using six TLPD435BS rivets. See figure 10. The edge of the large hole may need chamfering to enable the bellcrank bearing flange to sit flat on it.

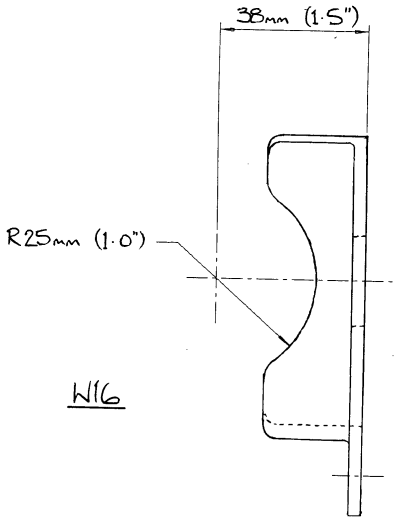



*Fig 9. Cut out dimensions for W16 bellcrank.*

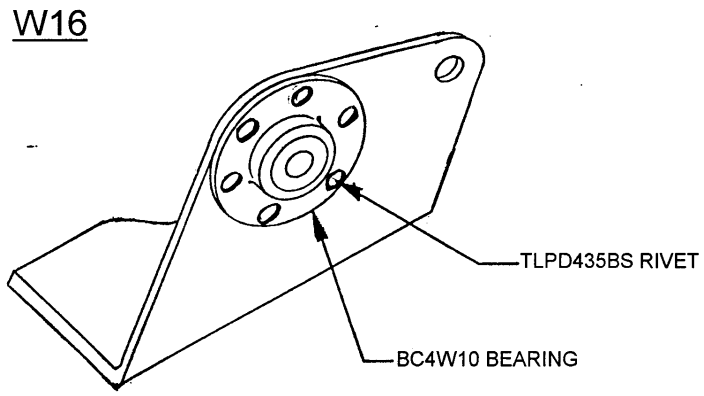



*Fig 10. Quick-connect bellcrank with BC4W10*

## Mounting bellcranks to wing spar

Because the port spar is in front of the starboard spar when the wings are rigged the port wing's quick connect bellcrank has to be mounted on the spacer S03 to bring it in line with its corresponding bellcrank in the fuselage. The starboard wing's bellcrank is mounted directly to the spar.

The mounting hole for the quick-connect bellcrank has been pre-drilled at 5mm diameter by the factory. The hole will be covered over with cloth during wing construction. Refer to figure 11 to establish the position of the hole. Carefully drill through the cloth at the front and back of the spar to re-open the hole to 1/4" dia.

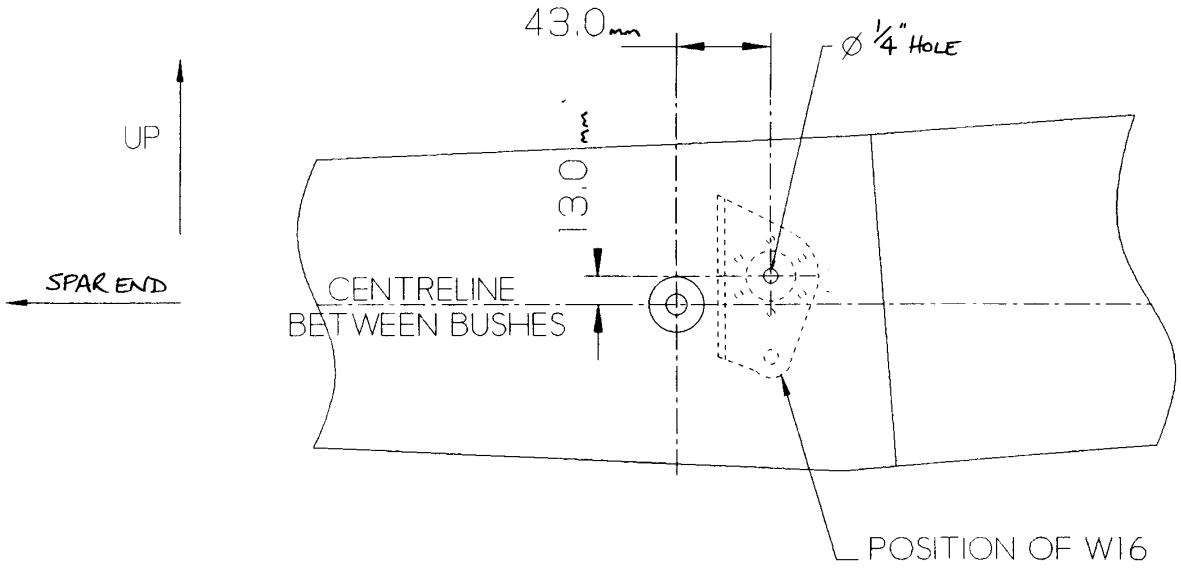



*Fig 11. Hole position on spar for quick-connect bellcrank W16.*

Using a 19 mm (3/4") diameter counterboring tool such as a spade or flat cutter (see figure 12), counterbore the hole from the front face of the spar on the starboard side to a depth of at least 5 mm (0.2") and on the port side to a depth about 16 mm (0.6"). This allows the bolt head to be below the surface of the spar and so not interfere with the adjacent structure.

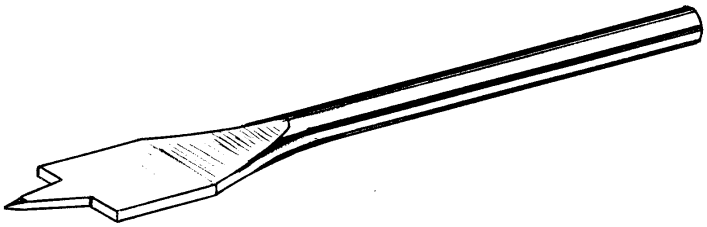


*Fig 12. Spade cutter*

## Starboard wing

Slide an AN4-20A bolt, with a EUR001 washer on it, through the hole in the starboard spar from the front so that the head enters the counterbore. Place on the bolt two EUR001 washers, the W16S bellcrank, another EUR001 washer and finally screw on an MS21042-4 nut.

The counterbore hole will be later filled with flox, but leave it for now as there is a high probability that you will need to move the bolt slightly to align it with the corresponding fuselage mounted bellcrank. Details of what to do are described later.

## Port wing

Fitting the W16P bellcrank is essentially a repeat of the starboard side except that an AN4-31A bolt is required and the S03 spacer is placed on the bolt shank before fitting the two EUR001 washers and the bellcrank.

Fit a rod-end bearing to the quick-connect bellcrank as you have already done for the aileron bellcrank.

Slide the lateral push-rod into position and screw it into the rod-end bearings at both ends, with AN316-4R locknuts, equalizing the thread engagement. Check carefully that there is clearance through all rib holes and that there is no fouling of the lateral push-rod through its full stroke, filing the ribs as necessary to achieve this. Bear in mind that when the aileron is connected the movement will be less than it is now. Once you are satisfied that the installation moves freely, tighten the locknuts.

## Airbrake bellcrank

The airbrake bellcrank is similar to the aileron bellcranks. Rivet a BC4W10 bearing to the bellcrank (one port and one starboard) and assemble it to the brackets according to figure13. Note that the bracket flanges are orientated towards each other on this assembly. It makes life easier if you install the rod-ends to the bellcrank at this stage.

To provide clearance for the push-rod which connects the bellcrank to the airbrake, part of the flange of each bracket needs to be filed away using a large half round file.

Small cut-outs are also required on the sides of the W11 and W12 brackets to clear the bolt head and nut of a bellcrank stop.

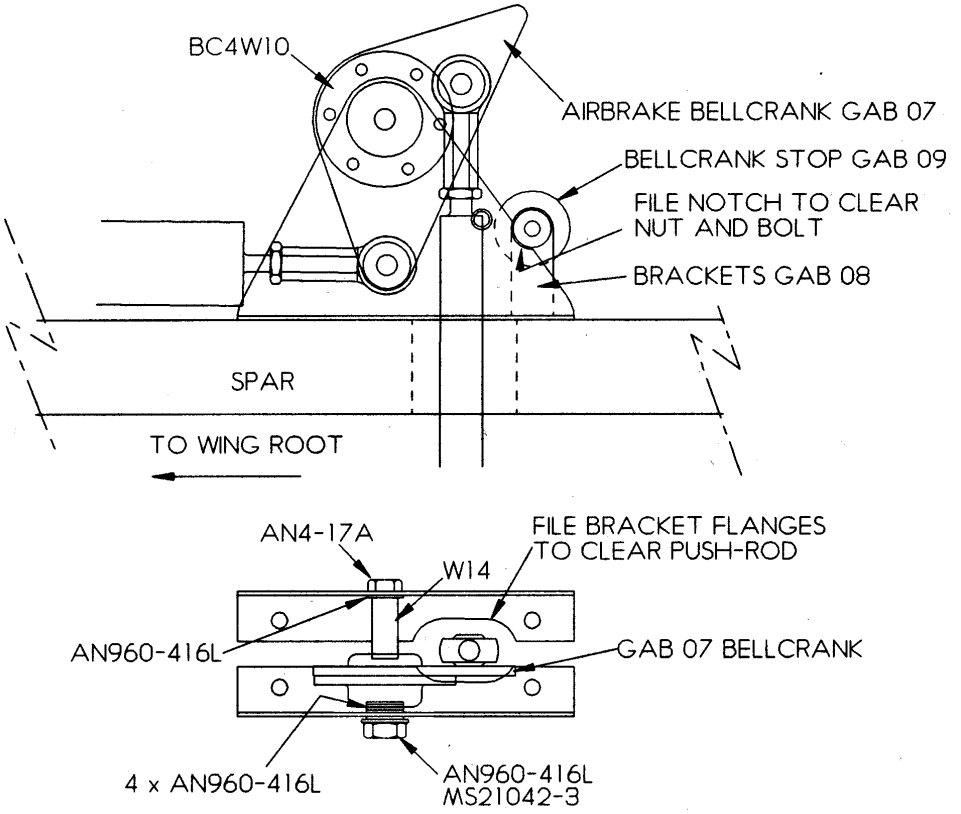



*Fig 13. Cut outs on W11 and W12.*

When bolting the airbrake bellcrank assembly to the forward face of the spar, bolt in also the stop assembly support brackets GAB08. Install the stop GAB09 between the two brackets using an AN52510R28 bolt (inserted so that its head can be accessed with a no. 2 cross head screwdriver) and an MS21042-3 stiffnut. Ensure that the cut-away in the stop GAB 09 is oriented on the side where the push-rod is. A 1/4" drive 1/4" socket will be required for this nut.

### Airbrake push-rods

Cut the 1" diameter light alloy tube (part no. TU1) to be approximately 95" long (the final length will be shorter). File the ends square and fit to one end only at this stage a W17 end fitting in exactly the same way that you did with the aileron push-rods.

### Pressure equalization

It is necessary to ensure that all parts of the wing are vented to atmosphere to prevent pressure differentials building up when the aircraft changes altitude.

The leading edge ribs and the trailing edge ribs which have push-rod holes through them already provide venting. To ensure that the entire wing is vented, drill a 5mm (3/16") hole through all ribs outboard of these ribs. Drill also the outboard airbrake stiffener and the plywood between the outrigger mounting plates.

### Pitot/static tube

You will see that a section of the port wing lower skin has been indented to allow for the fitting of a pitot/static head. The head is fitted similarly to the aileron bellcrank access door, with two MS21047-3 anchor nuts riveted to the inner skin.

A drawing of the holes required in the wing for the pitot/static is given at figure 14. Transfer this drawing to the indent and cut out the oval hole, remembering that the pitot/static head must point forwards, and must be at right angles to the spar, not the wing leading edge. Drill the two mounting holes as shown in figure 14.

Temporarily fit the pitot/static head in position using AN525-10R8 bolts screwed into the MS21047-3 anchor nuts. Attach the anchor nuts using TAPK33BS rivets. Remove the pitot / static head.

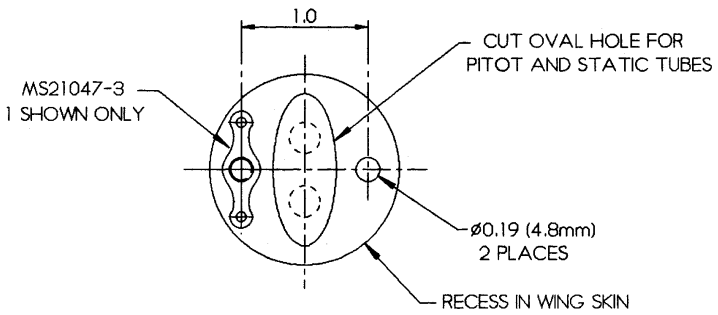



*Fig 14. Mounting of pitot static head to wing.*

## Pitot / static plumbing

The plumbing for the pitot / static needs installing in the port wing. Drill 10.2mm (3/8") holes through the 3 ribs inboard of the pitot head positioned approximately 15cm - 17cm (6" - 6.5") aft of the spar - see figure 15, and central within the depth of the ribs, and fit the 543-204 grommets. Pass the two 3mm bore PVC tubes through the grommets, leaving enough to pass through the outer skin where the pitot head is mounted, and coil up about 1m (39") into the bay between the root rib and the 2nd rib. Protect the tubing inside a plastic bag and tape it to the spar in the first bay approximately 50 mm (2") away from the root rib. You will have to fish this out at a later date through the holes you will drill in the root rib. These are shown at figure 16, but should not be drilled yet.

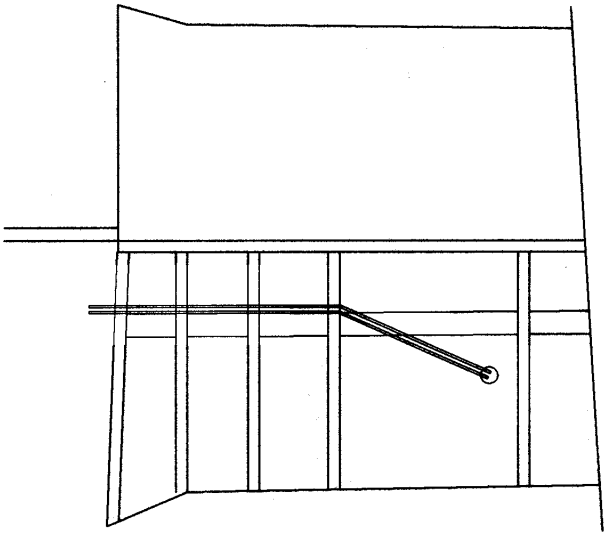


*Fig 15. Pitot / static tube routing.*

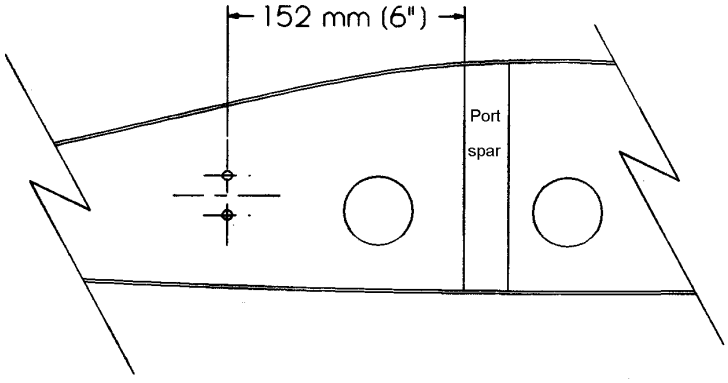



*Fig 16. Position of pitot/static tubing at the root rib.*

**Note:** The next stage of the build will normally be to assemble the inner wings to the fuselage, as this requires much less room than would be needed if the wings were fully finished first. So at this stage you should jump to chapter 27a or 27b - **Fitting wings to fuselage,** before returning here**.**

## Bonding on the C-spar extensions

The spar extensions are now to be bonded on. Scuff sand the area to be bonded. The C-spar is fitted to the main spar from the rear, and the flat moulded face is to the rear.

For each wing you will need two pieces of straight steel box section 25mm x 25mm (1" x1") at least 1.2m (4ft) long. Cover these with a layer of parcel tape as a release material. You will also need 2 pieces of 12 or 13mm (½") plywood approximately 12 cm (4 3/4") square, again covered with parcel tape.

Clamp the steel box section above and below the main spar, taking care to align the edge of the box section with the rear face of the spar, and having it half on the spar, with the other half hanging off the end.

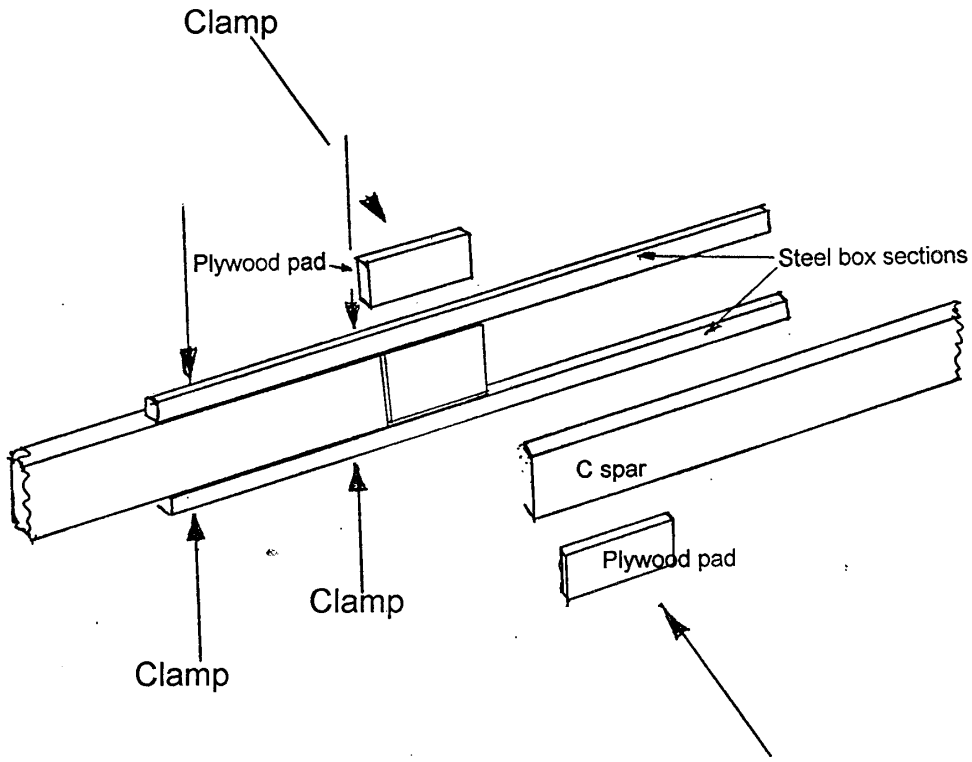



*Fig 17. Fitting C spar to main spar.*

The C spar can now be slipped over the main spar, and with the two pieces of plywood protecting the faces of the spar, clamp the spar sections together with a couple of clamps.

Check that the box section is still in line with the main spar and that the C spar is also in line, and check with a long straight edge that the pair are parallel.

Clamp the outer end of the C spar upper and lower flanges to the box section with suitable clamps.

When you are happy that you can get everything lined up, remove the clamps and prepare for bonding.

Mix up some Araldite 420 (56 gm - i.e. 40 gm yellow and 16gm blue) and add just enough flox until you have a non-sag mixture. Apply a thick coat to the contact face of the main spar, and spring the C spar over the top, taking care not to wipe out the adhesive from the upper and lower flange area. Replace the two box sections and re-clamp with the box aligned with the rear face of the main spar, and reclamp the two wooden pads in place. Recheck that the C spar is in line with the main spar, and clamp the C spar upper and lower flanges to the box sections at their outboard ends.

Remove any excess adhesive from around the joint on the rear face and along the forward edges adjacent to the steel box, and with this excess adhesive make a fillet on the forward face of the spar joint - see figure 18.

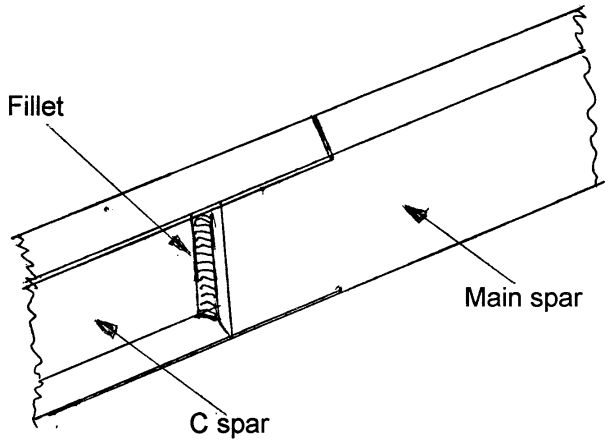



*Fig 18. Joining C spar to main spar.*

## Joining the outer 3/4 panel

Earlier in the manual mention was made of the three sets of wing templates, BL29, BL163 and BL251. (You will recall that BL is Butt Line and is the distance in inches from the aircraft centreline). The template for BL29 was used for the wing incidence board, and this will now become the inboard wing cradle. Transfer the shape of the templates for BL163 and BL251 on to 19mm (3/4") board and cut out carefully. You will need one of the BL29, two of the BL163, and one of the BL251.

The straight edge of the board needs to have a piece of timber approx 50mm (2") square x full length fixed into place on both sides, to enable the four cradles to be free standing. Use straight and planed timber for this, and ensure that they are attached accurately, as a level will be positioned on this timber, which controls the twist (or more accurately the lack of twist)of the wing. Fig 19 shows an example of a completed cradle.

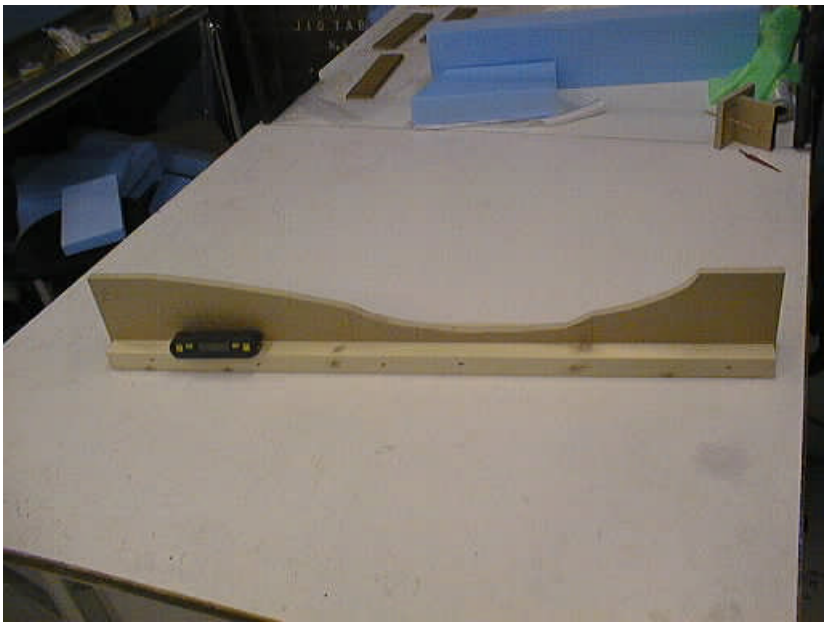


*Fig 19. Example of wing cradle*

These four cradles will sit on four trestles approx 75cm (30”) to 90cm (36”) high. The middle pair of cradles will need to be about 25cm (10”) apart, so if you are making the trestles from scratch, you can make one wide one instead of two narrow ones.

Set the trestles out on the floor with the cradles on top. Mark the centreline of the wing on the floor (midway between the two spar pin bushes); set the first cradle at BL29. The next two (from the template of BL163), are positioned at BL158 and BL168; the smallest one at BL251.

*Fig 20.Clamp fitted to stop wing shifting aft.*

The inboard panel of the wing should drop inverted into the first two cradles. Adjust the position of the cradles until the wing sits snugly, and clamp a piece of wood at the trailing edge of BL29 and BL158 to prevent the wing from shifting aft - see figure 20.

The outer panel can be slipped over the main and C spars, and the inboard end butted up to the edge of the joggle. Arrange the two outer cradles to support the panel, checking along the leading edge with a length of string and /or a straight edge. With the two panels in line, clamp two further pieces of wood at the trailing edge of the BL168 and BL251 cradles, again to prevent the panel from shifting aft.

Using a taut piece of string, align the bases of all four cradles by shimming under the feet of the trestles as necessary. Now check that the cradles are at the same incidence with a level on the wooden base of the cradles, and shim under the cradles to get them all level.

When you are happy with the alignment of the two panels in terms of sweep, incidence and dihedral, apply fillets of 'bondo' to fix the trestles to the floor, the cradles to the trestles, and the inner 3/4 panels to the cradles. You are effectively temporarily bonding everything together to prevent any movement. Now using a 3.3mm (1/8") drill carefully drill through the inboard flange of the outer 3/4 panel into the outboard flange of the inner 3/4 panel in 6 places, and install clecos, working aft from the leading edge to ensure that there is no gap under the leading edge area - see figure 21.

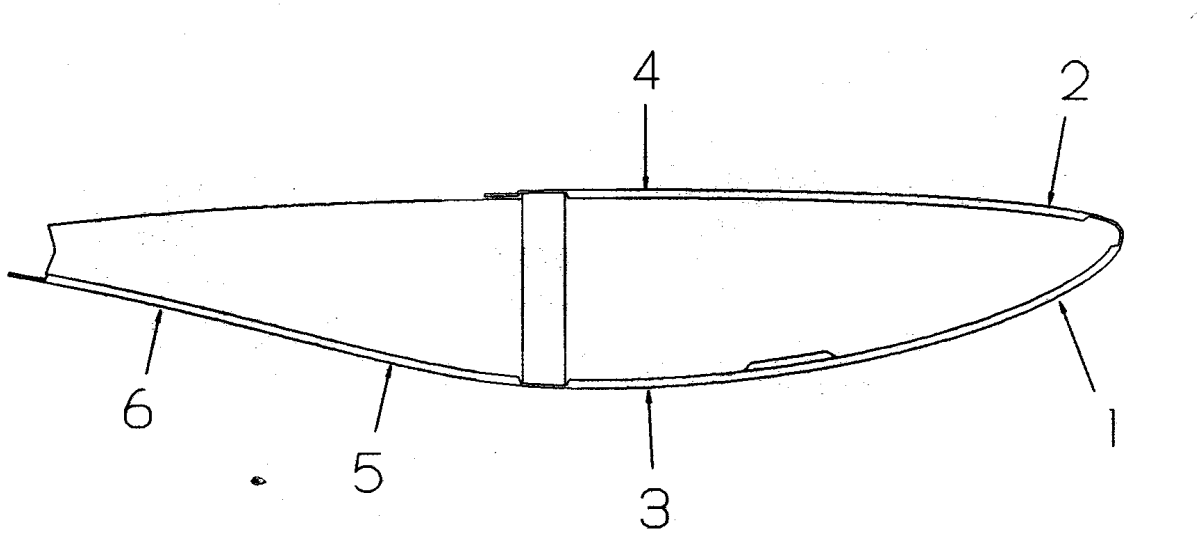



*Fig 21. Clecoing panel to rib.*

Check that the outer C spar is in line with the main spar, and drill through the outer 3/4 panel skin with a 3.3mm (1/8") drill into the top and bottom flange of the C spar, approximately 75mm (3") from where the main spar ends, and 75mm (3") in from the extreme end - see figure 22.

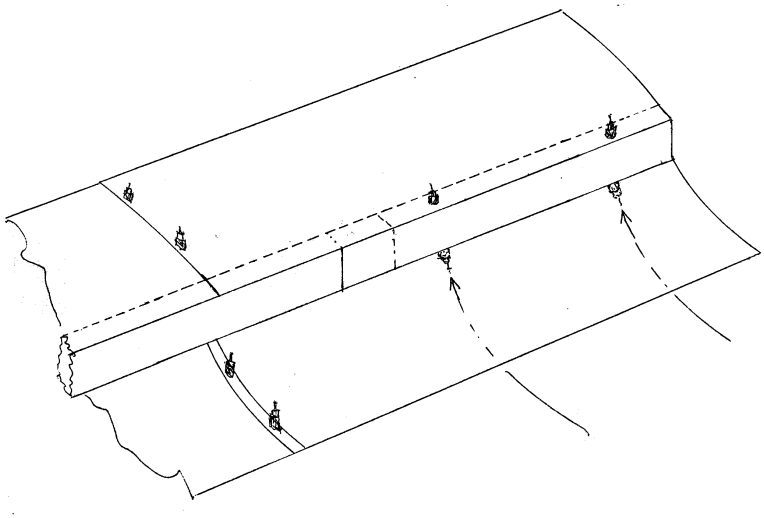


*Fig 22. Clecoing panel to C spar.*

From the centreline, mark out lines on the skin of the outer 3/4 panel at BL200 and BL249. These are the positions of the two ribs which are to be bonded into the panel. The ribs have the BL stations moulded into them for identification.

Transfer these lines using masking tape to the inside of the skins; also mark the position of the spar. The moulded face of the rib is installed at the BL station, the flange is inboard of this line.

Remove the clecos and carefully remove the outer 3/4 panel without disturbing the cradles. Scuff sand all the bond areas of the spar, ribs , spar flanges and the inside skin using 80 grit paper as before. Vacuum the dust remembering to wear appropriate protection.

Support the 3/4 panel on the bench with the leading edge down, and position the BL200 and BL249 leading edge ribs into their correct places. Check with an engineer's square that the are at 90° to the spar line and are upright. Ensuring that the ribs are fully forward, drill in a similar fashion to the flange joint, working from front to rear. Two clecos each in top and bottom flanges are needed.

With the 2 clecos in the upper wing skin, (remembering that the wing is upside down in the cradles) position the outer 3/4 panel back into the cradles and re-Cleco the panel to the inboard 3/4 panel and the C spar. Replace the 2 remaining clecos into each of the BL200 and BL249 ribs. The use of a tapered punch or bradawl will help to find the holes.

Offer the trailing edge BL200 and BL249 ribs into position, again checking with a square that they are at 90° to the spar.

Two clecos through the top skin into each rib are required. This is the time for a few 'dry run' attempts at getting the outer 3/4 panel on. Positioning weights as required, and possibly a webbing luggage strap around the wing at the inner/outer join, etc.

Get used to sliding the outer 3/4 panel on with as little disturbance as possible in the area of the bonded joints, i.e. Keeping the leading edge apart, springing it over the spar so that when the panel is finally put on you do not wipe off the adhesive unintentionally. Two pieces of foam or similar can be used to keep the skin open at the leading edge. You will find it necessary to have one or preferably two assistants for this job.

To recap - the outer 3/4 panel has been clecoed to the inner 3/4 section, and to the C spar; the ribs BL200 and BL249 have been fitted; all areas to be bonded have **both** surfaces scuff sanded. You are satisfied that the panels are correctly aligned, in which case.....

## Bonding

Assistant no. 1 should start mixing the Araldite 420 adhesive. The total amount needed will be of the order of 350 - 400 grams, but it should be mixed in smaller quantities to prevent an exothermic reaction. We suggest you mix approx 80 - 100 grams at a time.

Keep some of the adhesive unthickened and paint this on to the inner skin of the 3/4 panel at all the bond sites.

Thicken the rest of the mixes with flox, just enough to prevent it sagging from the upside down mixing stick, and apply an even coat to the leading edge BL200 and BL249 rib flanges. Spread the 3/4 panel adjacent to these two ribs and push the ribs firmly into place, making contact with the upper wing skin only at this stage (remembering that the wing is upside down!).

Locate the holes in the ribs through the outer skins and Cleco them into place, having applied a film of grease to the shank of the clecos to prevent permanent bonding. Keep the lower skin away from the ribs at this stage.

Remove excess adhesive from the flange side of the ribs and make a small fillet up against the moulded face of the ribs.

Apply flox thickened Araldite 420 to the spar top and bottom, to the outer flange of the inboard panel, and the rear face of the leading edge BL200 and BL249 ribs.

This is where the teamwork / dry runs pay off. You need to get the outer 3/4 panel over the spar into its correct position without wiping the adhesive off. Keep the panel spread open until it is in place, removing the spreaders at the last possible moment. Locate and clamp together the two panels, working from the leading edge aft, in the same sequence as the holes were drilled. Remove excess adhesive from the outer skin. Re-strap with the luggage strap if necessary. Find the holes and pin the panel to the C spar with greased clecos.

The two trailing edge BL200 and BL249 ribs can now be positioned, applying adhesive to the upper and forward rib flanges. Locate with clecos. Remove any excess adhesive from the flange side of the ribs and make a small fillet up against the non-flange side, including the forward BL249 rib / lower skin joint.

Double check that everything is correctly aligned and that the workshop temperature is adequate, and GO AWAY until everything has cured!

## Aileron closeout

The outboard 1/4 wing skin panels now need the aileron closeout bonding on. The outboard panels are the ones with the three boxes on for the aileron mass balance horns, which are at the trailing edge. The aileron closeouts are the long 4 faceted C section mouldings. The inboard end is very slightly wider. The inboard end of the 1/4 panel has the inspection panel depression moulded in it. Mark both to identify them.

The aileron closeout fits flush with the trailing edge of the 1/4 panel. To be able to do this , the 3 aileron mass balance arm boxes need to have the rear faces cut away in the four facet shape of the closeout. Cardboard templates made around the closeout will help transfer the shape - see figure 23.

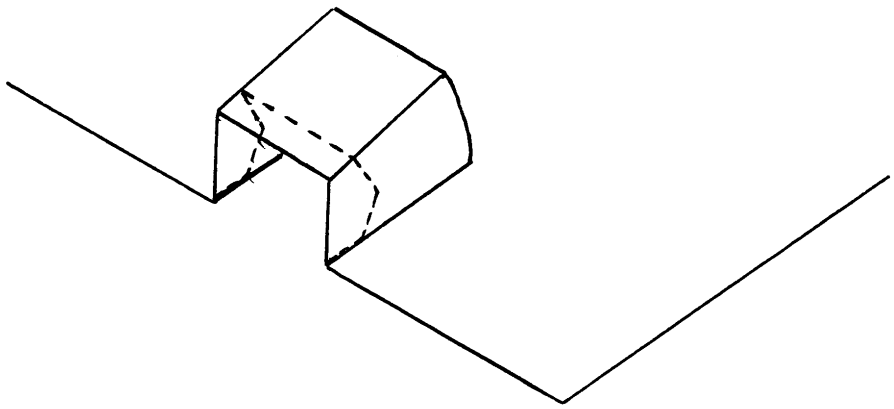


*Fig 23. Cutting away mass balance arm boxes to fit aileron closeout.*

After cutting away the boxes the closeout can be offered up to the 1/4 panel. Scuff sand the areas where the closeout makes contact with the skin, and for approximately 25mm (1") forward of this, on the mass balance box for approx 25mm (1") ahead of the cutaway section and all of the long closeout upper surface.

To bond the closeout to the outer panel you will either need a 2.3m (7ft 6in) long bench and a piece of 25mm square steel angle section the same length, or two pieces of the angle section the same length. The aim is to bond the 1/4 panel and the closeout trapped between two straight surfaces. Using Araldite 420 thickened with a little flox, bond the lower surface of the closeout to the trailing edge of the 1/4 panel with the angle section clamped gently in several places with the aft edge of each kept in line. Use suitable release materials. Allow to cure fully.

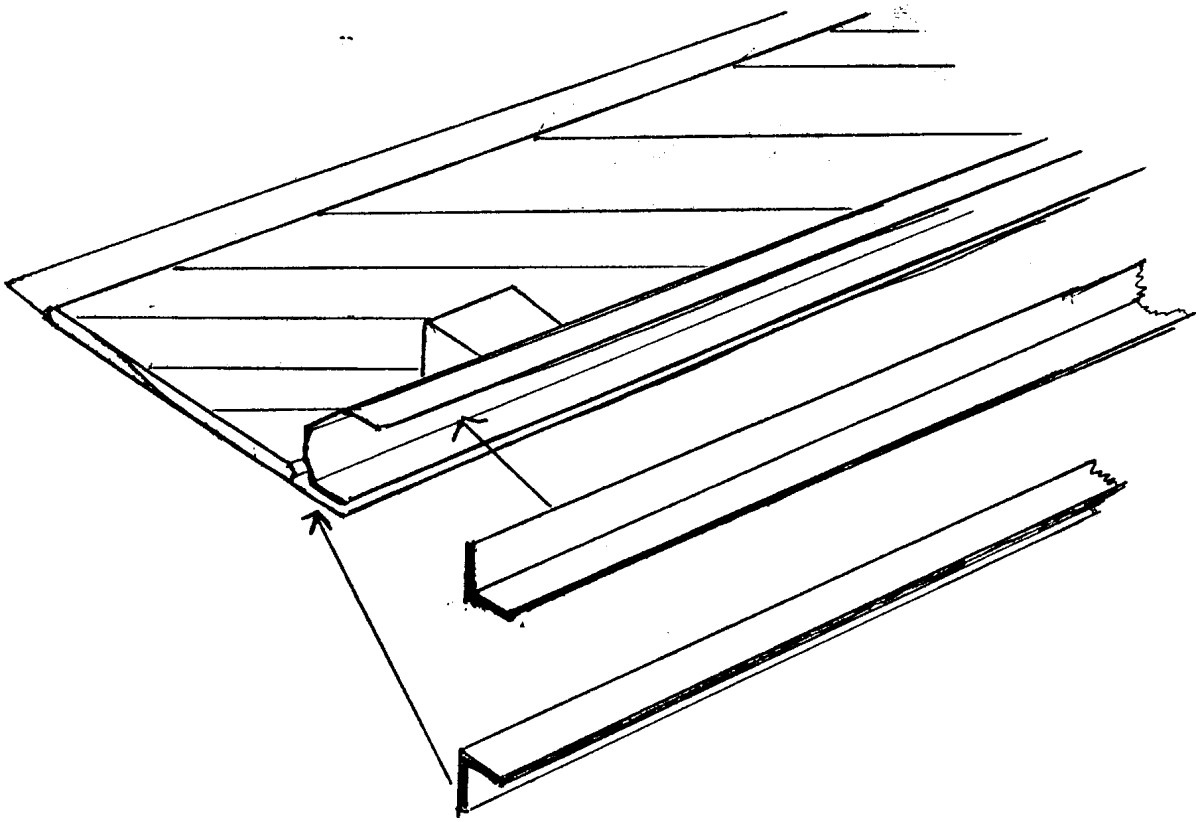


*Fig 24. Bonding 1/4 panel to closeout.*

When the aileron closeout / 3/4 panel joint has fully cured, an additional layup is applied to the forward face of the closeout and on to the inner skin of the panel and mass balance boxes - see figure 25. Scuff sand all areas.

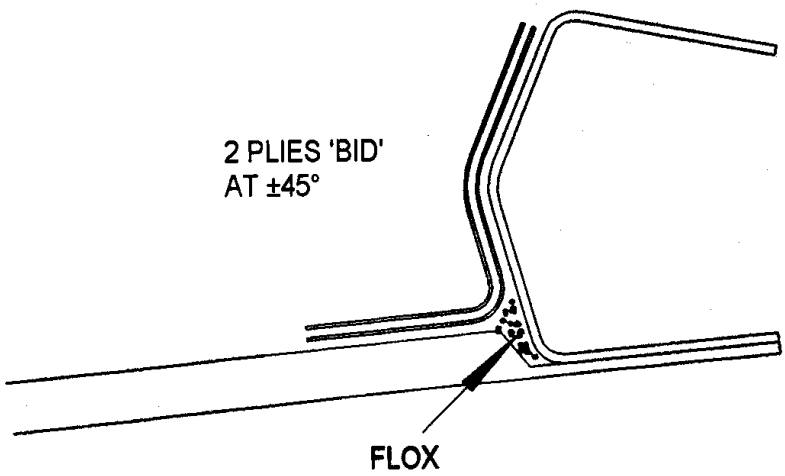



*Fig 25. Layup on closeout and mass balance boxes.*

Use a generous flox fillet in the corners, and apply two layers of 'bid' at ±45° from the top of the closeout down and onto the inner skins and mass balance boxes. Peel ply in the areas of BL200 and BL249 for future bonding to the rear of the outboard ribs. Allow to cure.

### Bonding inner and outer 1/4 panels

Now is the time for a 'dry run' for fitting the inner and outer 1/4 panels. The area of the inner 1/4 panel where the airbrake fits will need to be removed, otherwise the panels should be a good fit. Mark on to the inner surface of the skins the position of the ribs / airbrake subspar / spar flanges where the contact will be made. Ensure all bond sites on all the parts that will be bonded together are scuff sanded ready for the adhesive. Put clecos through the 1/4 panels into the 3/4 panels in several places as a reference point for later bonding. Vacuum all the dust out of the wing. The two aileron pushrods should now be removed (leave the MW4 rose joints in place) and protect the complete bellcrank assemblies with a wrap of thin plastic sheeting.

Straight steel box / angle sections will be needed running the full length of the spar joints and the various lengths of the individual sections of the trailing edge above and below the wing. Where the sections will pass through the cradles cut away the cradles to clear. 25mm x 25mm x 1.5mm (1" x 1" x1/16") works the best. Cover all the steel sections with parcel tape, and also the wing skins where the sections will make contact - just to make sure that nothing gets permanently stuck together!

Again do a dry run. Many clamps will be needed, the smaller the better - a clamping range up to 75mm (3") is ideal, since large clamps tend to weigh too much and pull down the trailing edge. Even with the smaller clamps, it is advisable to support the sections and clamps. Aim for a clamp about every 15cm (6")

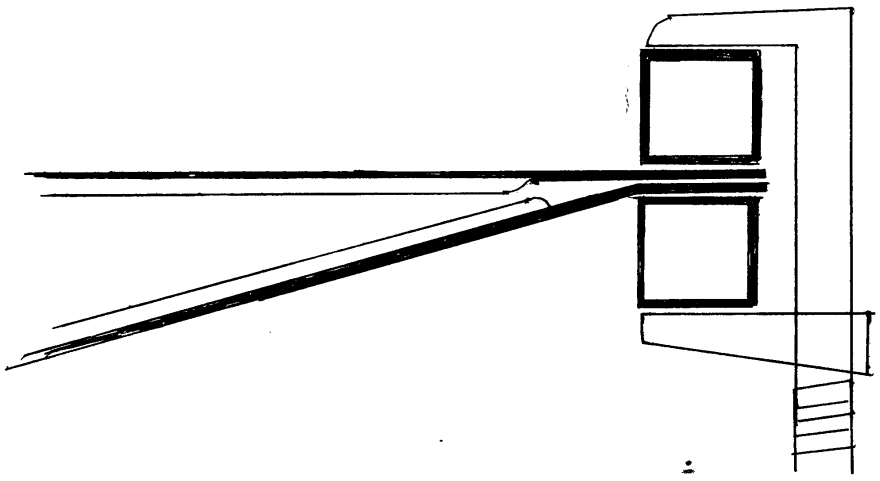


*Fig 26. Box sections clamping trailing edge skins.*

When you are happy with the fit, remove all the clamps, box / angle sections etc., and get going with the Araldite 420 adhesive.

Mixing in small batches, apply unthickened Araldite 420 to the contact areas of the inner 1/4 panel, thicken up the rest with flox and apply to the inboard 3/4 panel. Close up the two panels, locating them with the greased clecos. Repeat this operation with the outer panels, including adding adhesive to the joggled flange of the inner 1/4 panel. Cleco the outboard 1/4 panels on. Add the steel box / angle sections on to the spar joint, and weigh down with a number of small weights, just enough to squeeze out some of the thickened Araldite 420. Secure the box with tape to stop it sliding about. Clamp the pairs of box sections together with the clamps, applying just enough pressure to squeeze out excess adhesive.

Remove any adhesive that has been squeezed out, and support the weight of the clamps.

Leave to cure fully, meanwhile go for a beer, you deserve it!

### Spar / rib reinforcement

Further plies of 'bid' now need to be added between the spar and the root rib, the 6 plies that have been mentioned before - see figure 27. They will be laid at ±45° both forward and aft of the spar. These are applied in pairs, the first longest pair are taken 50mm (2")past the centre of the spar pin bush, cutting the cloth around the flanges of the bush.

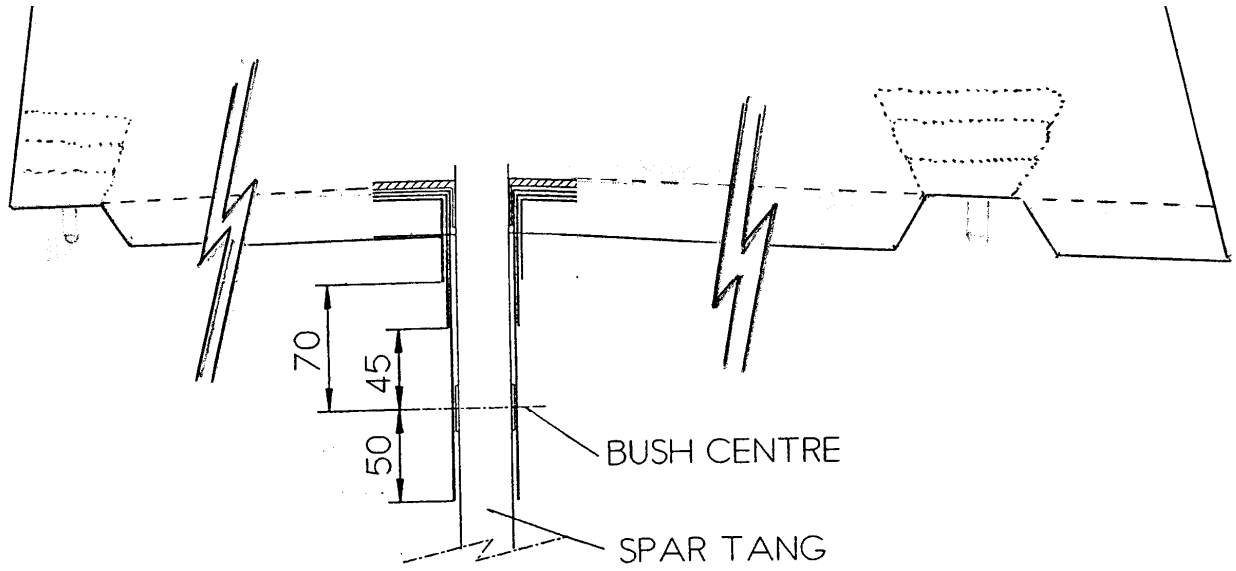



*Fig 27. Reinforcement plies.*

The 'bid' is taken on to the rib, with a small flox fillet in the corner all the way along the rib and on to the inside of the overhanging wing skin. Where the cutaways are at the wing pin positions, take the cloth over on to the outer wing skins, the first pair of plies will go 75mm (3") on to this surface.

The second pair of plies run from 45mm (1 3/4") outboard of the spar pin bush around on to the rib and on to the outer skin, this time running 50 mm (2"0 on to the outer skin.

The third pair of plies run 70mm (2 3/4") outboard of the spar pin bush- and run 25mm (1") on to the outer skin.

By now, of course, you do not need reminding about scuff sanding **all** the surfaces to be laid up on!

You will need to carefully part the cloth over the lift/drag pins (which you will have covered with parcel tape!). Peel ply over the entire layup and allow to cure.

When fully cured, cut away the 6 plies where the pushrod holes for the aileron and airbrake pass through the rib, and trim away any excess cloth back to the wing skin.

Carefully sand away around the pins to remove any raised 'bid' from the area that would foul the outer face of the socket, taking **extreme** care not to mark the surface of the pins.

### Wing root skin reinforcement

The area of the wing skin up against the fuselage requires further reinforcement.

Scuff sand an area slightly larger than shown in figure 26 on both upper and lower wing skins, blending out any lumps and bumps in the 6 'bid' layup which wraps from the root onto the skin. Vacuum away the resultant dust.

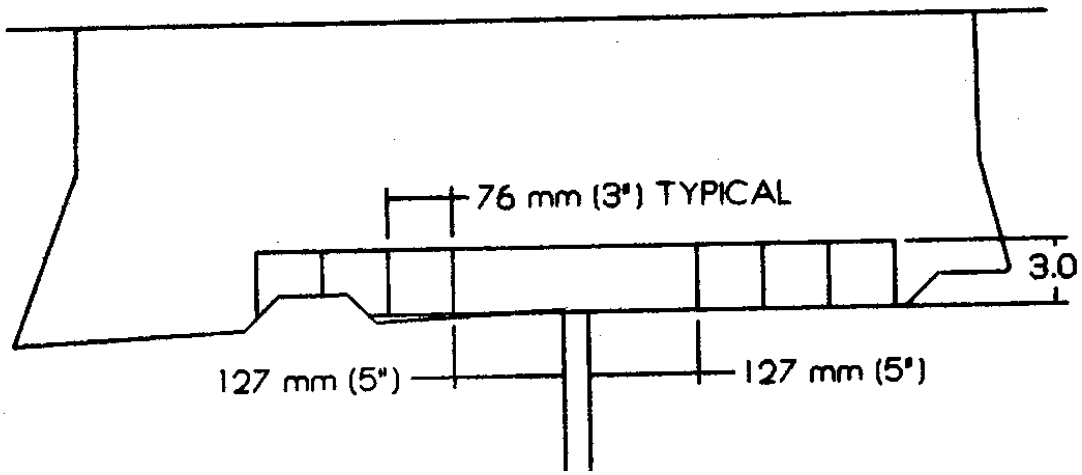



*Fig 28. Wing reinforcement area.*

The easiest way of applying these 'Uni' tapes is to use polythene sheeting as you did for the wing rib tapes.

Mark out on reasonably thick transparent polythene sheet the following lines with a marker pen, leaving a good margin around the outside - see figure 29.

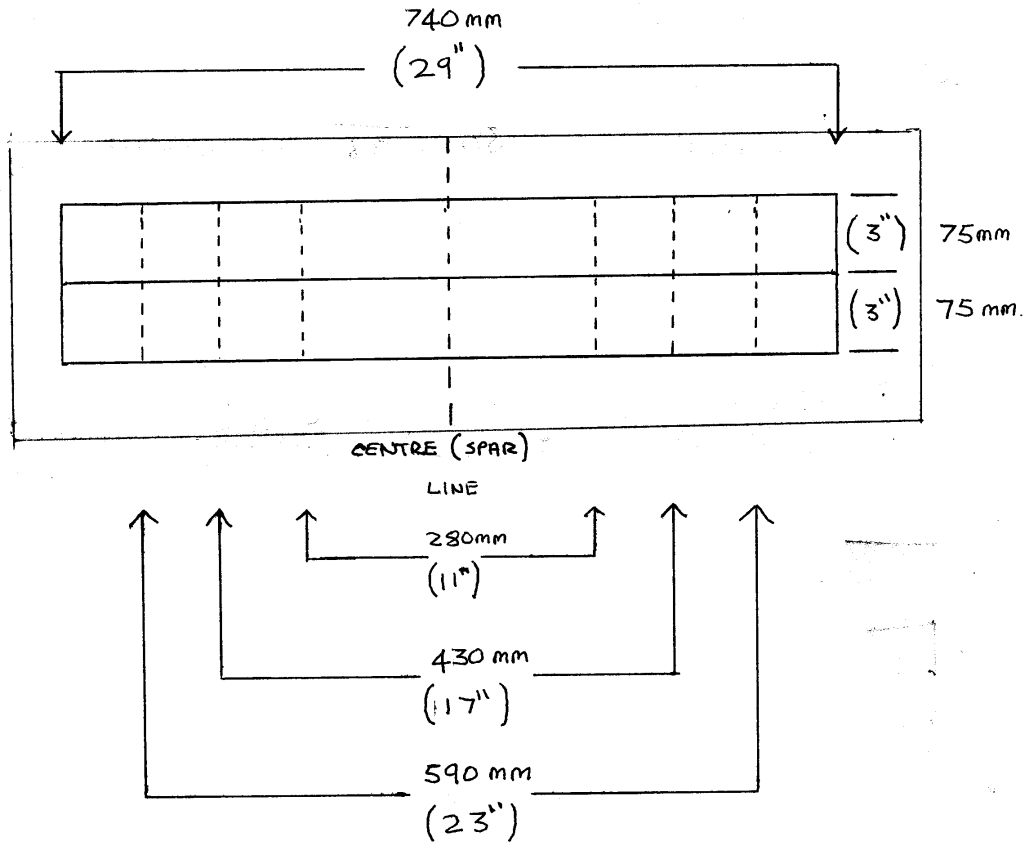



*Fig 29. Layout of 'uni' tapes.*

Turn the plastic over so that the resin will not affect the marker pen lines, and fully wet out the surface with resin.

Starting with the shortest 280mm (11") ply lay the 'uni' cloth on, with the main fibres aligned lengthwise, squeegeeing along the fibres. The cloth can be oversize on the width at this stage.

Continue this process in the order 430mm (17"), 590mm (23") and finally the 740mm (29") tapes, squeegeeing between each ply to fully saturate the fibres and to remove any excess resin.

Apply a coat of resin to the upper surface of the wing, and transfer the plastic/ply (sticky side down!) to the wing skin, with the centre/spar line on the plastic in line with the centre of the spar.

Keep the edge of the laminate in line with the edge of the wing skin, Carefully remove the plastic sheeting, whilst keeping the glass cloth in contact with the wing skin with a brush.

Squeegee to remove all traces of air and to make good contact with the skin, and peel ply over the entire layup.

The lower surface is much the same except the joint in the wing where the rear 1/4 panel butts up against the main 3/4 skin may need a little flox skimmed in it to bring it flush with the skins - see figure 30.

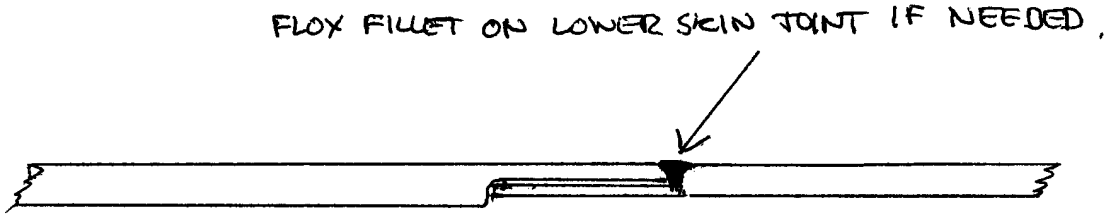



*Fig 30. Flox fillet on lower skin.*

The four plies of 'uni' and the plastic sheeting can now be cut out around the solid lines, leaving you with two pieces 740mm x 75mm (29" x 3")

### Pitot/static tubing

If you look into the aileron pushrod hole (aft of the spar) in the port wing, you will see the plastic bag containing the coiled pitot/static lines you taped there earlier. Fish them out. Refer to chapter 8 figure 14, and drill two 8mm (5/16") holes as marked through the port aft rib. Countersink the holes with a 13mm (½") drill bit as deep as the 6 plies of 'bid'. Find yourself a piece of welding wire / coat hanger, and bend it into a "U", so that it can be fed through these holes in turn and be made to exit the wing out of the pushrod hole.

In turn, push each of the hoses on to the wire and secure it with tape, then pull the wire back out through the 8mm hole, whilst feeding the hose back through the pushrod hole.

When both lines are through the two holes, "pot" them with a little rapid epoxy / flox fillet where they exit the rib. Lead them forward over the spar. They will enter the fuselage in the cockpit area, next to the spar pin area..

### Wing root fairings

The wing root fairings come to you as pre-moulded items. The outside surface will need washing with hot water/detergent to remove any trace of mould release agent.

The wings will need to be rigged onto the fuselage, and the BLRS411N pip pins installed.

Onto the fuselage, around the wing you will need to tape on a card or similar shim approximately 2mm (0.080") thick where the fairing will make contact with the fuselage. This is to allow for a layer of 'bid' which will later be applied to the fairing and for the finish paint, etc.

Mark a spanwise line on the upper wing skin in line with the rear pin, and mark a reference dimension along this line – about 300mm (12") outboard of the pip pin hole in the drag pin. This will allow you to locate the whereabouts of the pip pin when you lose sight of it under the fairing!

The fairing should be slipped on to the wing from the leading edge by opening up the trailing edge of the fairing and springing it over. The inboard trailing edge of the wing may need trimming to allow the top and bottom surfaces of the fairing to make contact again, when the fairing is pushed gently up against the fuselage.

When you are happy with the fit of the fairing onto the wing, it needs temporarily attaching to the wing. Make a note of where the spar is inside the wing. You will be using 4 clecos through the fairing into the wing on both the upper and lower surfaces, keeping away from the spar, and working from the front towards the rear, and about 12mm (½") from the edges.

Use adhesive tape along the trailing edge cut to hold the two halves together. The join should line up with the trailing edge of the wing.

Mark onto the wing skin where the outboard end of the fairing finishes, and remove the fairings. Scuff sand on the wing from this line inboard where the fairing makes contact, and scuff sand the inside of the fairing in the contact area. Also scuff a 50mm (2") wide area on the trailing edge surfaces of the wing and inside the rear of the fairing.

Scuff sanding on the gel-coated areas of the wings needs only to be enough to remove the shine from the surface, it is not necessary to expose the fibres of the structure. Scuff sanding of the 'bid' layup of the fairing needs to remove the shine and just cut into the fibres.

Remove all traces of dust from the surfaces. Araldite 420 is used as the bonding agent. Thicken with flox to the "just doesn't run" consistency that you have by now got used to, and apply an even coat to the wing skin in the area to be bonded.

Spring the fairing over the wing without wiping too much adhesive from the wing skin, and install the clecos, lightly greased, from the leading edge, in the same sequence as the holes were drilled. Tape the trailing edge together at the join.

You may find it helpful to temporarily tape the fairing to the fuselage to help the fairing to keep its shape, and also tape around the joint to the wing after removing any excess adhesive. Allow to cure fully.

Using the line that you marked on to the wing skin, locate position of the pip pin in the rear socket, and drill into the fairing, first with a small pilot hole, and then with progressively larger drills / hole saws, up to 30mm (1 3/16"), taking the opportunity to centre the hole over the pip pin if the original pilot hole was slightly off.

The fairing at this stage is still quite flexible at the area of contact with the fuselage, and will need temporary stiffening before the wings are removed. Using mixing sticks or similar small pieces of wood, you will need to "shore up" the outer edge of the fairing down onto the wing, with small blobs of 'bondo' or similar auto body paste. Position as required to ensure that the faring will lie flat against the fuselage. Every 150mm (6") will be enough.

Remove the pip pins and de-rig the wings.

Two plies of 'bid' now need to be laid up in the trailing edge area to join the fairing to the wing skin. This is the area you scuff sanded earlier.

The cavity between the wing skin and the inside of the fairing needs to be filled with scrap blue foam. Cut the foam to the best shape you can, and glue it into place with dryish micro. When cured sand the foam back to achieve a gentle transition from the edge of the fairing onto the flange of the wing skin.

Scuff sand the inside face of the fairing and the under surface of the root rib, putting a small radius on the corner of the rib flange, and lay up a single ply of 'bid' at ±45° over the entire fairing surface.

## Spar strap

When the wings become loaded in flight, the spars within the fuselage bend, as well as the wings themselves. Due to the spar pins being supported by the seat back bulkhead only, the spars try to twist as well as bend.

To limit the twisting effect, a 75 mm (3") wide glass fibre strap is to be attached to the port wing spar at the aircraft centre-line. The strap is to be laid up directly around the starboard spar, which will be suitably treated with release tape, to ensure a perfect fit.

## Preparation

## Starboard spar

To accommodate spar bending, the strap needs to be made with some clearance at each end over the spar's upper edge. Without this, the starboard spar would tend to shear the strap from the port spar as it bends. To form this clearance, cut a piece of thin card to the width of the spar and at least 90 mm (3/1/2") long and cover it with release tape.

Using two 3 mm thick spacers placed on the spar as shown in figure 31, position the card former between them so that it curves and, using the release tape, attach it to the spar. Wrap the release tape, all around the spar trying not to distort the curved shape of the card. It might be wise to support the card in various places underneath so you don't lose the curve.

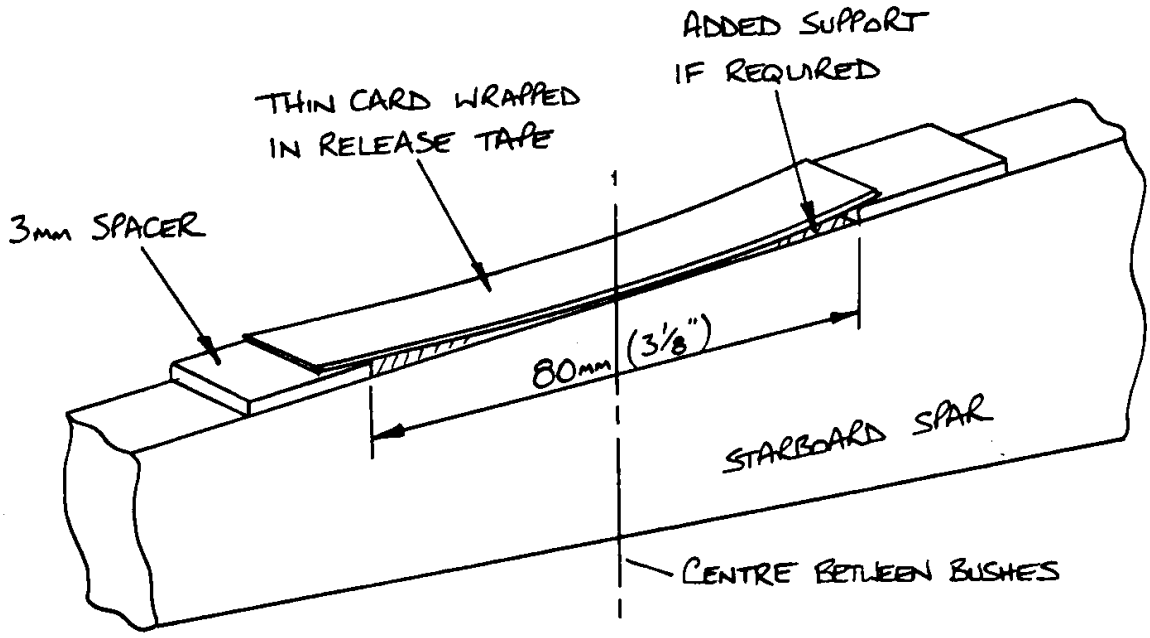



*Fig 31. Former position on spar.*

### Port spar

Scuff sand the central 15 cm (6") all around the port wing spar in readiness for bonding the strap to it. Support the port wing, leading edge down and arrange it such that the starboard wing can be rigging in position with it, but don't put them together at this stage.

## Layup

Cover an area of your work bench with plastic sheeting, then directly onto it make two different layups. One will be the strap, the other will form two brackets.

- **Brackets** - Layup 2 plies of 'bid' at ± 45º large enough to cut two 90 mm x 90 mm (3" x 3") squares.

- **Strap** - Layup a strip large enough to cut a piece 350 mm x 90 mm (14" x 3") to the following schedule.

2 x 'bid' at ± 45º .
2 x 'uni' (fibres running lengthwise).
2 x 'bid' at ± 45º .

Position the bracket layups onto the centre of the port spar, lapping just 25 mm (1") onto the spars rear face, one at the upper edge, the other at the lower edge. See figure 32. For now, leave the bracket's pieces hanging down.

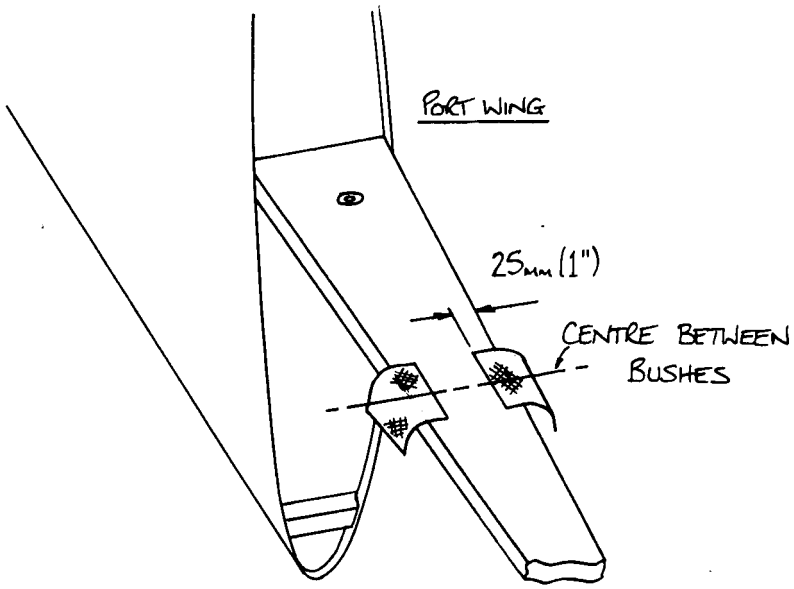



*Fig 32. Bracket plies in position on port spar.*

Now position the starboard spar onto the port spar and insert the spar pins or two ½" bolts through the spar bushes. Ensure that the spars are properly together, use clamps if necessary but don't squeeze the centres of the spars together.

With the spars together, wrap the bracket layups around the starboard spar. See figure 33.

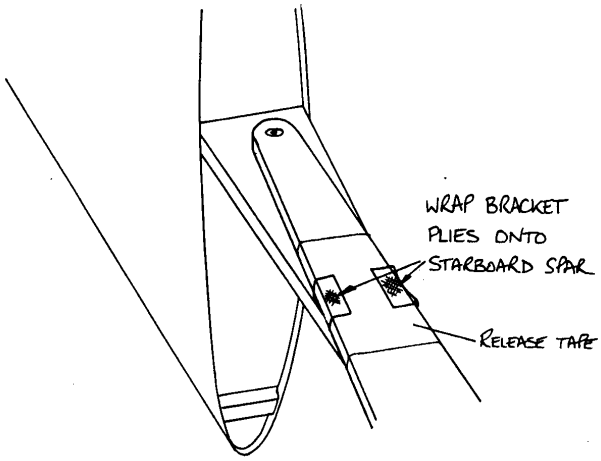



*Fig 33. Brackets wrapped around starboard spar.*

Apply flox to make a fillet between the bracket layups and the port spar then lay on the strap layup, over the brackets wrapping around onto the forward face of the port spar. The strap is not meant to overlap here, so trim the ends if necessary. Having made sure that the layups are properly in place, leave to cure.

After cure, remove the spar pins and separate the spars. Trim the edges of the strap to remove sharp edges, adjusting the strap's width to no less than 75 mm (3"). See figure 34.

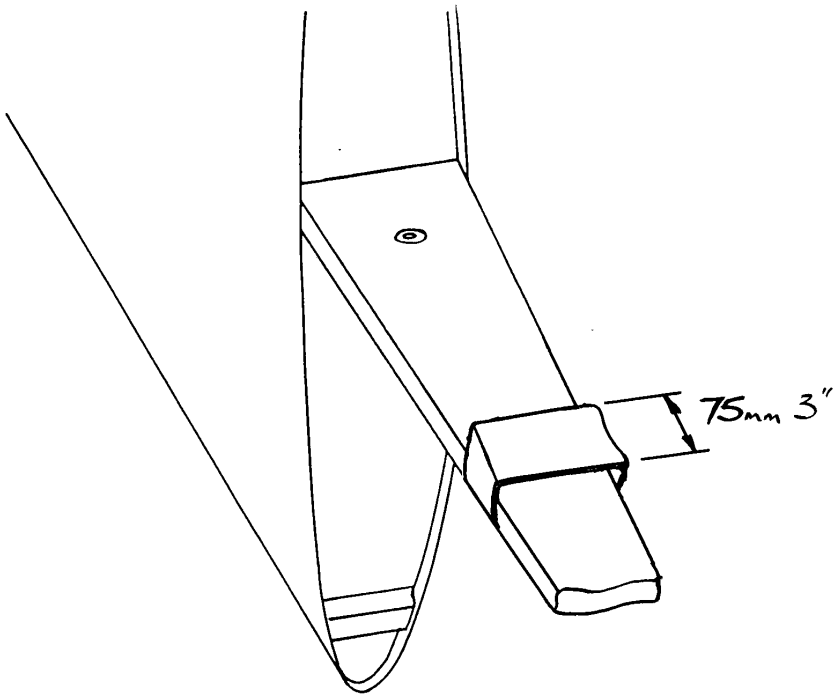


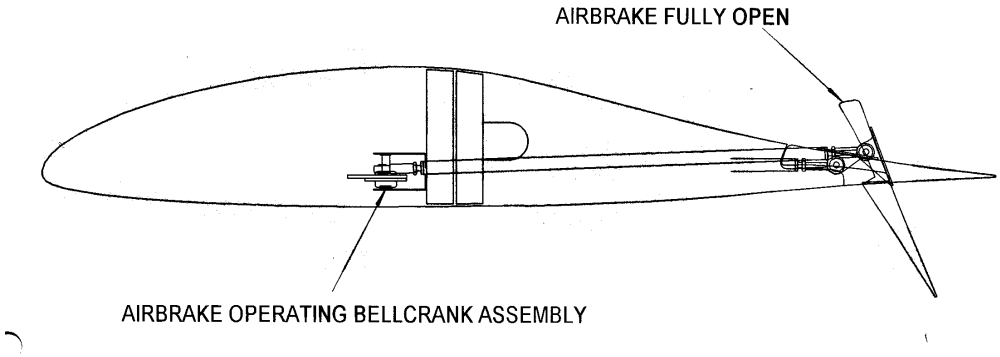

*Fig 34. Spar strap trimmed to size.*

**Note:** *It may be necessary to separate the spars with a scissor jack, but be careful not to apply any impact loads,*

Finally remove the release tape and card former from the starboard spar.

# 9. Fitting airbrakes and ailerons to the wing.

The airbrakes are fitted to the wing trailing edge. When operated from a lever in the cockpit, both rotate through a maximum of 60°. Part of the airbrake protrudes below the wing and part above it. See illustration.




### Airbrake hinge

A single 1828mm (72") length of the MS20001-3 hinge is used to attach each airbrake to the wing. AN525-10R8 bolts are used to attach the hinge to both the airbrake and the wing. Anchor nuts are to be installed onto the hinge because access to the nuts is not easy with a spanner when the push-rod is connected.

Firstly, position the airbrake into its relative wing, with a gap of 1.25mm (0.050") between its leading edge and the wing. For the hinge to fit, there needs to be a gap of 6mm between the hinge flanges of the wing and airbrake. Sand the hinge flanges to end up with straight parallel edges which are 6mm apart.

### Bolt positions

Next you will mark onto the hinge flanges of the wing and airbrake 18 hole centres each for the attendant bolts. Mark a centreline parallel to and 9mm (0.35") from the edge of the hinge flange of both the wing and the airbrake. From the centre of the airbrake to the airbrake recess of the wing mark a hole centre 76mm (3") at either side. Next mark every 101mm (4") so that you have a total of 18 centres with the end hole centres being 38mm (1 ½") from the end of the hinge. Drill through with a 3.3mm (1/8") drill initially as these will accept clecos.

Setting one half of the hinge against the flange so that its centre is 3mm from the edge of the flange (it may be necessary to chamfer the hinge flange of the wing or airbrake to accommodate the radius of the hinge pivot) and with the ends of the hinge an equal distance from each end, drill through with the 3.3mm (1/8") drill.

## Push rod hole

While the airbrake can be clecoed to the wing and is therefore quick to remove and attach, this is a good time to make the hole in the wing for the airbrake push-rod.

Using figure 1 as a guide, cut open a slot for the airbrake push-rod to pass through in the airbrake recess of the wing. As the push-rod will move up and down as it operates the airbrake, the slot will need to be elongated vertically by about 10 - 11 mm (nearly ½").

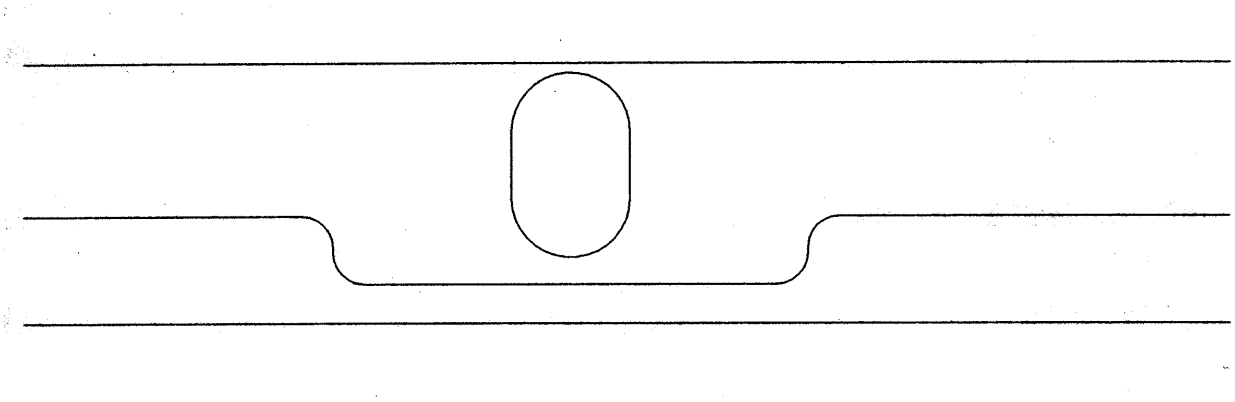


*Fig 1. Hole for airbrake push-rod.*

Screw the short push-rod into the rod end of the airbrake and screw another rod-end onto the push-rod. Feed it through the hole in the wing as you attach the airbrake and bolt up the rod-end to the bellcrank using an AN4-10A bolt, MS21042-4 nut, and EUR001 washers each side of the rod-end. Open the airbrake so that it rotates 60° and adjust the push-rod length so that the bellcrank contacts the stop , and check that the slot is sufficiently large for the pushrod movement.

## Attaching anchor nuts

Removing one Cleco each time, open up the bolt holes to 4.8mm diameter.

Using an MS21047-3 anchor nut as a jig, drill the two 2.4mm (3/32") holes for the rivets through the hinge and then countersink these holes on the side which will be in contact with the wing or airbrake (using a larger drill for this will suffice).

Rivet the anchor nuts to the hinge using TAPK33BS rivets, then bolt the assembled hinge to the airbrake and the wing using AN525-10R8 bolts, remembering to insert the push-rod into the wing first.

## Fitting airbrake brackets

A simple jig is required with which to install the two brackets GAB01L and GAB01R to the airbrake. This jig locates the brackets relative to the airbrake hinge flange. See figure 2.

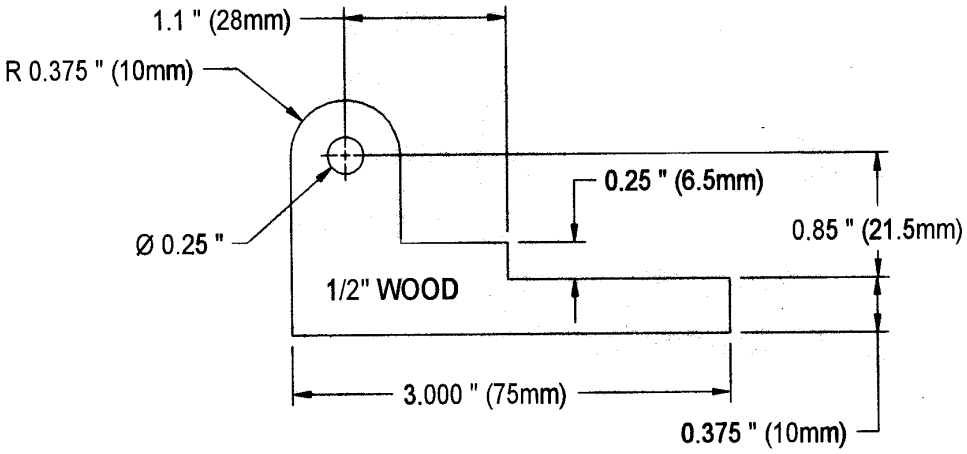



*Fig 2. Jig for positioning airbrake brackets.*

Using the drawing in figure 2 make the jig from ½" thick wood supplied. The thickness is quite important as this sets the gap between the brackets for the rod end and two washers.

Using the joint line between the two airbrake cores as your centreline, radius the outer edge of each slot to allow for the bend in the bracket so the bracket's flange can sit against the airbrake upper skin. Using the jig and an AN4-10A bolt, locate the brackets GAB01L and GAB01R - see figure 3.

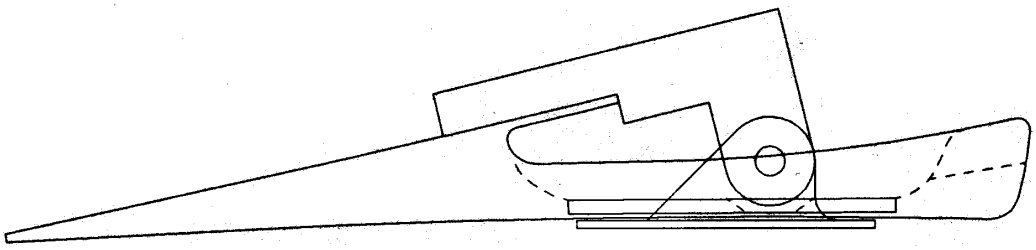


*Fig 3. Positioning airbrake brackets.*

Drill through the bracket flanges into the airbrake with a 4.8mm drill for the AN525-10R10 bolts. The brackets are to be bonded to the airbrake as well as bolted, so scuff sand the contact areas. Bond the brackets into place using epoxy mixed with flox and bolt them up (not too tightly) using AN525-10R10 bolts and MS21042-3 nuts with AN970-3 washers under them. Too much thread through the nut can be cut off if required, but don't use a shorter bolt. Once bolted into place, the jig may be removed, but check that the brackets can't move while the adhesive is curing.

After cure, tighten the bolts that last amount, then install between the brackets an MW4 rod end, each side of which is an EUR001 washer, using an AN4-10A bolt and MS21042-4 stiffnut.

### Aileron hinge rebates

Mark the rebates for the hinges on the trailing edge of the *bottom* skin of the wing as in figure 4.

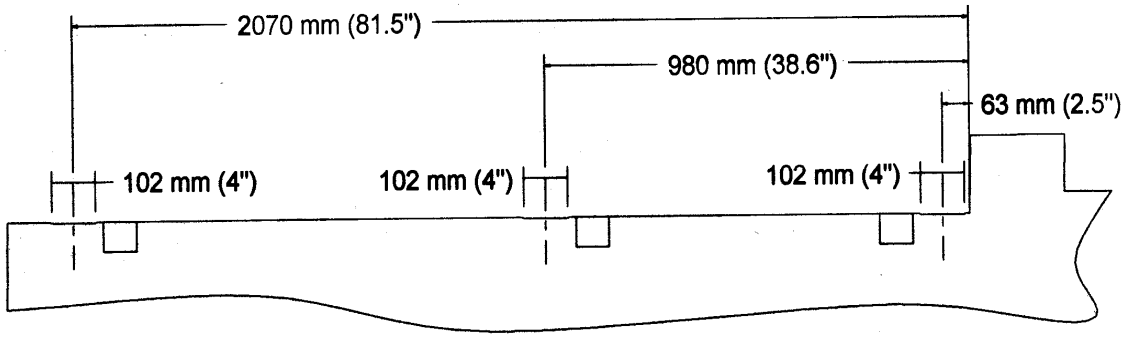



*Fig 4. View of wing underside. Adjust dimensions to suit aileron.*

Use the aileron to confirm these positions then cut the rebates 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 5 ) but drill only 3 . 3 m m (1/8")pilot holes through the glassfibre flange to start with.

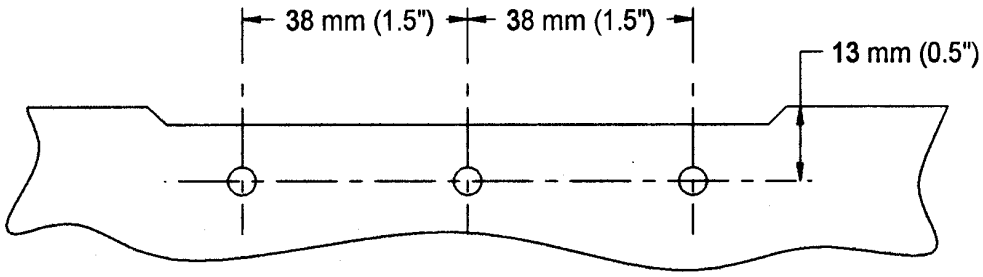



*Fig 5. Hole positions for hinge.*

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 3.3mm (1/8") drill in just one place per hinge, initially installing a Cleco to keep it in place.

Drill the remaining holes to 3.3mm (1/8"), putting clecos in some of them to give extra support, then carefully open them out to 4.8mm, taking care to prevent the drill wandering in the glassfibre flange until it has started cutting into the metal of the hinge.

## Fitting anchor nuts to hinges

When the link-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, 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" or similarly sized 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 anchor nut is shown in figure 6.

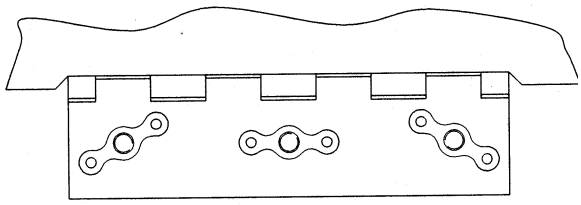


*Fig 6. Typical anchor nut rivet pattern.*

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° trailing edge up and 22° down is available. The final travel will be 23.5° up and 20° down. You may need to drill holes in the aileron leading edge to allow the anchor nuts to enter at 25° up.

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# 27a. Wing to fuselage assembly (retrofit)

## Overview

In this section you will be setting the wings' angle of incidence which is to be +2.0°. The angle of incidence is the angle between the chord line of the wing and the waterline of the aircraft.

The wing lift pins locate into sockets attached to the fuselage sides, and these hold the wing at the determined angle.

Take care when setting the angle of incidence, especially that both wings are set exactly the same. Any small angular difference between them will result in an aircraft that always wants to roll one way, requiring a roll trim tab permanently attached to one of the ailerons.

This chapter deals with retrofitting motor glider wings to an existing airframe which has already had the standard wings fitted.

If you do not intend to fit standard wings go straight to chapter 27b.

Included in the kit are drill bushes GDG01, GDG02, GDG03, and GDG04 -see figure1.

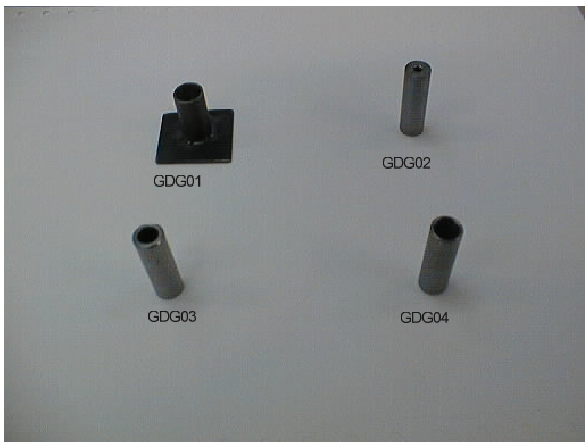



*Fig 1. Drill jigs*

Insert the drill jig GDG01 into the fuselage wing sockets - see figure 2.

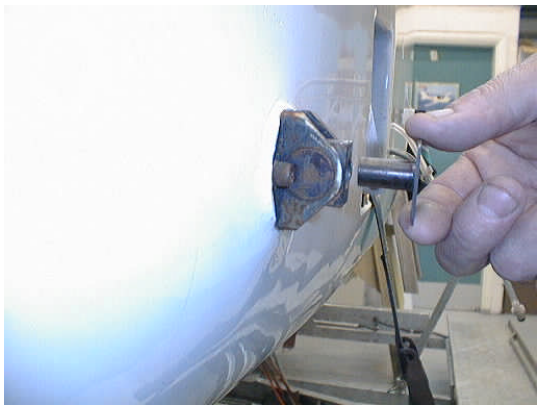


*Fig 2. GDG01 fitted to wing sockets.*

Cut off the threaded portion of the EUR047 bolts and grind a bullet shaped lead onto the ends.

Offer up the wings to the fuselage and insert the EUR047 bolts into the wing bushes through the seat back - a thin smear of oil on the bolts will make this easier.

Tie the root end of the wings forward from around the trailing edge to the undercarriage frame. Wedge the spar tips forward with suitable chocks.

Using the incidence board on the wing, reset the angle of incidence to 2.0°. During the set up stage you will be rigging and derigging the wings several times, so it will make things easier if you draw a line on the fuselage with a marker pen around the wing profile for future approximate alignment.

You will now need to set the wings for sweep and skew.

Mark lines at the outboard ends of the upper wing panels, in line with the **aft** face of the spar on the **port** wing, and the **forward** face of the spar on the **starboard** wing. These lines will be in the same relative positions on the wing skins because the port spar sits in front of the starboard spar on the rigged aircraft. Measure from these lines on the wing skins to the forward / outboard ends of the tailplane torque tube.

The two dimensions should be within 5mm (1/4"); this can be achieved by using small wooden wedges between the wing rib and the fuselage. Don't put undue pressure on the fuselage skin. For future reference make a note of these dimensions on the wing next to the spar.

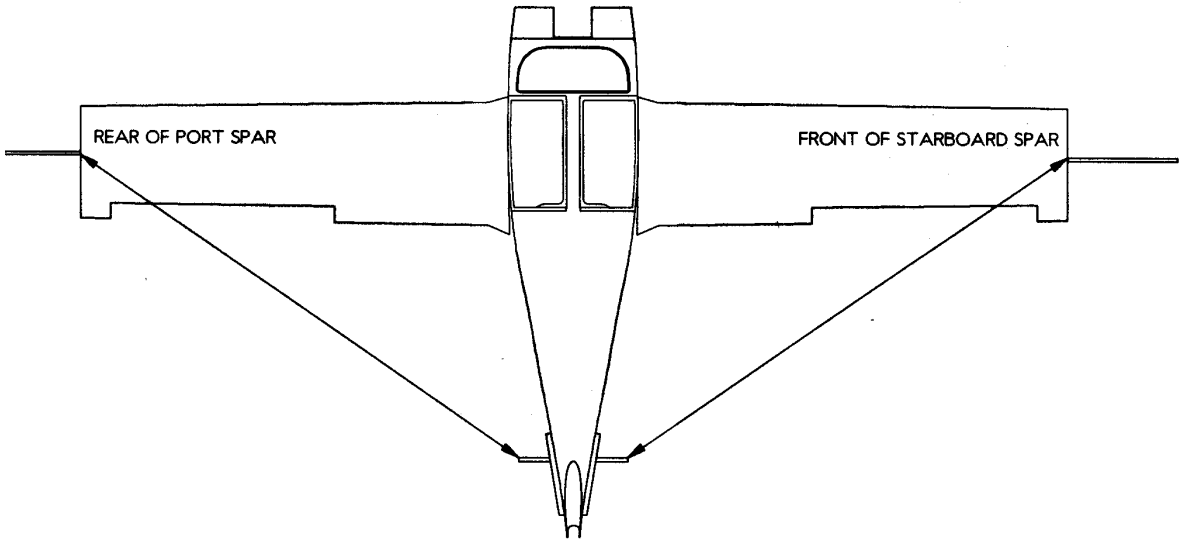



*Fig 3. Checking for zero sweepback at the main spars.*

Measure the gap between the square plates of the GDG01 jig and the root rib. the gap should be at least 3mm (0.1") at this stage.

Where necessary this gap will be filled by laminating aluminium alloy plates (part nos. GW03 and GW04 for the leading edge and trailing edge respectively) to the inboard face of the root rib. Each plate will be covered with 2 plies of 'bid', and finally there will be 6 plies of 'bid' added later which wrap onto the spar and wing skins.

To calculate the number of GW plates needed, deduct 2mm (.080") from the measured gap, and divide the result by 3.5mm (0.14"). The nearest whole number less than the calculated figure is the number of plates needed. (The 2mm (.080") deduction allows for the 6 plies which will be added later. The thickness of the GDG01 base plate is 1mm (.040"), and this amount, when the jig is removed, will be the gap finally achieved).

Make a note of each of the four gap dimensions and mark onto the wing skin the centreline of the four pins.

The overhanging flange inboard of the root rib will be cut away as per figure 4.

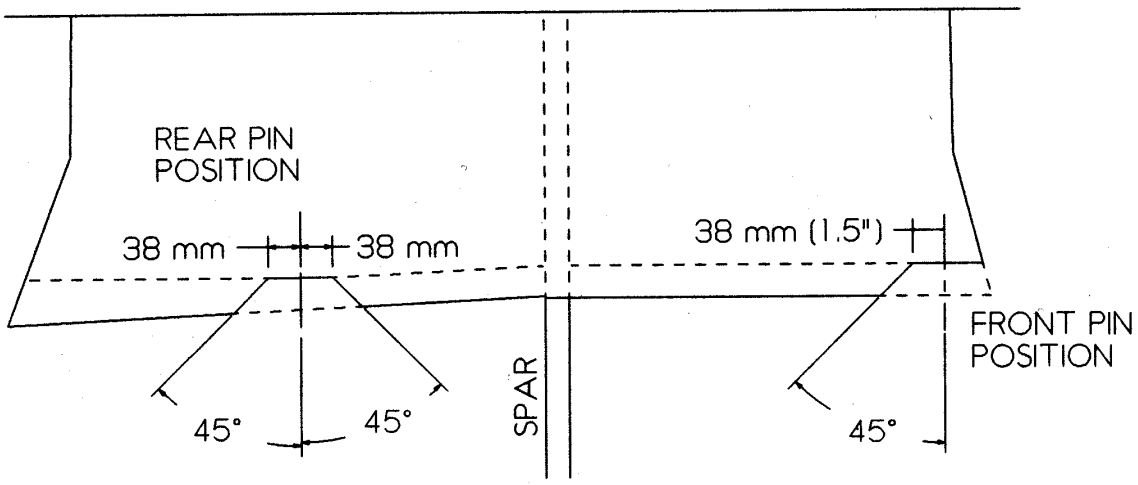



*Figure 4. Cutaways for inboard flange.*

All four areas of the root rib will need to be scuff sanded ready for the GW03/GW04 plates to be fitted If you have the 2mm clearance already you can skip the next lay-up section.

Trim the GW03 and GW04 plates if necessary and radius each plate to allow the fibres to go round easily- see figure 5.

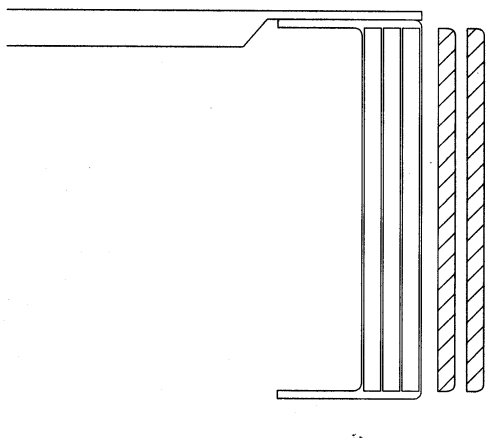


*Fig 5. Trimming the GW03/GW04 plates.*

Lay-up over the plates as required for each position, with 2 plies of 'bid' over each plate, including the last one, skimming a thin layer of flox on to all surfaces of the plates (to improve adhesion), and using flox fillets to help transition the cloth.

The lay-ups should be kept on to the face of the ribs, i.e. not allowed to run on to the skin or rib flanges.

Peel ply over the layup ready for the 6 layers of 'bid' which will be applied later.

When these layups have fully cured, the wings are ready to be reset into position for bonding on the four GDG01 drill guides. Leave the peel ply on at this stage.

Rig the wings on to the fuselage, repeating the angles and dimensions you had earlier (2° incidence ) using the incidence board, and the same measurement from spar line to tailplane torque tube, and recheck that you have the necessary 2mm clearance between the GDG01 and the ribs.

Pull the wings far enough away from the fuselage to gain access to the GDG01's and remove both them and any other temporary packing. Degrease the flat face of the bushes and roughen the surface for a good adhesive key.

Grease the barrel part, and the face of the bush that will be against the lift/drag sockets (to prevent inadvertent bonding of the drill bush on to the fuselage) and reinsert them into the sockets. Ensure that the swivelling rear socket is aligned with the forward lift socket with regard to the horizontal.

You will now be bonding the GDG01 bushes onto the inboard ribs with the wings set in the correct position.

Mix up a small amount of Araldite 420 (28 gm is enough) and thicken it with flox until it will just not run.

Apply to the outboard faces of the GDG01 drill bushes and re-rig the wings.

Carefully set up the wings with the incidence board and firmly support them ensuring that there is no possibility of movement. If you are doing this work outdoors and will have to leave it overnight to cure, you may like to bond short pieces of wood (i.e. 2" x 1") across the wing to fuselage joint with 'bondo' or similar near the leading and trailing edges of the wing. These will be knocked off after the wing is fully cured.

The Araldite 420 adhesive will need to cure for at least overnight at 21° C (70°F). If you need to make a tent around the fuselage/ inboard wing area to keep the heat in, ensure that the heat source is safe and that the tent is not made of a flammable material!

When the adhesive has cured, the wings need to be gently removed from the fuselage. This will need four people , one at the wing tip and two at the wing root, one each at leading and trailing edge, and one to remove the EUR047 seat back pins. The three on the wing should just take the weight of the starboard wing, whilst the fourth person withdraws the pins just enough to disengage the starboard spar. Without letting the wing drop or twist, remove the wing without breaking the bond of the GDG01 bush to the rib. Repeat the above for the port wing. If a fully bonded joint was not achieved, add further adhesive around the bush and wait until cured.

## Drilling

Mark lines on the wing skin over the plates and parallel to the spar. Fixing a straight edge in place with masking tape, so a portion of it overhangs the root, provides a good reference to maintain alignment in the horizontal plane. The drill operator will be able to see horizontal alignment but it would be useful to have an observer positioned level with the spar, sighting the drill against the line on the spar and giving "up" or "down" commands to the person on the drill - see figure 6.

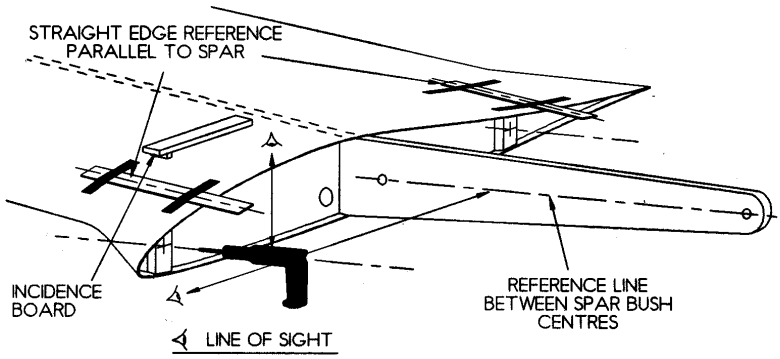



*Fig 6. Method of sighting for wing pin drilling.*

The GDG02, GDG03, and GDG04 drill bushes will be used in turn to drill into the wing ribs for the lift/drag pins to be fitted.

The first hole will be through the GDG02 bush, using a 1/8" drill bit. Keep the drill speed low to prevent too much heat being created. This is necessary to avoid the adhesive softening and thus allowing the bush to move. Change the bush to the GDG03 and drill out to 1/4", again gently. Change to the GDG04 bush and drill out to 5/16". Finally remove the GDG04 bush and drill direct through the GDG01 bush with a 10.2mm drill again slowly. A piece of cloth soaked with water and held in contact with the drill bush during the drilling operations will help keep the heat out of the bush. Alternating between each of the holes will also allow things to cool down.

Take care when drilling not to apply any sideways load which may break the bond of the drilling bush. When all four of the holes have been drilled out to 10.2 mm, the bushes can be removed. A gentle application of heat will soften the Araldite, and allow removal without damaging the rib layups. The safest way of heating is with a hot air gun, playing the heat directly onto the bush, protecting the ribs with card or similar mask.

## Tapping

The next operation is to tap the holes. Tap each hole with a 12mm x 1.75 coarse thread tap.

*Using taps*

*Tap sets are normally supplied with three taps, sometimes only two. Each tap is slightly different to enable the thread to be cut in stages. The first tap to be used will be markedly tapered to ease starting and will only partially cut the thread. The last, or finishing tap will only have a short lead-in taper and will cut the fully formed thread.*

*With the tap held in a tap wrench, which is located on the square end of the tap and enables the tap to be turned easily, hold the tap in the hole with a moderate force. Maintaining the force, rotate the tap in a clockwise direction by hand, keeping it as square as possible to the hole. It may take a few turns, keeping the force against the hole all the time, to start the thread. When you feel the tap 'biting' you can relax the force on it as it will pull itself in as you continue to turn. After the tap is able to pull itself into the hole, every half turn or so rotate the tap anti-clockwise, remove it and screw in the next taps to finish. Do not use any lubricant, as the pins will be bonded into place later.*

The rear lift pin has a circular backnut GW02 fitted; it will need trimming to fit within the confines of the rib. Make a cardboard template of the rib/hole position, and transfer this to the backnut - remove the excess material.

Degrease all the threads on the pins and the backnuts, and scuff sand the area where the backnut contacts the inner face of the rib. Mix up some Araldite 420 adhesive (again 28 gm is enough) and apply to the threaded portion of the pins, in the bore of the threaded holes in the rib, and in the threads of the GW02 backnuts.

The forward lift pins can now be fully screwed in, using a suitable soft cushioned grip to tighten them firmly.

The rear drag pins can be screwed into the aft holes until the thread is flush with the inside face of the rib. Thicken up the remaining Araldite 420 with flox to a firm paste, and apply to the flat face of the backnuts. Offer the backnuts up to the rib and continue to screw the drag pin through the rib into the backnut. The pin should be screwed into the backnut, not the nut screwed onto the pin. Any mismatch of the angle between the backnut and the rib will be taken out with the Araldite pad that is formed in the process. If you try to tighten the backnut, you may end up with the nut acting as a locknut, which will hinder removal of the pins if required at a later date. Screw the pin in fully, then unscrew 1 ½ turns, aligning the hole to be vertical. Trowel away any excess adhesive from around the nut to from a fillet.

Grease the pins where they will enter the fuselage and rig the wings. With the aid of a tapered punch or bradawl, align the hole in the GW01 drag pin to allow the insertion of a greased BLS4R11N pip pin through the W26 socket assembly into the pin.

Allow to cure fully.

## Spar / rib reinforcement

Further plies of 'bid' now need to be added between the spar and the root rib, the 6 plies that have been mentioned before - see figure 7. They will be laid at ±45° both forward and aft of the spar. These are applied in pairs, the first longest pair are taken 50mm (2") past the centre of the spar pin bush, cutting the cloth around the flanges of the bush.

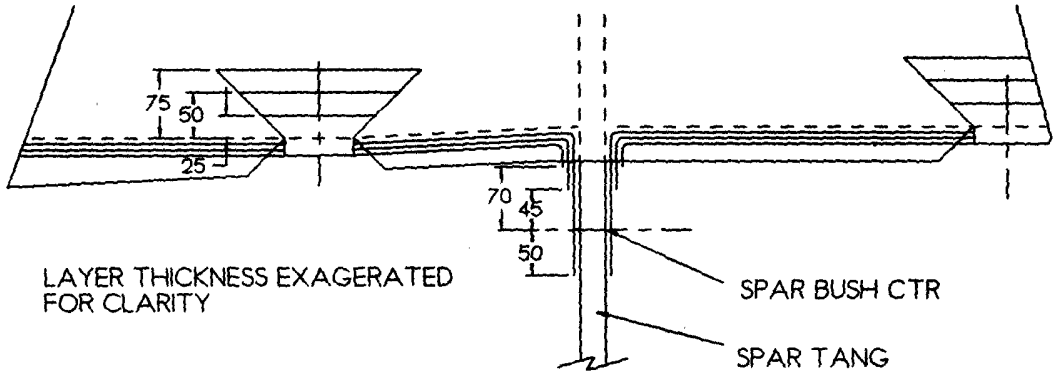



*Fig . 7 Reinforcement plies.*

The 'bid' is taken on to the rib, with a small flox in the corner all the way along the rib and on to the inside of the overhanging wing skin. Where the cutaways are at the wing pin positions, take the cloth over on to the outer skin, this time running 50 mm (2") on to the outer skin.

The third pair of plies runs 70mm (2 ¾") outboard of the spar pin bush, and run 25mm (1") on to the outer skin.

By now, of course, you do not need reminding about scuff sanding **all** the surfaces to be laid up on!

You will need to carefully part the cloth over the lift/drag pins (which you will have covered with parcel tape!) Peel ply over the entire layup and allow to cure.

When fully cured, cut away the 6 plies where the pushrod holes for the aileron and airbrake pass through the rib, and trim away any excess cloth back to the wing skin.

Carefully sand away around the pins to remove any raised 'bid' from the area that would foul the outer face of the socket, taking **extreme** care not to mark the surface of the pins.

If you look into the aileron pushrod hole (aft of the spar) in the port wing, you will see the plastic bag containing the coiled pitot/static lines you taped there earlier. Fish them out. Refer to chapter 8 figure 14, and drill two 8mm (5/16") holes as marked through the port aft rib. Countersink the holes with a 13mm (½") drill bit as deep as the 6 plies of 'bid'. Find yourself a piece of welding wire / coat hanger, and bend it into a "U", so that it can be fed through these holes in turn and be made to exit the wing out of the pushrod hole.

In turn, push each of the hoses on to the wire and secure it with tape, then pull the wire back out through the 8mm hole, whilst feeding the hose back through the pushrod hole.

When both lines are through the two holes, "pot" them with a little rapid epoxy / flox fillet where they exit the rib. Lead them forward over the spar. They will enter the fuselage in the cockpit area, next to the spar pin area.

## Wing root fairings

The wing root fairings come to you as pre-moulded items. The outside surface will need washing with hot water / detergent to remove any trace of mould release agent.

The wings will need to be rigged onto the fuselage, and the BLRS411N pip pins installed. Onto the fuselage, around the wing, you will need to tape on a card or similar shim approximately 2mm (.08") thick, where the fairing would make contact with the fuselage. This is to allow for a layer of 'bid' which will later be applied to the fairing, and for the finish paint, etc.

Mark a spanwise line on the upper wing skin in line with the rear drag pin, and mark a reference dimension along this line - about 300mm (12") outboard of the pip pin hole in the drag pin.

This will allow you to locate the position of the pi pin when you lose sight of it under the fairing!

The fairing should be slipped onto the wing from the leading edge by opening up the trailing edge of the fairing and slipping it over. The inboard trailing edge of the wing may need trimming to allow the top and bottom surfaces of the fairing to make contact again, when the fairing is pushed gently up against the fuselage.

When you are happy with the fit of the fairing onto the wing, it needs temporarily attaching to the wing. Make a note of where the spar is inside the wing! You will be using 4 clecos through the fairing into the wing on both the upper and lower surfaces, keeping away from the spar, and working from the front towards the rear, and fitted about 12mm from the edges of the fairing.

Use adhesive tape along the trailing edge cut to hold the two halves together. The join should line up with the wing trailing edge.

Mark onto the wing skin where the outboard end of the fairing finishes, and remove the fairings. Scuff sand the wing from this line inboard where the fairing makes contact, and scuff sand also the inside of the fairing in the contact area. Also scuff sand a 50mm (2") wide area on the trailing edge surfaces of the wing and inside the rear of the fairing.

Scuff sanding of the gel-coated areas of the wings needs only to be enough to remove the shine from the surface, it is not necessary to expose the fibres of the structure. Scuff sanding of the 'bid' layup of the fairing needs to remove the shine and just cut into the fibres.

Remove all traces of dust from the surfaces. Araldite 420 is used as the bonding agent. Thicken the Araldite with flox to the "just doesn't run" consistency that you have by now got used to, and apply an even coat to the wing skin in the area to be bonded. Spring the fairing over the wing without wiping too much adhesive from the wing skin, and install the clecos, lightly greased, from the leading edge, in the same sequence as the holes were drilled. Tape the trailing edge together at the join.

You may find it helpful to tape the fairing temporarily to the fuselage to help the fairing retain its shape, and also to tape around the joint to the wing, removing any excess adhesive.

Allow to cure fully.

Using the line that you marked on the wing, locate the position of the pip pin in the rear drag pin socket and starting with a small pilot hole, drill into the fairing and then with progressively larger drills/ hole saws, enlarge the hole to 30mm (1 3/16") diameter, taking the opportunity to centre the hole over the pip pin if the pilot hole was slightly out of position.

The fairing at this stage is still quite flexible at the area of contact with the fuselage, and will need temporary stiffening before the wings are removed. *Using mixing sticks or similar small pieces of wood, you will need to "shore up" the outer edge of the fairing down onto the wing, with small blobs of "Bondo" or similar auto body paste. Position as required to ensure that the fairing will lay flat against the fuselage*. Every 100mm (4") is the norm.

*Fig 8. Temporary Bondo stiffening.*

Remove the pip pins and de-rig the wings. Two plies of 'bid' now need to be laid up in the trailing edge area to join the fairing to the wing skin. This is in the area you scuff sanded earlier.

*Fig 9. Trailing edge 'bid' reinforcement.*

Fill the cavity between the wing skins and the inside of the fairing with scrap blue foam. Cut the foam to the best shape you can, and glue it into place with dryish micro/epoxy mix. When cured sand the foam back to achieve a gentle transition form the edge of the fairing onto the flange of the wing skin.

# 27b. Wing to fuselage assembly - first build

## Overview

In this section you will be setting the wings' angle of incidence which, measured at the wing root, is to be +2.0°. The angle of incidence is the angle between the chord line of the wing and the waterline of the aircraft. When you are flying at cruise speed the fuselage will be level and the wing will be leading edge up 2.0°

The wing lift pins locate into sockets, which are to be attached to the fuselage sides, and these hold the wing at the determined angle.

Take care when setting the angle of incidence, especially that both wings are set exactly the same. Any small angular difference between them will result in an aircraft that always wants to roll one way, requiring a roll trim tab permanently attached to one of the ailerons.

**Step 1**

Set the fuselage to be level, placing the spirit level on the door recess of the port side (which should be the only place you check the fuselage is level from now on) and ensure that it is secure and stable. You will need room not only for the wings to be installed, and left alone for sufficient time for Araldite 420 to cure, but also for them to be removed, so allow enough room for the spars to come clear of the holes in the fuselage sides. A total of 12.5 m (41 feet) across the spar ends will allow this, assuming that the wing outboard section has not been fitted at this stage.

**Step 2**

## Initial wing set-up

The following setting up of the wings will need to be temporarily disturbed after this step to allow access for local reinforcement plies to be added to the fuselage sides. Set the wings up so the spars are within the fuselage but not quite engaged in the spar sockets.

Dig out the BL29 wing template, and set it onto the wing root.

The flat top of the template is parallel to the wing root chord so, to be able to set the wing root angle of incidence to $+2.0^{o}$, the incidence wedge will be required to allow a spirit level to be used.

Support the wings so that the angle of incidence of $+2.0^{o} \pm 0.05^{o}$ is set - see figure 1.

Note that 0.05° equates to a difference in height of only 0.9mm (.036") over a chord of 1040mm (41"). When setting the wings ensure that if the bubble in the level is a bit off centre for one wing, then the other wing should be set to replicate this off centre position.

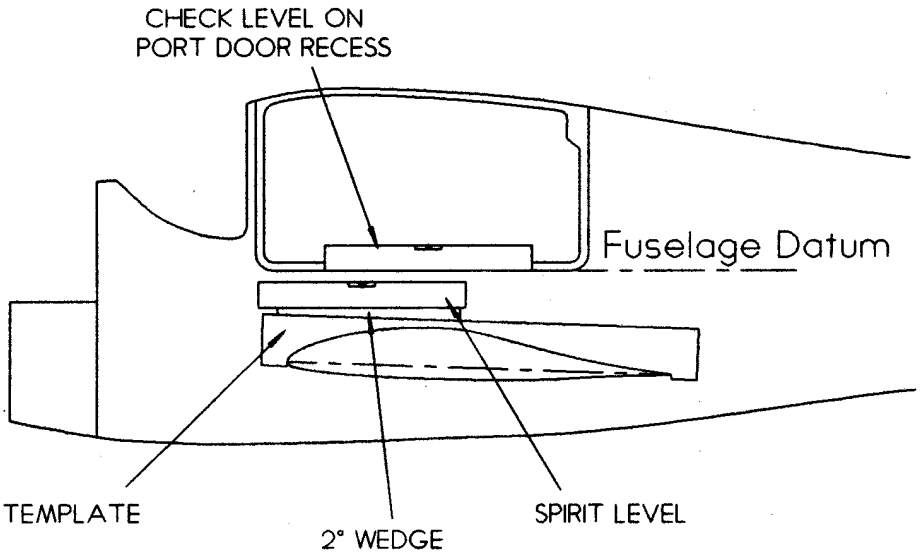



*Fig 1. Setting wing incidence.*

Mark the wing profile onto the fuselage side for reference. Remove the wing.

**Step 3**

## Reinforcement plies

Scuff sand both the inside and outside skins where the lift pin socket hard points are. On the outside skin, layup 4 plies of 'bid' at ± 45° to be a total of 4 cm (1 ½") longer than the hard points and vertically as large as the wing profile lines marked on the fuselage sides.

On the inside skin, layup also 4 plies of 'bid', but extend the layup over the forward hard point down to lap onto the thigh support by 2-3 cm (1"). Run the rear hard point layup onto the forward bulkhead of the baggage bay by 2-3 cm (1"). Cover each layup with peel ply and leave to cure.

Using the paper templates supplied for the wing lift and drag pin positions, mark on to the root rib the four pin positions (approximately will do at this stage).

Cut away the flanges of the wing skin - see figure 2.

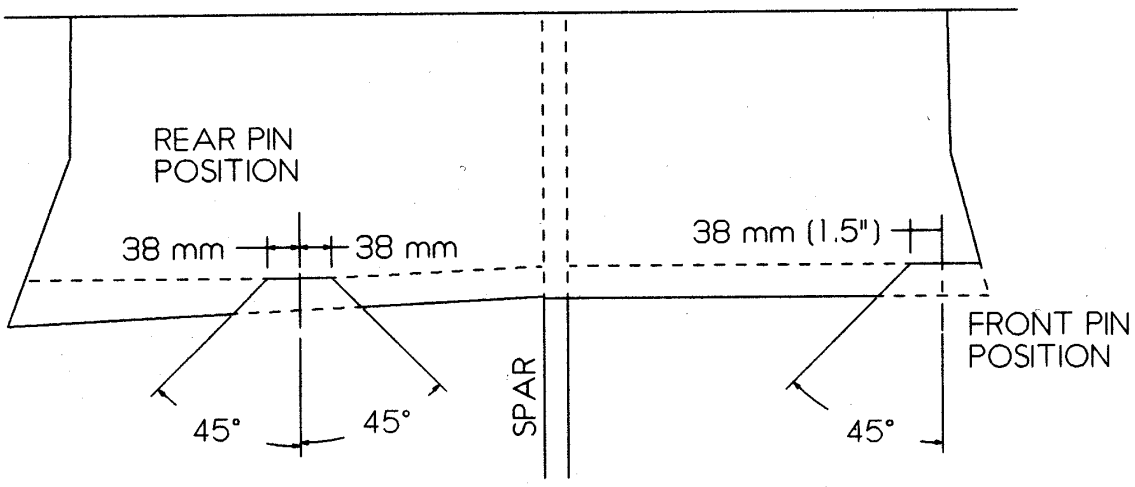



*Fig 2. Win skin cutaways.*

Re-rig the wings.

You will now need to set the wings for sweep and skew.

Mark lines at the outboard ends of the upper wing panels, in line with the **aft** face of the spar on the **port** wing, and the **forward** face of the spar on the **starboard** wing. These lines will be in the same relative positions on the wing skins because the port spar sits in front of the starboard spar on the rigged aircraft. Measure from these lines on the wing skins to the forward / outboard ends of the tailplane torque tube. The two dimensions should be within 5mm (1/4"); this can be achieved by using small wooden wedges between the wing rib and the fuselage. Don't put undue pressure on the fuselage skin.

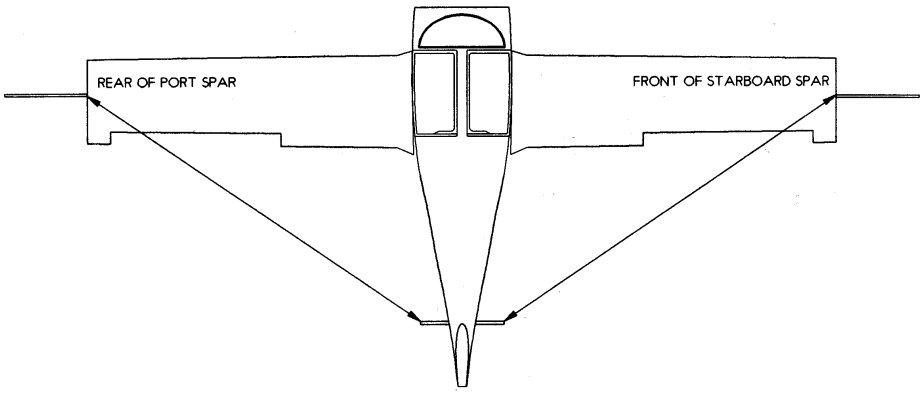



*Fig 3. Checking for zero sweep.*

Make a note of the two dimensions (a good idea is to stick a piece of masking tape next to the spar lines, and write the measurement from the tailplane torque tube on the tape). You will need to reset the wings a number of times back to this dimension.

## Wing root pin sockets

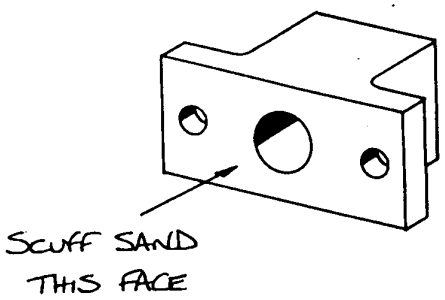



*Fig 4. W27 front socket.*

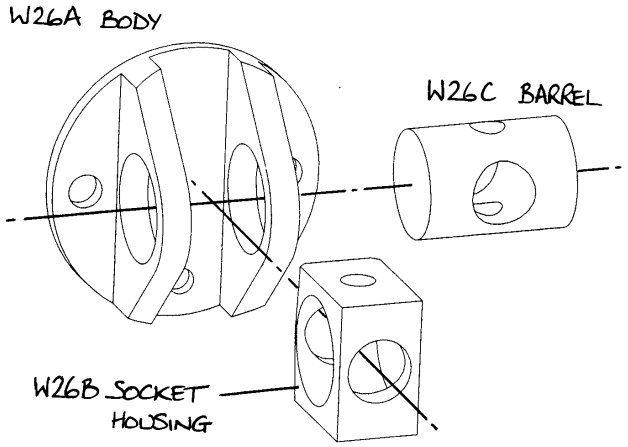



*Fig 5. Exploded view of W26 wing rear pin socket assembly.*

The front socket W27 is rectangular in section, and is shown in figure 4. Each rear socket is an assembly of a W26A, W26B and W26C. The W26A is the main body and is oriented with the smaller hole between the lugs at the bottom. W26B is the socket housing which slots between the two lugs of the body with the double cambered face innermost. These chamfers allow the housing to rock a limited amount. Holding W26A and W26B together is W26C, the barrel. See figure 5.

Slide the barrel in to the assembly from one side and rotate it so that the large and small holes align with the holes in the housing.

The socket assembly should be finally assembled using Loctite 638 to lock the barrel and housing together, but allow the barrel to rotate within the lugs of the housing. Make sure that the parts are clean and free from grease before this final assembly. If the barrel does become stiff in the housing, the use of a bar in the socket will enable it to be moved. It does not matter if the assembly remains stiff though.

The gap between the root ribs and the fuselage may need adjusting using the supplied alloy plates (GW03 forward and GW04 rear).

The forward (W27) sockets can be held in place(aligned with the mark you made on the rib) up against the fuselage, with the flange holes fore and aft, on line with the aircraft waterline.

Measure the gap between the outboard face of the socket and the root ribs.

Subtract from this dimension 3mm (0.120”), 2mm (0.080”) of which will leave space for 6 plies of ‘bid’ which will be added later, leaving a 1mm (0.040”) gap. Divide the result by 3.6mm (0.144”) - being 1 GW05 plate at 3mm (.12”) thick, and two plies of ‘bid’ at 0.3mm (0.012”) per ply. The result is the number of GW05 plates you will need to fit. To achieve the correct 1mm final gap you will probably need also to layup a number of plies of ‘bid’ under the first plate.

The rear socket assemblies can be treated in much the same way, except that a plywood pad needs to be inserted between the rear face of W26 and the fuselage. The wood will need to be shaped to follow the curve of the fuselage, and keeping the flanges of the W26 parallel to the aircraft centreline and also vertical. The plywood pads should be as thin as possible.

Holding the W26 socket in place, do the same calculation as for the forward socket, except that you should allow 5mm (0.2”) for the layup, as there will be four plies of ‘bid’ over the plywood pads later, as well as the six plies previously mentioned.

Mark out the position of the plywood pads on to the fuselage, including a reference line to indicate the rotational orientation.

De-rig the wings and prepare for the alloy plate layups. Scuff sand the root ribs and the correct number of GW03 / GW04 plates, radiusing the edges of the plates to aid draping the ‘bid’ cloth.

Layup the required number of plates with 2 layers of ‘bid’ at ±45° over each plate, starting with the individual plies if these are necessary. Apply a skim of flox to the surface of each plate.

Take the ‘bid’ layup forward and aft of the plate, but do not go outside the rib area on to the rib flange or upper skin.

Stagger the fore and aft positions of the ‘bid’ by 13mm (½”) with each pair of plies, the final 2 plies running at least 25mm (1”) on to the rib, with each previous pair of plies being larger, and transition the edge of each plate with a small fillet of flox.

Check the final position of the GW03 and GW04 plates to be centred on the pin centre, and peel ply over the complete layup, and allow to cure.

Taking the pin position templates again, tape them to the face of the root rib and spot drill through the marks with a 3mm (18”) drill deep enough to leave a dimple.

Take your time and be sure to double check your hole positions.

Before you drill, though, some guidance is required to help you maintain the correct alignment during the drilling process. It is important that the pins emerge from the wing root horizontal to the aircraft and parallel to the spar otherwise rigging/de-rigging will be impossible, or at the very least difficult and cause unnecessary wear.

Referring to figure 6, mark a line between the centres of the two bushes in rear face of the spar. This will provide reference to maintain alignment in the vertical plane.

Now mark lines on the wing upper surface parallel to the spar and using tape, fix in place a straight edge aligned with it.

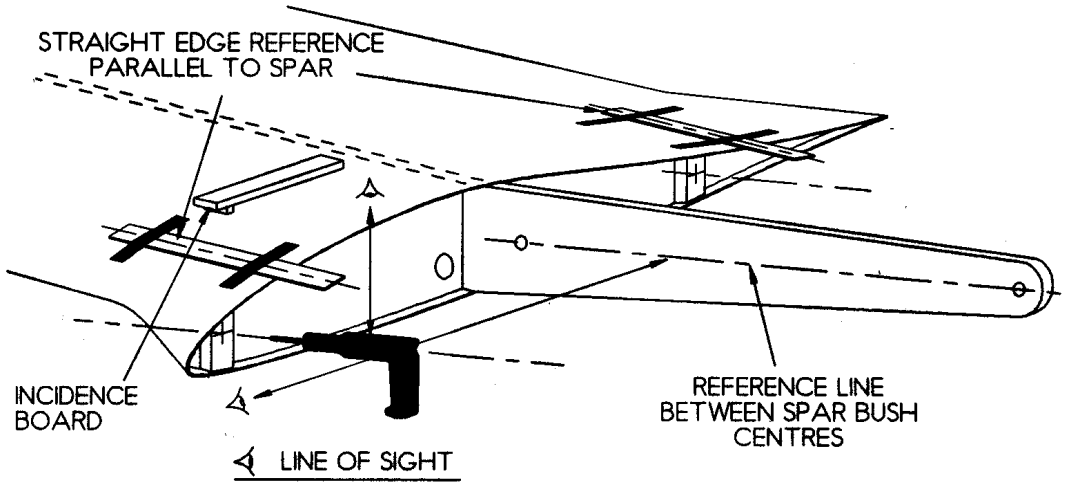



*Fig 6. Drilling the root rib for wing pins.*

The straight edge should overhang the root so that it provides a good reference to maintain alignment in the horizontal plane.

The drill operator will be able to look down to maintain horizontal alignment but it would be useful to have an observer positioned level with the spar, sighting the drill bit against the line on the spar and giving "up" or "down" commands to the person on the drill. Don't sight against the drill casing as it may not be parallel with the drill bit.

Drill and tap the plates on the marked centre, maintaining vertical and horizontal alignment, as described below.

## Drilling and tapping

The final drill size for tapping is 10.2 mm, however, it's not practical to drill this size in one go. Initially use a drill of no more than 3.3 mm (1/8") then drill again with a 6mm (1/4") drill, then drill the final tapping size of 10.2mm.

Drill right through the plates into the foam core but ***don't*** use a cutting fluid or oil as the pins are to be bonded in.

Avoid building up too much heat otherwise softening of the resin will occur. Alternate between pin holes allowing time for each hole to cool before recommencing drilling. Using a sharp drill will keep the amount of heat build up to a minimum. Keeping the drilling speed down will also help.

Having drilled the holes, tap them with a 12 mm x 1.75 coarse thread tap, again having an assistant to help with the horizontal alignment.

## Using taps

*Tap sets are normally supplied with three taps, sometimes only two. Each tap is slightly different to enable the thread to be cut in stages. The first tap to be used will be markedly tapered to ease starting and will only partially cut the thread. The last, or finishing tap will only have a short lead-in taper and will cut the fully formed thread.*

*With the tap held in a tap wrench, which is located on the square end of the tap and enables the tap to be turned easily, hold the tap in the hole with a moderate force. Maintaining the force, rotate the tap in a clockwise direction by hand, keeping it as square as possible to the hole. It may take a few turns, keeping the force against the hole all the time, to start the thread. When you feel the tap 'biting' you can relax the force on it as it will pull itself in as you continue to turn. After the tap is able to pull itself into the hole, every half turn or so rotate the tap anti-clockwise to break the swarf (the metal that has been cut ) and so reduce the likelihood of the tap jamming. Having screwed the tap in fully, remove it and screw in the next taps to finish.*

## Fitting rear sockets

The wooden pads need to be bonded on to the fuselage, taking care to position them as before. Flox them on to the scuffed surface and tape in place until cured. Sand a small radius on to the edge of the pad and layup four plies of 'bid' at ±45° over the wood on to the fuselage by approximately 50mm (2") all round, with a flox fillet at the base of the wood to help transition the cloth and prevent bubbles forming. Peel ply and allow to cure.

Back to the wing!

The rear lift pin has a circular backnut GW02 fitted; it will need trimming to fit in the confines of the rib. Make a cardboard template of the rib/hole position, and transfer this to the backnut - remove the excess material.

Degrease all the threads on the pins and the backnuts, and scuff sand the area where the backnut contacts the inner face of the rib. Mix up some Araldite 420 adhesive (again 28 gm is enough) and apply to the threaded portion of the pins, in the bore of the threaded holes in the rib, and in the threads of the GW02 backnuts.

The forward lift pins can now be fully screwed in, using a suitable soft cushioned grip to tighten them firmly.

The rear drag pins can be screwed into the aft holes until the thread is flush with the inside face of the rib. Thicken up the remaining Araldite 420 with flox to a firm paste, and apply to the flat face of the backnuts. Offer the backnuts up to the rib and continue to screw the drag pin through the rib into the backnut. The pin should be screwed into the backnut, not the nut screwed onto the pin. Any mismatch of the angle between the backnut and the rib will be taken out with the Araldite pad that is formed in the process. If you try to tighten the backnut, you may end up with the nut acting as a

locknut, which will hinder removal of the pins if required at a later date. Screw the pin in fully, then unscrew 1 ½ turns, aligning the hole to be vertical. Trowel away any excess adhesive from around the nut to from a fillet.

Allow to cure fully.

Ensure that the flanges of all four sockets are scuff sanded. Apply a smear of grease to all four pins and slide the sockets into their correct positions. Ensure that the swivelling components of the rear socket aligns the flange with that of the forward sockets (i.e. 90° to the spar bush line) and that the smaller of the three holes is at the bottom - see figure 5.

Dry run time again!

Re-rig the wings with the spar pins, and reset the sweep to the dimensions you marked earlier on the spar line at the outer end of the inner panel. If your arithmetic was correct you should have a 3mm (.040") gap between all four sockets and the fuselage / pads. The maximum allowable is 4mm (.080"). If your gap is outside the limit contact Europa. Remember that you have allowed 2mm (.080") for the six plies of 'bid' which will be added later, resulting in a final gap of 1mm (.040"), with a top limit of 2mm (.080") after these plies have been added.

With the aid of the BL29 incidence board and a Smart level, or the incidence wedge and a spirit level, reset the wing incidence to +2° relative to the port door sill. Recheck the sweep. You may find that the wings will tend to migrate rearwards so tie them forward at the root, around to the undercarriage frame so as to make full contact with the seat back, and wedge the end of the starboard spar forward. The S02 spar cups will need to be slipped over the spar tips at this time. The forward lift pins may make contact with the fuselage preventing the correct sweep to be achieved, so carefully nark and drill into the fuselage to allow the pin to enter - make sure the incidence is correct first! When you are happy that the incidence and sweep can be set, it's time to get sticky again! Remove the wings.

Mix up some Araldite 420 (about 56 gm) and thicken to the "just doesn't run" with flox. Apply generously to the faces of the sockets, ensuring that the forward pair are aligned horizontally. Close the wings up to the fuselage, keeping them roughly in line before they make contact, to prevent the Araldite being wiped off. Insert the wing pins (the EUR047 bolts with the thread cut off and ground to a bullet shape) and reset the wing incidence with the level, and the sweep with a tape measure, supporting them ensuring that there is no possibility of movement. If you are doing this work outdoors and will have to leave it overnight to cure, you may like to bond short pieces of wood (i.e. 2" x 1") across the wing to fuselage joint with 'bondo' or similar near the leading and trailing edges of the wing. These will be knocked off after the wing is fully cured.

Remove any excess Araldite from around the sockets, and jam some mixing sticks between the forward socket and wing rib to push the socket hard up against the fuselage, again checking the horizontal alignment of the holes in the flange.

The Araldite 420 adhesive will need to cure for at least overnight at 21° C (70°F). If you need to make a tent around the fuselage/ inboard wing area to keep the heat in, ensure that the heat source is safe and that the tent is not made of a flammable material!

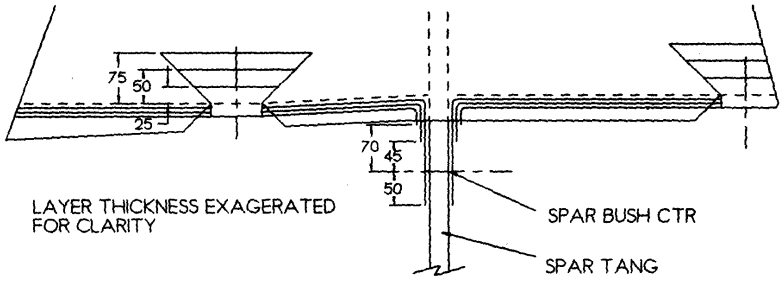
When the adhesive has cured, the wings need to be gently removed from the fuselage. This will need four people , one at the wing tip and two at the wing root,( one each at leading and trailing edge), and one to remove the EUR047 seat back pins. The three on the wing should just take the weight of the starboard wing, whilst the fourth person withdraws the pins just enough to disengage the starboard spar. Without letting the wing drop or twist, remove the wing without breaking the bond of the bush sockets to the fuselage. Repeat the above for the port wing.

## Spar / rib reinforcement

Further plies of 'bid' now need to be added between the spar and the root rib, the 6 plies that have been mentioned before - see figure 7. They will be laid at ±45° both forward and aft of the spar. These are applied in pairs, the first longest pair are taken 50mm (2") past the centre of the spar pin bush, cutting the cloth around the flanges of the bush.

The 'bid' is taken on to the rib, with a small flox in the corner all the way along the rib and on to the inside of the overhanging wing skin. Where the cutaways are at the wing pin positions, take the cloth over on to the outer skin, this time running 50 mm (2") on to the outer skin.

The third pair of plies runs 70mm (2 ¾") outboard of the spar pin bush, and run 25mm (1") on to the outer skin.




By now, of course, you do not need reminding about scuff sanding **all** the surfaces to be laid up on!

You will need to carefully part the cloth over the lift/drag pins (which you will have covered with parcel tape!) Peel ply over the entire layup and allow to cure.

When fully cured, cut away the 6 plies where the pushrod holes for the aileron and airbrake pass through the rib, and trim away any excess cloth back to the wing skin.

Carefully sand away around the pins to remove any raised 'bid' from the area that would foul the outer face of the socket, taking **extreme** care not to mark the surface of the pins.

If you look into the aileron pushrod hole (aft of the spar) in the port wing, you will see the plastic bag containing the coiled pitot/static lines you taped there earlier. Fish them out. Refer to chapter 8 figure 14, and drill two 8mm (5/16") holes as marked through the port aft rib. Countersink the holes with a 13mm (½") drill bit as deep as the 6 plies of 'bid'. Find yourself a piece of welding wire / coat hanger, and bend it into a "U", so that it can be fed through these holes in turn and be made to exit the wing out of the pushrod hole.

In turn, push each of the hoses on to the wire and secure it with tape, then pull the wire back out through the 8mm hole, whilst feeding the hose back through the pushrod hole.

When both lines are through the two holes, "pot" them with a little rapid epoxy / flox fillet where they exit the rib. Lead them forward over the spar. They will enter the fuselage in the cockpit area, next to the spar pin area.

### Wing root fairings

The wing root fairings come to you as pre-moulded items. The outside surface will need washing with hot water / detergent to remove any trace of mould release agent.

The wings will need to be rigged onto the fuselage, and the BLRS411N pip pins installed. Onto the fuselage, around the wing, you will need to tape on a card or similar shim approximately 2mm (.08") thick, where the fairing would make contact with the fuselage. This is to allow for a layer of 'bid' which will later be applied to the fairing, and for the finish paint, etc.

Mark a spanwise line on the upper wing skin in line with the rear drag pin, and mark a reference dimension along this line - about 300mm (12") outboard of the pip pin hole in the drag pin.

This will allow you to locate the position of the pip pin when you lose sight of it under the fairing!

The fairing should be slipped onto the wing from the leading edge by opening up the trailing edge of the fairing and slipping it over. The inboard trailing edge of the wing may need trimming to allow the top and bottom surfaces of the fairing to make contact again, when the fairing is pushed gently up against the fuselage.

When you are happy with the fit of the fairing onto the wing, it needs temporarily attaching to the wing. Make a note of where the spar is inside the wing! You will be using 4 clecos through the fairing into the wing on both the upper and lower surfaces, keeping away from the spar, and working from the front towards the rear, and fitted about 12mm from the edges of the fairing.

Use adhesive tape along the trailing edge cut to hold the two halves together. The join should line up with the wing trailing edge.

Mark onto the wing skin where the outboard end of the fairing finishes, and remove the fairings. Scuff sand the wing from this line inboard where the fairing makes contact, and scuff sand also the inside of the fairing in the contact area. Also scuff sand a 50mm (2") wide area on the trailing edge surfaces of the wing and inside the rear of the fairing.

Scuff sanding of the gel-coated areas of the wings needs only to be enough to remove the shine from the surface, it is not necessary to expose the fibres of the structure. Scuff sanding of the 'bid' layup of the fairing needs to remove the shine and just cut into the fibres.

Remove all traces of dust from the surfaces. Araldite 420 is used as the bonding agent. Thicken the Araldite with flox to the "just doesn't run" consistency that you have by now got used to, and apply an even coat to the wing skin in the area to be bonded. Spring the fairing over the wing without wiping too much adhesive from the wing skin, and install the clecos, lightly greased, from the leading edge, in the same sequence as the holes were drilled. Tape the trailing edge together at the join.

You may find it helpful to tape the fairing temporarily to the fuselage to help the fairing retain its shape, and also to tape around the joint to the wing, removing any excess adhesive.

Allow to cure fully.

Using the line that you marked on the wing, locate the position of the pip pin in the rear drag pin socket and starting with a small pilot hole, drill into the fairing and then with progressively larger drills/ hole saws, enlarge the hole to 30mm (1 3/16") diameter, taking the opportunity to centre the hole over the pip pin if the pilot hole was slightly out of position.

The fairing at this stage is still quite flexible at the area of contact with the fuselage, and will need temporary stiffening before the wings are removed. *Using mixing sticks or similar small pieces of wood, you will need to "shore up" the outer edge of the fairing down onto the wing, with small blobs of "Bondo" or similar auto body paste. Position as required to ensure that the fairing will lay flat against the fuselage*. Every 100mm (4") is the norm.

*Fig 8. Temporay Bondo stiffening*

Remove the pip pins and de-rig the wings. Two plies of 'bid' now need to be laid up in the trailing edge area to join the fairing to the wing skin. This is in the area you scuff sanded earlier.

*Fig 9. Trailing edge 'bid' reinforcement*

Fill the cavity between the wing skins and the inside of the fairing with scrap blue foam. Cut the foam to the best shape you can, and glue it into place with dryish micro/epoxy mix. When cured sand the foam back to achieve a gentle transition form the edge of the fairing onto the flange of the wing skin.

Now go to the main Europa Build Manual at chapter 27 page 5 step 6 **- Front sockets.**

# 28a. Airbrake controls in fuselage

## Introduction

The airbrakes are operated by a lever in the central tunnel, situated to the left of the throttle lever. This lever, which runs in a slot in the top of the central tunnel of the cockpit module, operates a short torque tube, which drives two push-pull cables. These cables, mounted under the pilot's side thigh support, are routed to run just in front of the seat backs, one to port, the other to starboard. Brackets bolted to the seat backs bulkhead support the end of the cables. Holes through the fuselage side allow for the connection of the cables to a push-rod which is installed in the wing. The diagram in figure 1 at the end of the chapter shows the general layout viewed from above.

The lower end of the airbrake lever (GAB06) is provided with 2 holes so that it can be bolted to the single pair of horns on the torque tube GAB04. (Don't fit the lever yet, though). When the torque tube is installed in the aircraft the drive for the lever will be in the tunnel, and the double pair of horn drives, which actuate push pull cables, will be in the cockpit.

The inboard end of the torque tube runs in a split phenolic bearing which is mounted against the tunnel on the cockpit side, and the outboard end is mounted in a support bracket (CS09) via an end cap (CS10C/2) running in a self-aligning bearing (CS09B) - see figure 2.

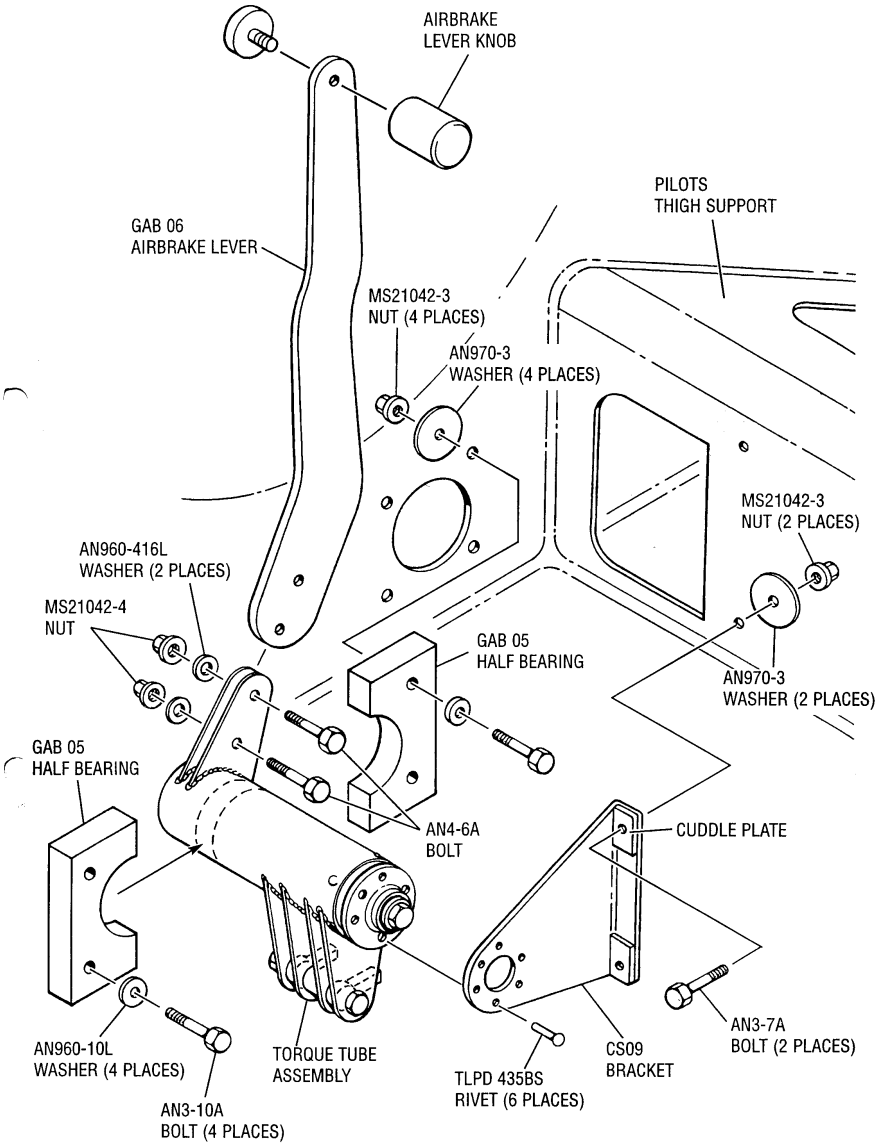



*Fig 2. Airbrake operating lever and torque tube assembly.*

## Torque Tube Assembly

Referring to figure 3, insert an AN4-10A bolt through the hole in the CS10C/2 end cap, from the face with the raised boss, and screw an MS21047-4 anchor nut on to the bolt, such that the anchor nut is hard against the inside of the end cap. Using a 3.3mm drill bit, and running the drill slowly, open out the holes in the anchor nut, and drill through the end cap. Remove the bolt from the end cap, and deburr the components.

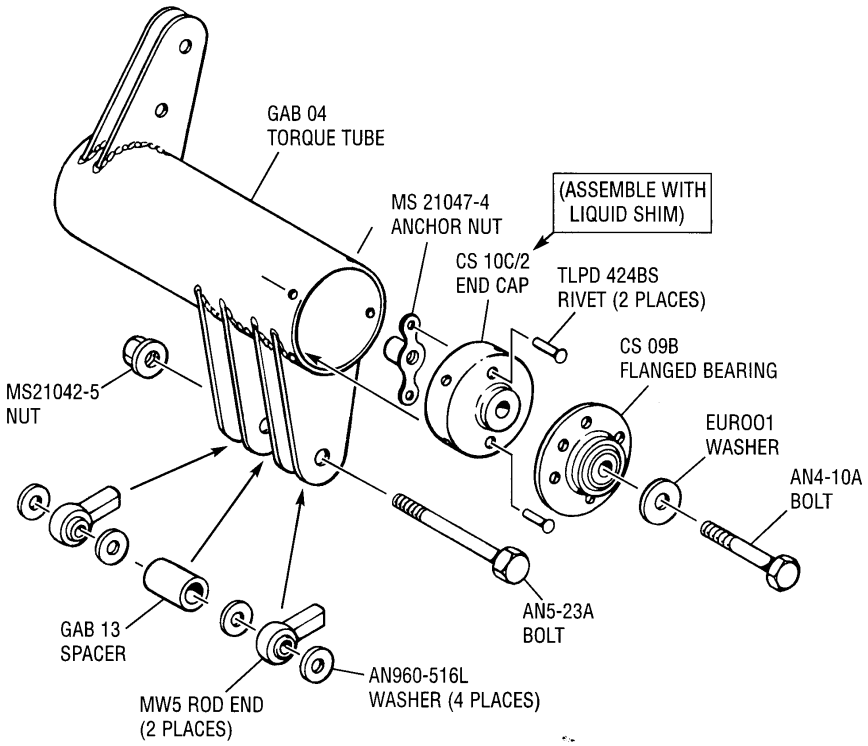



*Fig 3. Torque tube assembly.*

Rivet the anchor nut to the inside of the end cap with two TLPD424BS pop rivets, inserting the rivets from the raised boss side.

Degrease the end cap and the inside of the open end of the torque tube, and using rapid epoxy as a liquid shim, bond the end cap into the end of the torque tube, keeping the cap flush with the end of the tube and as square as possible. Wipe away any excess epoxy and allow to cure.

Mark out and drill 4 holes 3.3mm diameter positioned as shown in figure 4. Rivet the end cap into the torque tube with four TLPD424BS pop rivets. The rivets should be pulled up in 3 or 4 stages, pulling up different rivets until the final pull.

A small amount of light oil or similar can be introduced into the inside of the tube for corrosion protection if required.

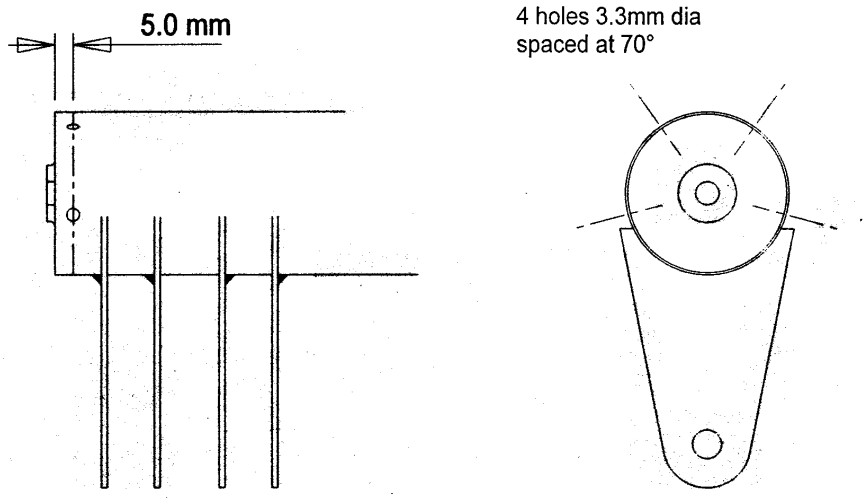



*Fig 4. Riveting torque tube end cap.*

## Support Bracket

Assemble the bearing CS09B to the bracket CS09, and rivet them together using TLPD435BS pop rivets, making sure that the bearing is riveted to the "outside" of the bracket, as shown in figure 5.

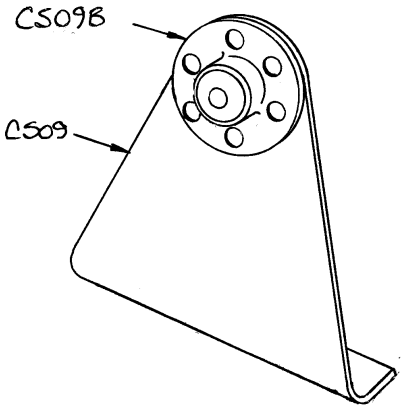



*Fig 5. Riveting CS09B bearing to bracket.*

To reinforce the attachment area of the bracket locally it is necessary to manufacture the CS09A "cuddle plates" from the EUR010 aluminium alloy plates. They should each be 25mm (1") long and have one edge filed so as to snuggle up to the radius of the bend on the bracket flange - see figure 6.

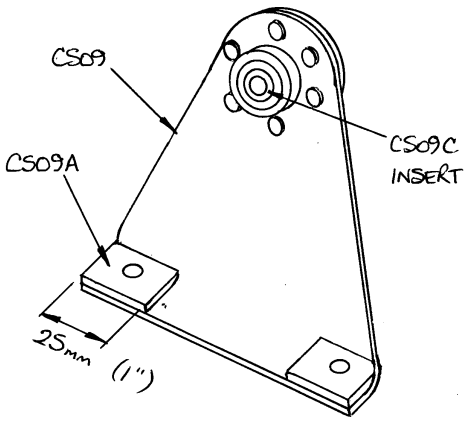



*Fig 6. Fitting cuddle plate to CS09 bracket.*

Scuff sand the cuddle plate surfaces and the corresponding area on the flange, and bond them together with Araldite 420, holding them together with suitable clamps until cured.

After cure, using the holes in the bracket as a guide, drill a 4.8mm diameter hole through each cuddle plate.

### Assembly

Temporarily attach the torque tube to the bracket with the AN4-10A bolt with a EUR001 washer under the head, and tighten until the bearing is against the boss on the CS10C/2 end cap.

Now take the phenolic bearing halves (AB05) and assemble them to the handle end of the torque tube (refer to figure 2). The fit needs to be free but not excessively slack. If necessary polish the bearing surface of the phenolic block with fine abrasive (600 / 800 grit) paper until an easy rotation is achieved. Do not apply any lubricant as this may soak into the bearing material and cause it to swell.

### Preparing the Cockpit Module

Before the support bracket CS09 can be bolted to the cockpit module, a portion of the vertical face of the pilots side thigh support needs to be reinforced using 3mm plywood. See figure 7. Cut a piece of 3mm plywood to fit into the opening to the inboard side of the control column. The plywood should be 30mm (1 1/4") wide. Glue the plywood in position using rapid Araldite then, having scuff sanded all around, layup 3 plies of bid over it, lapping into the surrounding cockpit module by at least 25mm (1"). Take care not to get any epoxy near to the control column bearings if they are already installed.

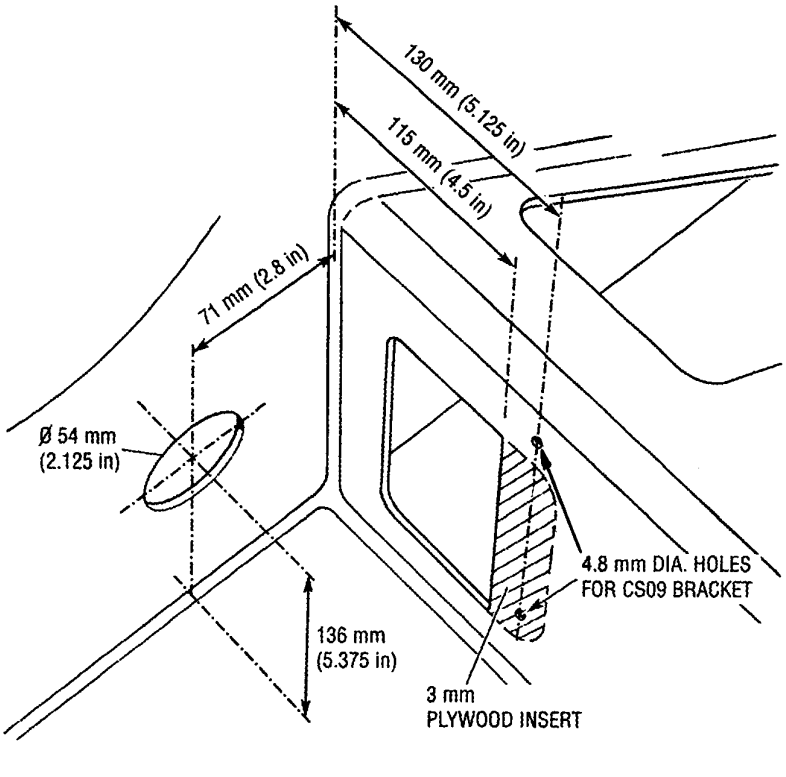



*Fig 7. Preparation for fitting torque tube.*

Again referring to figure 7, mark the hole centre onto the cockpit module centre tunnel as shown. Mark out where the two half bearings will be. You'll notice that the central tunnel is not flat here. Checking that you won't drill into anything behind, drill a 54mm (2 1/8") diameter hole through the centre tunnel side. You may need a drill with a 90° gearbox or a 90° adaptor in a regular drill to do this. If you are retrofitting the motor glider controls into a finished airframe or one that is in an advanced stage take care not to damage rudder cables, fuel lines, electrical systems already fitted into the tunnel. You may need to deflect the port side rudder cable downwards slightly to avoid conflict with the end of the torque tube. Position the Tufnol cable guide to achieve this.

The two holes for the CS09 bracket are to be drilled using the bracket as positioning guide, but first draw a vertical centre line on the front of the thigh support which is 130mm (5 1/8") from the side of the central tunnel.

Using the AN4-10A bolt, including the EUR001 washer, bolt the torque tube and bracket together. The self aligning bearing will allow the bracket to rock relative to the torque tube, but will be useful in spacing it away the correct distance from the front face of the thigh support while you position the phenolic half-bearings in preparation for mounting them.

Slot the handle end of the torque tube through the hole in the central tunnel and, using a suitable support, hold the bottom of the torque tube so it is (115mm) 4 ½" above the floor. Position the CS09 bracket against the front of the thigh support and drill through the holes in its flange with a 4.8mm drill.

Holding the two half bearings, with the join vertical, in position around the torque tube and against the central tunnel, drill through in the four corners with a 4.8mm drill.

Cover the faces of the phenolic bearings and the torque tube with packing tape and apply a dryish flox mix to the cockpit side. Install the torque tube/bearing assembly with greased bolts and remove any excess flox. This flox will form a pad to keep the bearing upright - allow to cure, after which the tape can be removed from the bearings/torque tube and reinstalled permanently. Referring to figure 2, mount both the bracket and half bearings into the cockpit module.

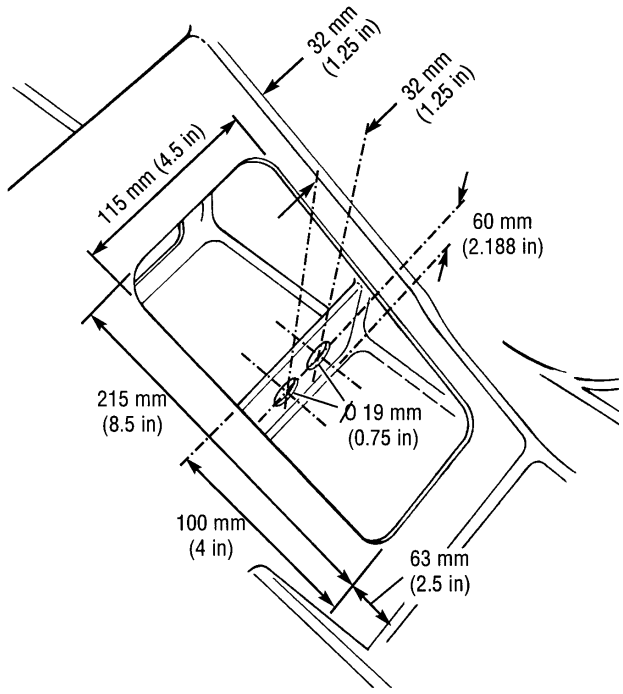



*Fig 8. Cable access and mount*

## Cable access and installation

The top of the inboard section of the pilot's side thigh support is to have an access hole cut into it to enable the installation of the two airbrake actuating cables and their mounting bulkhead. See figures 8 and 9.

Mark out and cut the access hole a shown in figure 8. Using the 54mm (2 1/8") hole saw at each corner before cutting the edges is suggested as a good way to start cutting the access hole.

## Cable mounting bulkhead

Now make the cable mounting bulkhead from 3mm plywood. A piece approximately 130mm x 100mm (5 3/4" x 4") should do, but check that these dimensions are suitable for your cockpit module before cutting it.

The 19mm (3/4") diameter mounting holes in the bulkhead are to be centred 32mm (1 1/4") apart and 60mm up from the floor. Their positioning sideways should be such that they are directly behind the lugs of the torque tube.

## Bulkhead installation

Install the two cables into the bulkhead, clamping each in place approximately half way along the threaded portion using the nuts and locking washer. Fit an MW5 rod-end bearing to the end of each cable, and attach them in place on the torque tube (refer to figure 3). It is not necessary to fit the spacer, washers and nut yet, just slide the AN5-23A bolt through at this stage.

The ends of the cables can articulate a small amount to take up small angle changes as the torque tube rotates. Support the cables so that they are not beyond the maximum articulation angle downwards when the torque tube lugs are at 90° to them. Set up as described, scuff sand the cockpit module and floor and bond the plywood bulkhead in place using flox filled epoxy.

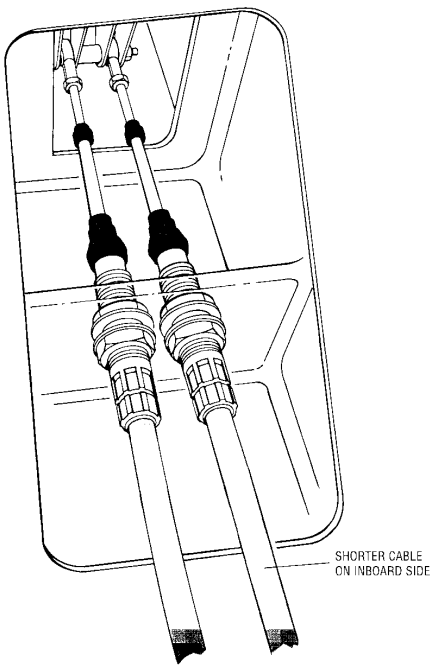



*Fig 9. Airbrake operating cables installed.*

After cure, carefully remove the cables from the mounting bulkhead and, after suitable scuff sanding, layup 3 plies of 'bid' at ±45° to each side lapping onto the floor and sides by at least 25mm (1"). Cover with peel ply and allow to cure.

Following cure, remove the peel ply and open up the 19mm (3/4") mounting holes.

## Cable installation

The cables are different lengths, as the driving torque tube is offset from the aircraft centre line. To enable the maximum bend radius of the shorter cable which is to operate the port airbrake, mount this cable to the inboard side of the mounting bulkhead. The other end of the cable is to end up pointing outboard and just below the spar pin hole. See figure 10.

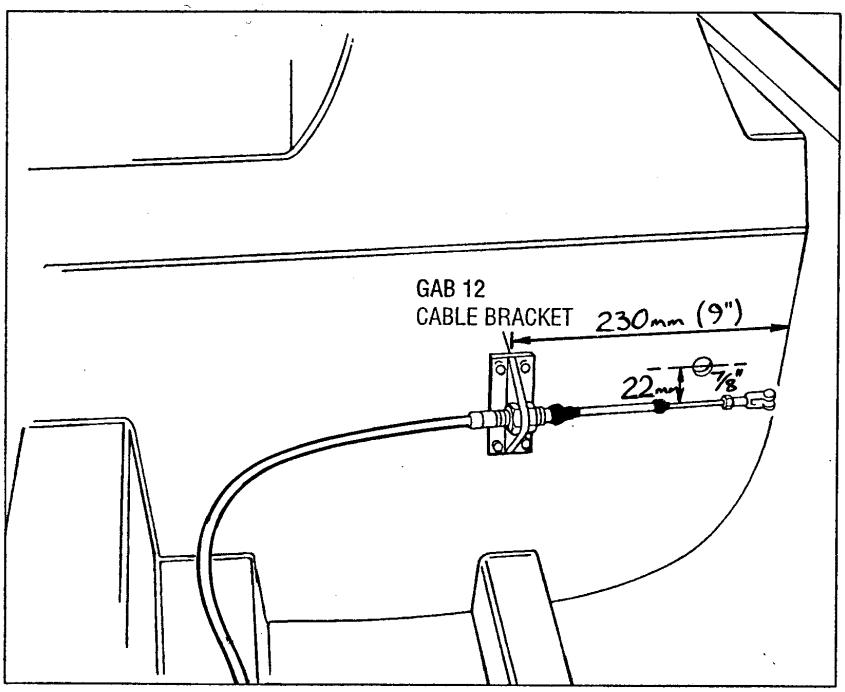



*Fig 10. Positioning of outer end of cable.*

The cable end is mounted into a support bracket GAB12, which is bolted to the seat back bulkhead. See figure 11. The precise position of the cable support bracket is determined with the wings in place.

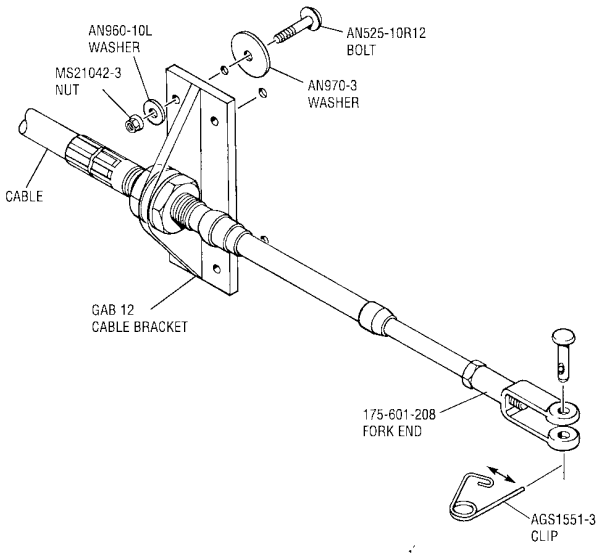



*Fig 11. Detail of cable mounting and end fitting.*

## Starboard cable

The starboard airbrake cable must pass through the central tunnel and not conflict with anything within it. Referring to figure 12, cut a 25mm (1") diameter hole into the left side of the centre tunnel. Also cut a 25mm (1") diameter hole in the right hand side of the centre tunnel according to the dimensions shown in figure 12. You will probably need to elongate these holes to be about 38mm (1 ½") deep to allow the cable to fit through properly.

With the long cable **not** attached to the torque tube, feed it through the holes in the centre tunnel, then, passing the cable over the shorter cable, connect one end to the outboard pair of lugs on the torque tube. Refer to figure 3.

The spacer GAB13 must be fitted between the pairs of lugs on the torque tube when you finally fit the AN5-23bolt and MS21042-5 stiffnut.

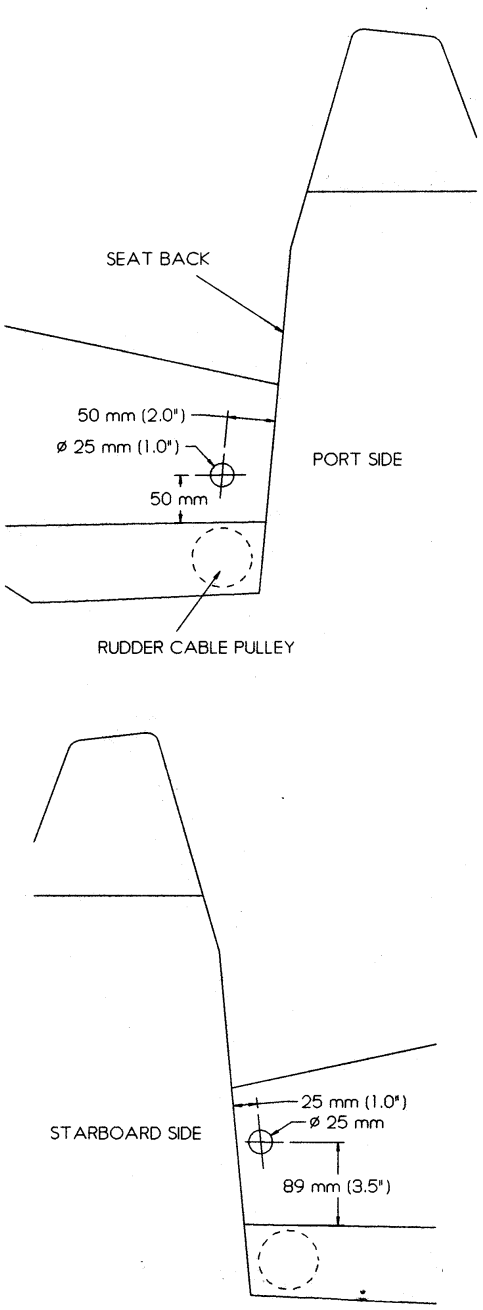



*Fig 12. Position of holes for starboard cable.*

## Airbrake lever installation

## Lever slot

Mark out on the top of the cockpit module centre tunnel the position of the slot for the airbrake lever according to figure 13. To allow for a "Closed" gate, note that the slot widens towards the front. The "Closed" gate is made using 12mm thick Tufnol, and the lever flexes inboard as it moves forward, springing back as it passes the front of the Tufnol block. There is no gate to hold the airbrakes open.

The brakes are held in the open position by the pilot. First cut the slot using a hacksaw blade, following your marked lines.

Using the 12 mm Tufnol block, make the "closed" gate according to figure 14. Drill also the two 4.8mm diameter holes.

With the angled edge protruding into the slot and the opposite edge parallel to the slot, position the gate block according to the dimensions in figure 13. Using the holes as a guide, drill through the cockpit module centre tunnel using a 4.8mm drill.

Scuff sand the upper side of the gate block and the appropriate place on the underside of the tunnel, and bolt and bond it in place using Araldite 420/flox and AN525-10R14 bolts, MS21042-3 nuts and AN960-10 washers. Make a fillet all around with the excess adhesive that oozes out from the joint.

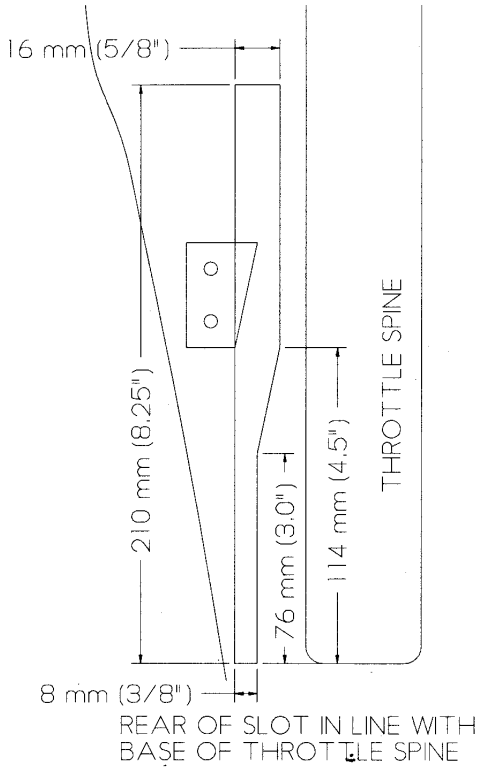



*Fig 13. Dimensions for slot.*

## Lever

When bolting the airbrake lever GAB06 to the torque tube first feed the end of the lever through the slot in the centre tunnel. Refer to figure 2 and install the lever. The lever should run centrally within the rear portion of the slot. You may need to adjust the bends of the lever to get the final position just right. Check that, when in the forward position, there is no conflict with the landing gear (monowheel aircraft).

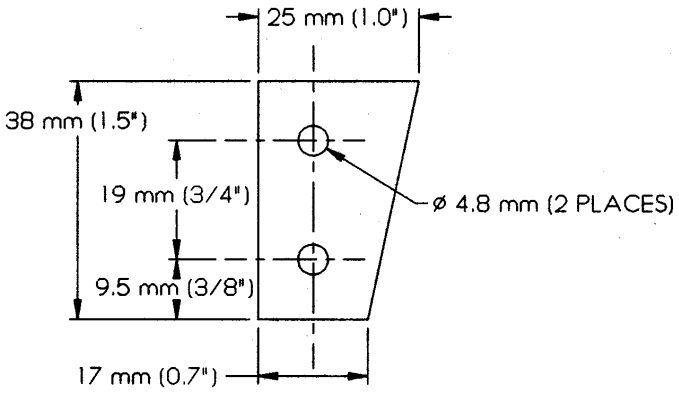



*Fig 14. "Closed" gate.*

Now go to main Europa Build Manual chapter 28 page 13 step 20 (monowheel) or page 8 step 15 (trigear) **Baggage bay rear bulkhead.**

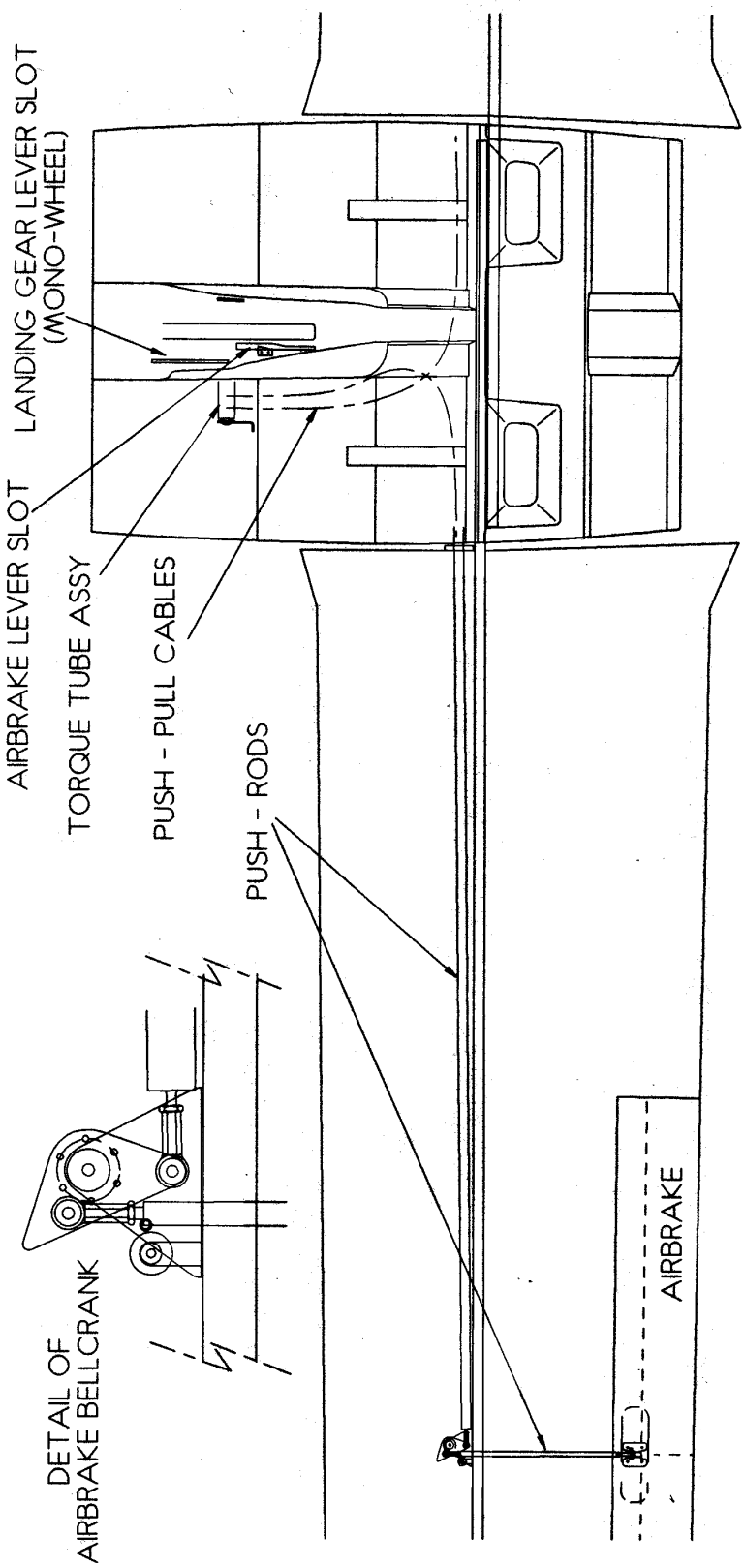



*Fig 1. General layout of airbrake controls.*

# Annex F