

CONST. FILE 3, WINGS, PART 2 by Harley Michaelis, June 3, 2012

ROTARY DRIVER SYSTEM

The pictures that follow show the original 1999 Kimbrough couplers and solid, one piece wire drive shafts. These couplers are still produced and the pictures showing them are left in for reference for those who may have purchased them.

However, for the Genie line ships, the G2 System, the new version of the RDS, is much favored. It uses a new design coupler and lighter and stiffer hollow SS tubing for shafts. Elsewhere in this website, the G2 system and its installation is fully documented.

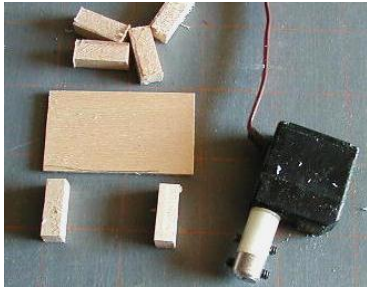
Using the RDS with no servos in the tips, construction & installation are simpler, mass is kept more inboard and you get a nicer looking, faster, quieter and less draggy airframe since nothing hangs out.

Like anything new, there's a learning curve & then it becomes routine. I've installed it in my last 75 plus airframes, experimenting with various things to secure & rotate the drive shafts long before collaborating with Kimbrough Products to make couplers and with IRF Machine Works to make other parts for the system.

Super thin "wing servos" are not easiest to work with. Best bets are compact servos nominally 1/2" thick, such as the JR 368 or 351's for flaps and 331's or 341's for ailerons, the Airtronics 761, etc. New servos keep appearing that look well suited and for which there may be an adapter on the Kimbrough 5 adapter tree that fits.

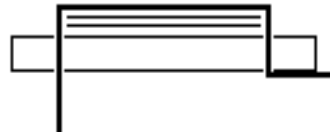
SERVO MOUNTING: A dedicated system to allow tilting & servo shifting is detailed below. This works well, whether the old RDS or the new G2 system is used.

HARLEY'S EASY MOUNTING SYSTEM ("HEMS")



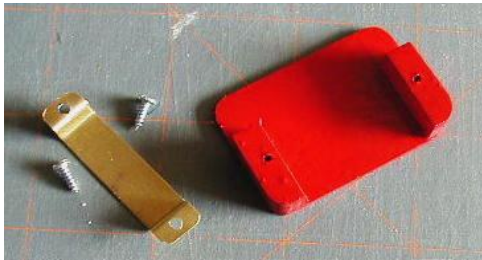
Remove servo lugs. A JR micro is shown here. Cut 1/16" ply bases to fit the servo case plus space for the rails. Make rails from 1/4" sq. spruce or bass. Cap them with 1/32" ply to prevent splitting out. Coat the servo with paste wax to prevent it from being glued in or size a ply piece to wax up to correctly space the rails all squared up & so the servo can't shift side to side. Use glue, such as common Elmer's Carpenter's Wood Glue, to attach rails & the caps.

Make bracket from .016" x 3/8" K & S brass strip. Size a block to use to get width just right. Make a form (left) from 1/8" ply to slip the unbent bracket legs through. Add layers (right) of 1/64" ply to get the leg length just right to cinch servo down with screws.

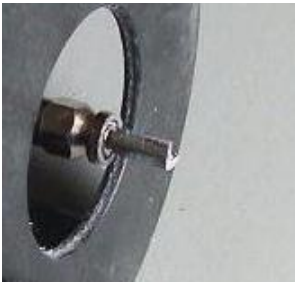




The bracket should rest flat on the case & fit the sides without play or bind. Spray paint for a finished look.



ROUTING CLEAN, UNIFORMLY- SIZED SERVO WELLS

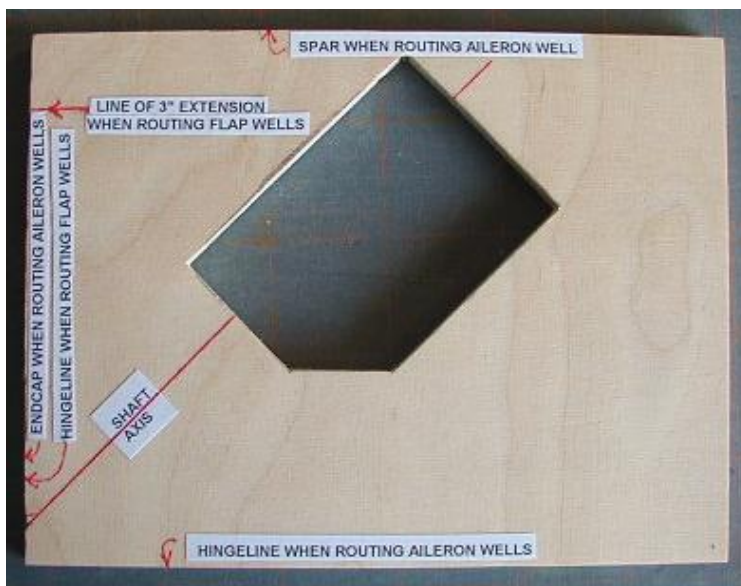


The Dremel with router base, 1/4" router bit & 3/8" bearing can be used. The Boca (see add in MA) bearing R2-ZZ is shown slipped onto the bit. Run the bit fully into the chuck & tighten it well. Adjust the router base so the bit will cut through the skin. To minimize wear, cut only the well perimeter. Peel off the remaining skin. Dig out all core to the top skin so its downward slope can be utilized to direct RDS shafts into the pockets. When the skin is well cured, any fuzzy edges can be sanded smooth.

To control the router path, from 1/4" birch ply cut a 4-1/2" x 6" template blank. The long 45 degree red line represents the axis of the servo output gear & the RDS drive shaft. It exits the template centered 5/16" up from that corner. For JR micro or similarly sized servos, mark a 2-5/8" x 1-7/8" opening positioned so 1/8" of material remains at the upper corner.

Using a 3/8" bearing makes the opening 2-1/2 x 1-3/4", a good size for servos JR size. For other sized servos, router bits & bearings, carefully sort out opening size in advance.

With bandsaw, etc. enter at the upper corner to cut the opening. True up vertical edges with a sanding file, small sanding drum in the drill press, etc. Close corner by gluing in 1/64" ply, etc.



For the ailerons, the RDS drive shafts are to exit the center section endcaps centered at a point 5/16" ahead of the aileron hingeline. Mark the shaft center line on low tack masking tape on the wing.

To router a well, firmly tape template in precise position after flaps & ailerons are cut loose from the panels.

The template is configured so wells clear the spar & is used for all wells. As shown here, it's positioned to cut the right aileron servo well with wing inverted.

SHORTER AILERON SERVO WELLS: Since shifting is not needed to attach/detach the aileron drive shaft, those wells may be made shorter by jamming $\frac{1}{4}$ " balsa at the upper end of the template. However, the aileron servo lead tunnels should conveniently terminate inside the wells. If you choose to shorten the wells, position the template higher along the axis line so a tunnel enters the well. Flip & rotate the template as needed to router the wells oriented as shown a couple of pages below. The flap servo wells should have about 2" of skin intact between them where the split grommet goes. This is set by placing the left side short red line (in $\frac{5}{8}$ " from the top in the picture) at the edge of the 3" wide extension between the flaps.

After wells are cut, remove remaining foam to the top skin. Make tunnels for shafts from hingeline to the couplers on the flap servos. Use long drill bits, round jeweler's files, etc. It doesn't matter if tunnels get a bit oversize. For flaps, the openings in the RDS "pockets" are centered where the drive shafts intersect the hingeline.



I got a Buffalo Tools 3,500 RPM Trimmer Router for \$10 on sale. Only 2-1/2" in diameter, it's a handy size & has a $\frac{1}{4}$ " chuck. From Boca I got a $\frac{1}{2}$ " OD bearing, item R188-ZZ.

At a local hardware outlet I found a $\frac{3}{8}$ " carbide-tipped "straight" bit, Exchange-A-Bit brand, for \$12. The bearing & bit protrude 1" from the router base, so to avoid going through the top skin, I made a $\frac{1}{2}$ " thick template using two layers of $\frac{1}{4}$ " birch ply first glued together.

This is a noisy & powerful single-speed tool, so proceed with care. Turn off the motor to lift it out. The bit makes a clean cut through a glass/CF skin. When worn, it can be exchanged for a new one at half price.

SNAKING LEADS THROUGH THE TUNNELS: When it's time to do this, make a $\frac{1}{8}$ " loop at an end of thin music wire. Check for tunnel blocking by trying to run it between the wells from either end. If blocked, drill a hole through the endcap to run in music wire $\frac{1}{8}$ " or so in diameter to clear the tunnel. When the thin wire can be run through, proceed as next shown.

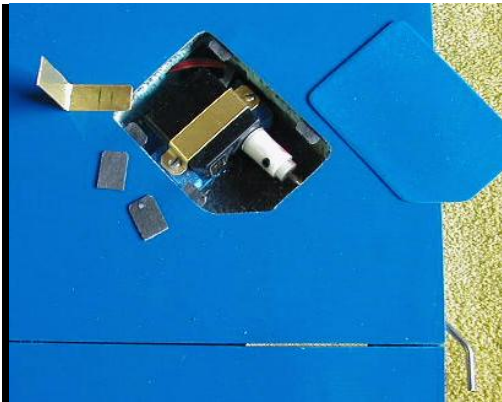


At a flap servo well, use HS tubing to join the long lead & thin wire with a short bend in its end. Shrink to minimum size. Pull to the aileron servo well.

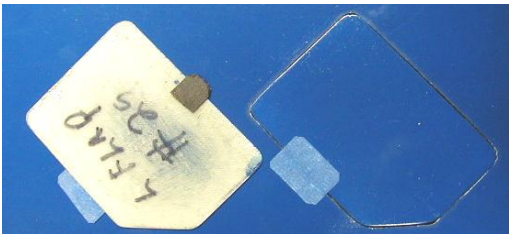
To prevent "oil-canning", reinforce the skin inside the well with CF pieces to fit to the well edges. Coat the skin inside with a slower epoxy & brush the pieces down flat. As pictured on the next page, aileron servos are located so the drive shaft exits the end cap centered $\frac{5}{16}$ " ahead of the hingeline. To attach the mount with servo & coupler attached to it, mix 5 minute epoxy with Cabosil, etc. as a filler. Coat the mount's bottom, position it & promptly insert the drive shaft into the coupler to assure alignment as the epoxy cures.

The mount is to be centered sidewise & for flap servos, positioned so the servo bottom will be spaced $\frac{1}{4}$ " from the rear edge of the well. Mounts are permanent, but bracket screws & setscrews are accessible to shift a flap servo or to remove it or the shaft.

An easy cover is 2" duct tape which comes in colors, but as shown below, it's simple to support a rigid cover with bits of CF laminate under the skin. Note the tool made from sheet brass to slit between skin & core. Partly withdraw the tool to use as a support & guide to horizontally push a tab in place. Apply a drop of thin CA glue to wick between tab & skin. Proper servo installation is shown below.

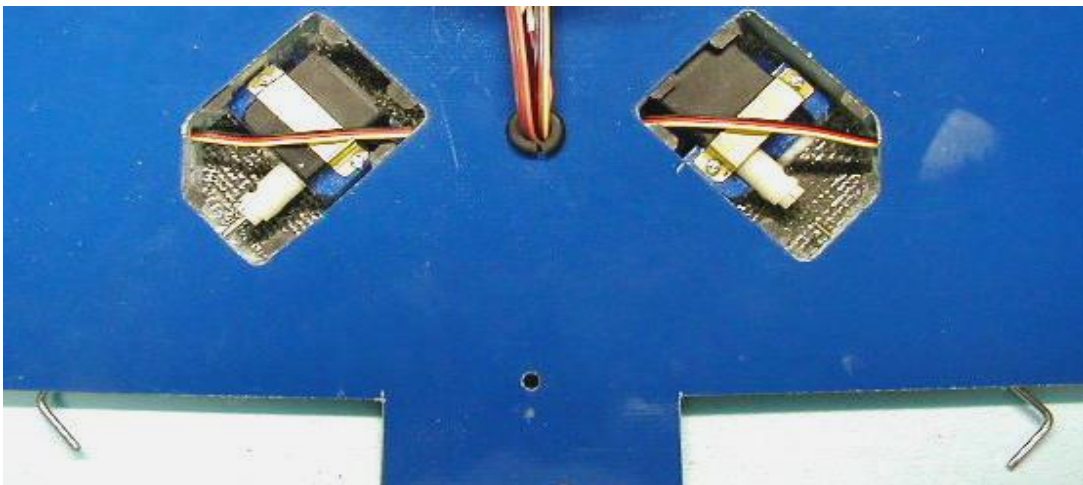


This cover was cut from a sheet of fiberglass made from 3 layers of 1.4 oz. cloth wetted out with bagging epoxy over waxed plate glass. After fitting it to the opening, pinholes were filled & then primed & painted. This pic shows how the aileron drive shaft is to exit the endcap. That's an individual Kevlar "easy hinge" peeking through the hingeline. The servo well can go closer to the spar if a longer shaft is used. The well may be cut so the servo can be flopped the other direction if more convenient to then run the lead into the tunnel. Just be sure the well will clear the spar.



In addition to the other tabs, a tab on the underside of a cover can be slipped under the skin. As illustrated with blue tape, a small piece of clear tape can alone then be used to neatly secure the cover.

Left below, shows a flap servo & drive shaft in operational position, bend elbow about 1/8" behind the hingeline. Right, if a servo needs service it's shifted back on its mount. With setscrews loosened, the shaft can be slid out of the coupler & into the pocket.



Optionally, an aileron servo/well can be oriented like a flap servo/well. Depending on how a lead exits the servo case, this may allow more convenient routing into the long tunnel. If flaps, with pockets in, are to be hinged after servos are mounted, they are slipped in place over the protruding shafts. To subsequently remove a servo, leaving hinges intact or to initially install a shaft & servo where the surface is pre-hinged, the mount must allow servo shifting. Shiftability also allows a little leeway with a sized shaft in putting the elbow of the bend in the "sweet" spot for smoothest operation.

If using Walt's aluminum coupler tops, the shaft goes in 9/16". With bracket screws loosened, a servo can be slid back 1/4" & the shaft slid out of the coupler, as shown above right. This enables servo & shaft to be removed in a hinged surface.

COVER MAKING SEQUENCE: Place clear sheet over a well. Mark the perimeter to cut it as a “Well cover pattern”. Duplicate the shape on 1/8” ply as a “Form for well cover”. Lay it on the cover material, mark around it, cut it out & sand the edges for a custom fit over each well. Put ID on the backs.



POCKET FABRICATION: See CONST. File #6. Size flap pockets 1/2” x 2-1/2” with 1-1/2” slot. Tops & bottoms can be made of Formica, CF plate, compact disk, etc. Use Dremel with cutting disk & sanding tools, Spacers can be made from 3/32” hard balsa, bass, spruce, etc. Spacers must be uniform in thickness to space tops & bottoms in parallel planes with a “slightly snug” fit. An opening .005” less than shaft diameter feels just right.

Fully remove foam between skins where a pocket goes. As needed, bevel the pocket to fit between the skins without a bump. Wrap ends with fine Kevlar thread to prevent splitting out. Cap the pocket on top with light balsa to bevel to nicely fit between the skins. Keep installed pockets clean by blowing out dirt with a compressed air canister. Use powdered graphite (keyhole lubricant) to reduce friction.

FLAP POCKET INSTALLATION

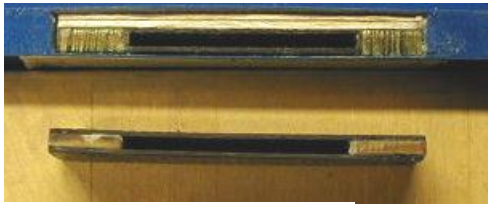
Foam is removed between the skins to laterally center the pocket where the shaft crosses the hingeline. The bottom of the pocket should go directly against the bottom skin. Clear foam 1/8” either side of the pocket so CA glue doesn’t meander to it when wicking the pocket assembly between the skins. Clear out the foam behind the pocket opening so an installed shaft can be moved out of the coupler.

A pocket needs to be thin enough at its rear edge to avoid making a bulge in the top skin when recessed 1/16” behind the flap LE. Before wrapping it with Kevlar thread, as needed, bevel the top from front to rear. In the spacer areas, then wrap with a single layer. Using thin CA, wick soft balsa to the top side of the pocket.

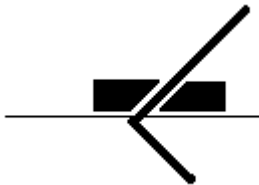
Sand balsa top to fit between the skins without bulging. To keep the opening uniform & undistorted, prepare a temporary waxed spacer to fit it. Wick pocket to the skins. Remove the spacer.

In the pic below, a yet unwrapped pocket (CF plate with bass spacers) is in the lower part of the picture. Above is one wrapped & installed. The view is head on at the LE of the flap. The raw foam had been painted the same color as the underside of the wing.

A thin bead of epoxy can be applied around the recessed front & painted like the raw foam to get a finished look. Don’t get any epoxy in the opening.



Make a waxed spacer to keep the opening squared up when installing a pocket. This one is .028" CF plate bonded to 1/16" aluminum bar. It matches spacer thickness.



In denser foams the tunnel, if not oversize, can prevent lateral flap shaft movement. Alternatively, small blocks can be installed between the skins ahead of the hingeline.

MECHANICS & PROGRAMMING STEPS FOR FLAP OPERATION: Refer to File A6, starting with caveat #5. Review about making opposing flats on the shafts. Invert wing. Plug the servos to be used for flaps into their spots in the receiver. Position them on the inverted wing skin oriented as shown in the big picture a couple of pages above. With adapter & coupler bottoms slipped on, but not yet fastened with the servo screw, run the inboard setscrews into the coupler bottom for visual reference in the next steps.

Program the Tx for full 90 degrees rotation for down flap. This will likely require any knobs or multiple position levers to be in certain positions. Program so the left flap servo on the right moves CW & the right flap servo on the left moves CCW.

Radio on, position the stick/lever intended for flap use & any related trim tab in what would be its "neutral". Mechanically reposition the coupler bottoms on the output gears so, as closely as possible, the inboard setscrews angle down at approximately 45 degrees. As the stick/lever is moved to full down, the inboard setscrews should angle up at approximately 45 degrees & become accessible.

See if reflex is possible by a trim tab, or a switch or other programming. If necessary to get reflex, reposition the couplers one spline (about 15 degrees) in the reflex direction. Fasten the coupler bottoms to the output gears with the servo screws. Insert the coupler tops & partially drive the setscrews nicely squared up through both coupler parts, leaving clearance inside to insert the shafts. Attach servos to the HEMS, make the tunnels for the drive shafts if not made & install the HEMS with a glob of epoxy putty. Use a length of 3/32" wire to align it into the coupler. Where the wire exits the wing, its inverted top edge should be approximately 1/16" below the bottom skin of the inverted panel. It will then nicely align to the low slot in the pocket.

The drive shafts can now be made. See below now about making the bend in a shaft, getting the length correct & grinding the opposing flats.

SIZING FLAP SHAFTS: Round an end of 3/32" SS wire. Clamp 5/8"-11/16" in a vise. With hammer, pound close to the jaws to put in a low radius 90 degree bend. Position the elbow 1/8" behind the hingeline. Mark the longer part to cut it approximately 3/16" beyond the setscrew hole in the coupler bottom. Remove any burr. Insert the shaft until it butts the servo screw. Manually rotate the shaft to full down flap position.

If flaps have been cut off, slip them over the shafts. Trim a shaft to length so with it butting the servo screw, the wing & flap corners don't jam or leave a big gap. Remove any burr. The elbow of the bend will typically be 1/8" behind the hingeline.

While servos can be shifted a bit on the HEMS to make a fine adjustment for the "sweet" spot of the elbow, this must not impair moving the flap servo rearward enough to get the shaft out of the

coupler. Incrementally shorten a shaft to get it just right. Use a marker pen to color the shaft section exposed between the coupler & edge of the servo well. That gives a visual reference where things go if a servo has to be removed & replaced.

FLATS: See File A6 about making a holder for grinding flats. Position the grinder rest close to the wheel. Make the flats, remove burrs & jam the shaft to the servo screw.

By doing the programming sequence detailed above it is only necessary to fully seat the setscrews once. Fine tune the Tx for neutral & deflections. Hinge if not hinged.

RDS AILERON SERVO SETTINGS: Radio on, trim tab neutral, program so servos are in their neutrals. Proceed similarly as for flaps in dealing with neutral & deflections. Size shafts to protrude $\frac{1}{4}$ " beyond the center section endcap. Fine tune Tx for neutral & travel. To prevent adverse yaw, use very little down aileron.

LE FINISHING, CONTINUED: After working off the excess epoxy with the Stanley Surform or coarser sanding blocks, continue with finer blocks down to 150 grit, but don't cut into the glass tape. **Go to the CONST. FILE #6 (FINE FINISHING) & follow those instructions.**

ADJUSTING VERTICAL ALIGNMENT OF TIP TO CENTER: Attach a tip. If alignment is not satisfactory, try changing blade ends. Try switching the blades. Knock out the seals at the inboard ends of the blade boxes so a blade can be moved more into the center or the tip. When best alignment is found, mark which blade end goes where. If necessary, file a new blade with a "step" in it on one side. Ultimately, bend the end that goes into a tip so it stays put at the best spot. Add a drop of CA glue to help keep it there.

3/16" BIRCH DOWEL ALIGNMENT PINS: slot $\frac{1}{16}$ " ply to fit over a blade. Mark & trim it to airfoil shape. Locate $\frac{3}{16}$ " holes, vertically centered, 1- $\frac{1}{2}$ " ahead & 3- $\frac{1}{4}$ " behind blade. Drill $\frac{5}{8}$ " deep, opposing $\frac{3}{16}$ " holes in endcaps. Don't enter aileron drive shaft tunnels.



Make four 1" pins from $\frac{3}{16}$ " birch dowel. Round ends & secure in the tip sections with thin CA, $\frac{9}{32}$ " protruding. Progressively open holes to $\frac{5}{16}$ " in the center endcaps. Coat pins & near them with paste wax.

Fill the $\frac{5}{16}$ " holes to $\frac{1}{16}$ " of their tops with quick epoxy. Slip in the blade. Jam tip in position. Hold in good alignment until the epoxy partially hardens, then separate & remove the blade. Peel away any oozed epoxy. If needed, shorten pins to fully enter the sockets.

MAIN BOLT HOLE TOP: From the bottom drill through the top skin. Seat a bolt on top. Poke around the head with a sharp #11 blade. Serrate end of brass tube to finish rounding a neat hole while removing foam so the bolt bears on the plate between spars.



BOLTING WING AT THE REAR. From $\frac{1}{8}$ " aluminum make a tapped plate. The tapped hole should be angled back about 12 degrees so the bolt head bears flush to the ply bottom of the fairing. See next pic. It's far easier to get the hole centered in a plate than get a blind nut centered in a 2-layer ply piece. A piece of $\frac{1}{8}$ " carbon plate or 2 layers of $\frac{1}{8}$ " birch ply tapped & treated with CA are lighter weight options. Use of a nylon bolt is recommended here, so it can shear in a bad landing and spare damage to the hole in the extension between the flaps.

Bolt the main bolt unit (CONST. File #1) to the center section. Position the wing on the saddle. Squeeze fuselage to hold the unit in place. Remove wing. Mark unit's location. Preferably glue it in place using clamps & Elmer's version of Gorilla glue. Let it cure well. Bolt center section on & square it up. Mark centering lines on the extension & turtle deck front. If using the tapped plate, locate where to drill through the extension. Position the plate on the rails to align the holes. Mount the plate.

If using the blind nut unit, drill a 5/32" pilot hole through both the extension & the ply plate, perpendicular to the extension's top. Open that hole to 3/16" for the 10-32 rear bolt. Trim the flange off the T-nut to be used. Open the bolt block, still angled at the 12 degrees, to accept the threaded part of the T-nut. Unscrew the block. From the underside, press & glue in the T-nut.



The rear fairing, not used on the LT/S composite fuse, has a 1/16" ply base the bolt seats on & a balsa top contoured to merge with the turtle deck. To make it, attach the wing with the main bolt. Square it up. Bevel the rear edge of 1/16" ply to fit flush to the turtle deck. Make a hole in the base for the rear bolt. Shape the base. Bevel balsa to butt the turtle deck. Glue this to the base. From the underside, make a hole for the bolt through the balsa. Bolt this in place. With #11 blade or serrated brass tube, cut around the bolt head down to the base. Remove that balsa. Seat the bolt to the base. Bear a blade against the turtle deck to trim the fairing to approximate fit.

Unbolt the fairing. Progressively trim & sand it to shape. Jam an Exacto knife in the base. Lightly spray the top with 3M77. Pull a layer of light glass cloth over it. Tilt the fairing to dribble instant CA glue back to front to fill the weave. Cut away cloth over the hole. Harden inside with CA glue. As needed, fill weave with light spackle, wet sand & then apply sanding primer to prepare for paint. It may take several coats of primer followed by wet sanding to get a smooth finish. The fairing won't stick well to the extension. Bolt it in place when mounting the wing. Store it on the fuselage.

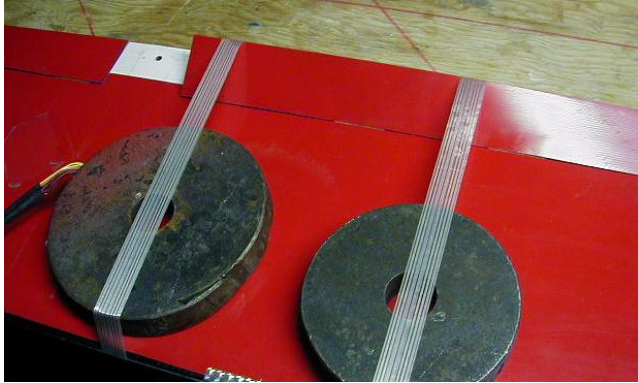
WIRING HARNESS: See CONST. FILE #9.

DEALING WITH TWISTS IN BAGGED WINGS

If your plane flew straight & true previously but is veering off to one side, it may have developed a twist in a flap, aileron or panel. This may be temporarily helped by use of a trim tab (piece of beverage can) placed outboard on an aileron with double sticky tape.

Use of a heat gun to render a surface flexible enough to be twisted & hand held in the opposite direction to cool can bubble, mar & discolor paint, destroy the epoxy bond, disintegrate the core or delaminate skins from the core.

For flap or aileron twist, a useful technique is to position a panel so the twisted surface can be held overnight, forcibly twisted in the opposite direction, with a combination of weights & strapping tape. Pictured below, the outboard end of the right flap (viewed from the rear) was drooping to cause veering to the left. Since the outboard end only allowed slight reflex & could not be twisted up, it was clamped in neutral between pieces of ply & the inboard end twisted down. When returned to neutral, the effect is to straighten the outboard end & offset the left veering tendency.



The objective is to forcibly spring the surface long enough to remove the twist. When released, it will mostly spring back over a couple of days but find a final new position. It may take more than one such overnight treatment to get it just right.

For an aileron twist, position the panel upright.

If a panel has a twist, support it so the offending end extends from a work surface. Wrap a thick towel around it. Pour near boiling water over the towel. Clamp boards together over the towel, extending ahead or behind the panel to add weight to undo the twist. Let it set overnight. Since it'll tend to spring back, more than one treatment may be needed.

I had one stubborn tip that required "surgery" to fix. Working with a thin kitchen knife, I loosened the bottom skin from the hingeline to near the LE & kept it separated from the core with sticks jammed between. I applied a brush-on, water based contact cement. When dry, I weighted the ends down to a flat plane surface, withdrew the sticks & pressed all flat for a permanent fix. The individual Kevlar hinges were under the top skin & not disturbed.

REPAINTING A PANEL

Ideally, you'll get perfect paint transfer & always be happy with the cosmetics of the wing. More realistically, a time may come where you'd like to repaint something.

My own experience with trying to spot fix an offending area is that it's essentially an effort in futility. Bagging leaves a residue of wax that prevents new paint from bonding well to feather into adjacent areas. Removing the wax risks harming the paint. New paint can soften the old & expose weave making a worse mess. Heat to soften the paint will harm the epoxy bond or disintegrate the foam. However, full restoration is possible. This involves first removing overall old paint without harming the core. This will take some time & elbow grease. What follows would apply to separately redoing either a top or bottom surface. If doing both, sort out which to do first.

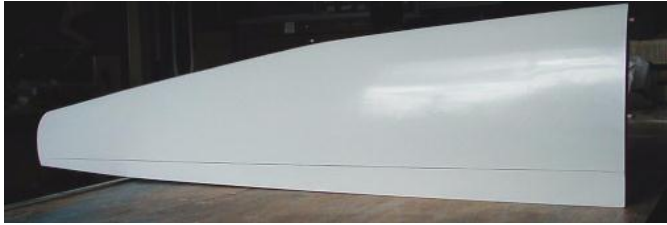
Most rattle can paints we commonly use can be softened with solvents & then scraped/peeled off with single edged razor blades.

If solvent gets to exposed foam, it will vanish. Tilt the panel to prevent that. It will be best to first remove the paint in that area by wet sanding with coarser 'wet or dry' sandpaper. Don't be concerned about scratches made.

The existing epoxy/glass/CF skin provides a pretty good seal, but should not be flooded with solvent. Apply a little to an old washcloth, etc. & rub into the paint to soften it for scraping. Just dampen new spots on the cloth & work a small area at a time. With the paint removed, you'll have an ugly, coarse carbon surface. I've only restored a top surface, so will describe that.

Cut .014 Mylar to fit the panel's perimeter. Wax & paint it. Cut light glass cloth on a 45 degree bias to go over it. Wet out with bagging epoxy & a foam roller. Sop up excess epoxy to look dry. Trim along the perimeter. Place this over the panel. Fold the work in the drop cloth with breather. Put in the bag & pull vacuum. If depressions appear, undo the bag & place something more rigid

between it & the drop cloth. 1/16" ply worked for me. There were no depressions in the panel. Paint transfer was perfect & the surface smooth with a nice sheen.



The "Individual Kevlar Hinges" had been installed. I slit the new skin between & over them & added trim colors below. First pic is distorted by close camera proximity. Same tip is shown in the picture by the car door.



See CONST. FILE #6 about paint trimming, including putting a painted finish on the endcaps where they butt before adding the dowel keying pins and sockets.

Using the same masking as when joining core sections, endcaps can be primed & painted to provide a finished appearance. After painting, keying pins & epoxy sockets go in. Note the vertically elongated hole for RDS aileron shaft "float" in this center section endcap.

