

Paul Prout
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Plans

#14A

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LONG EZ WHEEL PANTS

GENERAL

These pants were designed for Long EZ's equipped with 5X5 wheels about 14" in diameter. They are "Semi-Profile", extending down to the rim of the wheel leaving the tire exposed underneath to accomodate rough fields at the expense of some drag. The pants are formed to look compatible with the Long EZ, and are set at a negative angle of incidence of three degrees to conform to induced flow.

Since ease-of-construction was an important guideline, the basic form was made symmetrical about the vertical plane to avoid LH and RH "tooling". There is a modest penalty in frontal area for this approach. Left and right-hand pants are created only by the fitting and mounting of the shells.

CAUTION!

Before you begin on this project read and understand everything so you can progress without surprises. If you complete and install these pants before your taxi tests, TAKE 'EM OFF! CONDUCT NO LOW NOR HIGH-SPEED TAXI TESTS WITH PANTS INSTALLED. Under normal flight operations DO NO TOUCH AND GOES THAT EMPLOY HARD BRAKING WITH EACH PASS. The name of the game is to avoid frying brakes, tires, brake lines, main-gear struts and wheel pants. OK?



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DISCLAIMERREAD THIS!

Because technique and detail will vary with each builder there can be no assurances that your results will be the same as presented herein. By using the information contained herein you, the builder, assume all responsibility for the construction, installation, safety and performance of the wheel pants described. You assume all operational risk associated with the installation and use of these wheel pants including, but not limited to, braking heat, flat tires and rough terrain that might be encountered.

CONSTRUCTION STEPS

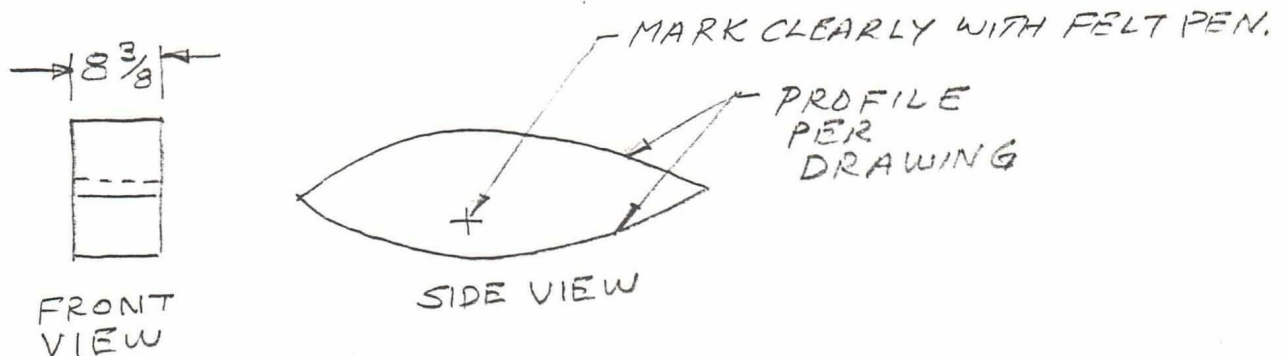
Ready? OK- let's outline the steps:

- Step 1 Making a plug.
- Step 2 Making the mounting hardware, including some work on the axles.
- Step 3 Making the pants.
- Step 4 Mounting and aligning the pants.
- Step 5 Finishing.

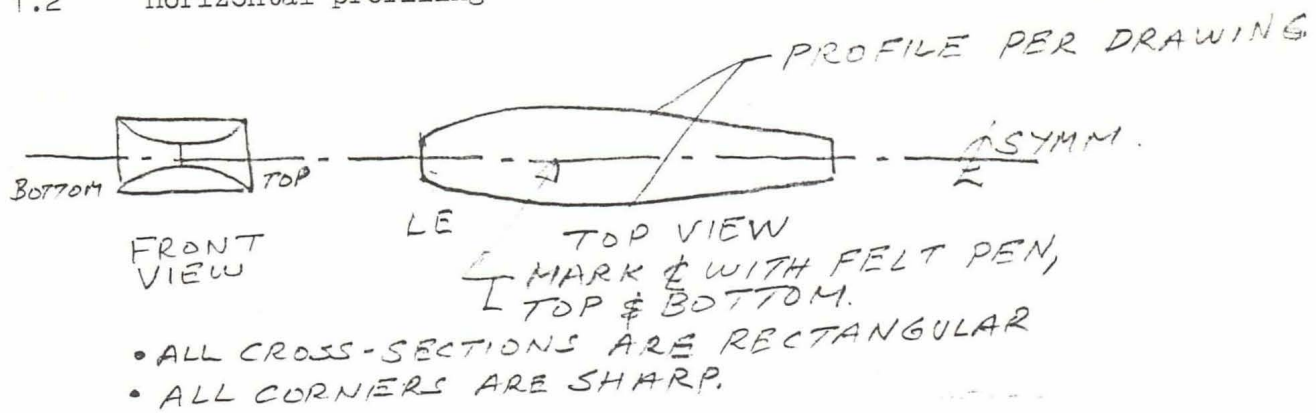
STEP ONE MAKING THE PLUG

The plug is the male mold around which you will form the pant shells. It is made from green (polyurethane) foam 8 3/8" X 11" X 31" over-all. This can be made by joining foam blocks with micro- but be very careful to keep micro away from anticipated final surfaces.

1.1 Vertical profiling

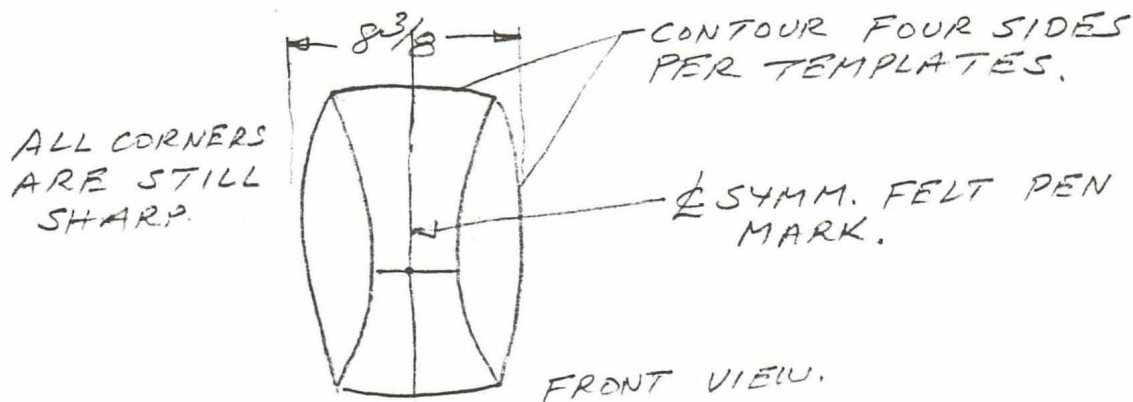


- ALL CROSS-SECTIONS ARE RECTANGULAR
- ALL CORNERS ARE SHARP.



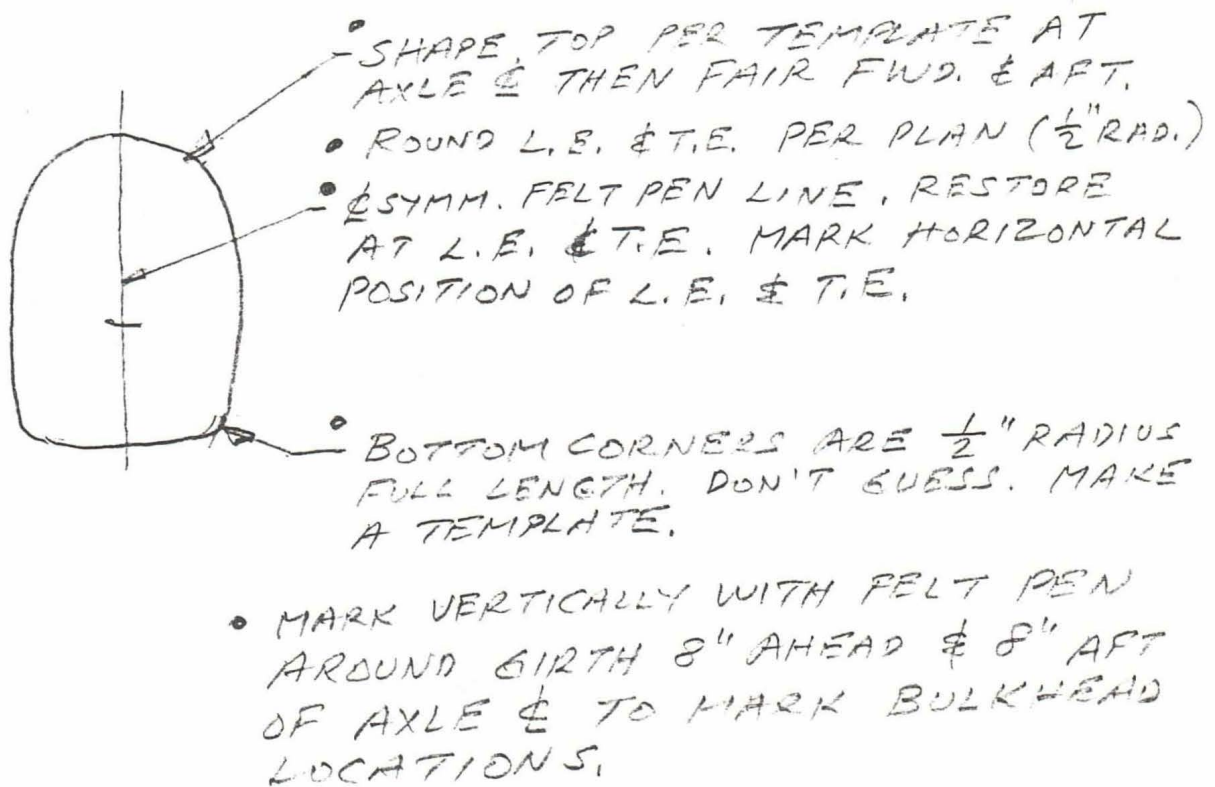
1.3

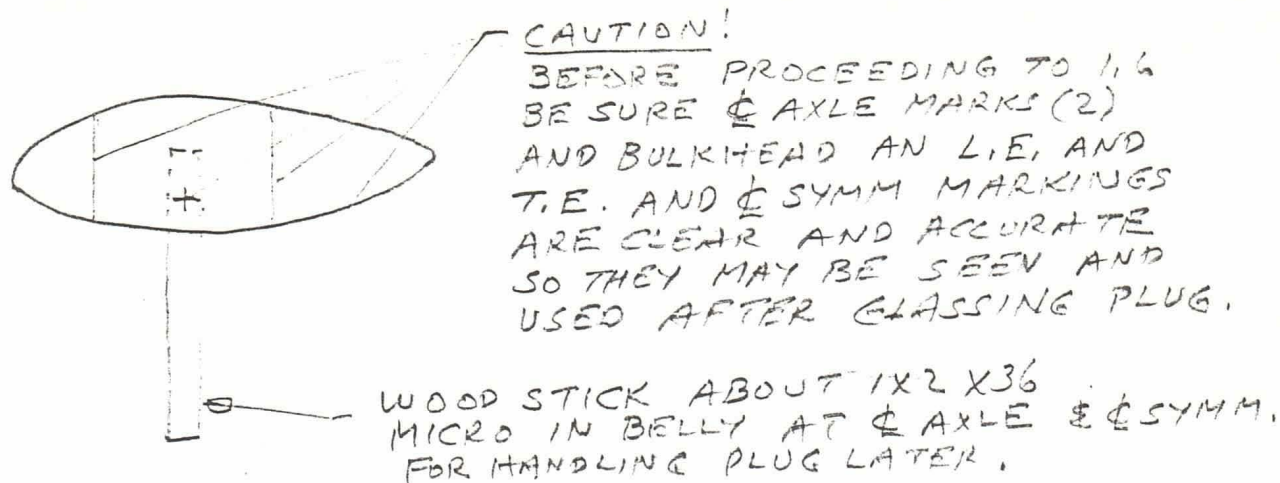
Cross-sectional profiling



1.4

Final contouring





1.6 Glassing the plug:

1.6.1 Micro-fill foam.

1.6.2 3 plies BID. Orientation not important. Make overlaps at least one inch. Try to keep edges and overlaps at bottom of plug.

1.6.3 At knife-trim time fill weave with dry micro. Let cure.

1.6.4 Fill and finish dead smooth. (Be sure felt pen marks on foam core can be seen). Be fussy. Use "laminating" technique. "Laminating" is a term originated by sail-plane finishers. For any positive (compound or straight-element curve such as noses, wing LE's etc, low spots requiring filling can be detected and outlined by rocking a 12" steel ruler over the surface at different angles. When you hear a "click" you have encountered the lip of a low spot.

1.6.5 Apply THIN film of epoxy all over plug with a very dry brush. Cure. Idea is to get a shiny, smooth surface for easy release later.

1.6.6 At center-line axle points (one on each side) drill 1/16" dia through glass. Also, drill 1/16" dia holes at the LE and TE symm. points. Place piano wire in these holes later when you lay up your shells so you will have these points for reference when installing the pants.

1.6.7 Three coats minimum of Meguiars mold-release wax- or cover plug with grey tape plus wax. (No wrinkles nor tape overlaps!)

Your plug is now ready to lay up pant shells over it. Step two can be done anytime, but if you haven't already done step two, now is a good time.

STEP TWO MAKING THE MOUNTING HARDWARE

- 2.1 Make two "pyramids" per drawing, one LH and one RH, complete with slotted inlaid washer and bushing. The concave face of one side of the "pyramid" is for clearance for the valve-access Wilke plug. The slot in the washer is for axle-nut cotter pin clearance.
- 2.2 Make two $\frac{1}{4}$ " dia. studs from AN bolts per drawing. Course threads ($\frac{1}{4}$ -20) go into axle, per drawing.
- 2.3 Drill, counterdrill and tap each axle end dead center per drawing. Install stud in axle allowing it to extend $1 \frac{5}{16}$ " from axle end. Using DRILL PRESS, drill matching cotter pin hole through the stud so that the axle-nut retaining cotter pin will also retain the stud and prevent its rotation. Remember, the axle is aluminum and the stud is steel, so drill carefully.
- 2.4 Make two spiders per drawing. Don't forget the $\frac{3}{16}$ " hole in the center.

STEP THREE MAKING THE PANTS

Note: The drawings show a right wheel pant. Left is opposite. In final form the pant is in two parts. The inboard part, retained by the spider, is referred to as the "BANJO". The outboard part is retained by the "pyramid" glassed to its inside surface. The two parts are held together with MS 24694 screws engaging nut plates mounted to a flange on the outboard part.

- 3.1 Cover entire plug with 3 plies BID, orientation 45 deg. Overlaps should be at least one inch. Try to overlap at LE, TE and bottom.
- 3.2 At knife-trim time: Dremel saw completely around the center-line-of-symmetry (parting line). Fill weave with dry micro. (This will save a lot of sanding and filling later). Let cure. Fill, sand, finish as needed to get a perfect surface while still on plug. Be fussy. The surface should be primer-ready at this point.
- 3.3 Carefully layout the cut-lines for the inboard part (banjo), the tire preliminary cutout on the bottom, and the main-gear strut cutout on the top. Remember, the drawing is a PROJECTION of the cut lines, NOT a flat pattern. Cut line of the banjo is NOT a constant radius. The strut and wheel cutouts will have to be finalized for your particular airplane. Outline the bulkhead locations. Preserve the $\frac{1}{16}$ " holes at the axle center line and LE and TE. Make witness marks with a felt pen abundantly at random across the parting line you have sawed to help you later in perfectly realigning the two shells for reglassing together.

- 3.4 Remove the two shells. Be patient! Make a large tongue-depressor-shaped piece out of .216 aluminum and use this to work between the shell and plug working from the parting line, of course. Compressed air works great. Take your time. Don't become impatient and damage the plug or shell. Congratulations! You now have two symmetrical shells to work with. Set the outboard half aside. We'll get back to it.
- 3.5 With a felt pen make random witness marks across the banjo cut line. Cut the banjo with a Dremel saw out of the inboard shell along the cut line you previously marked. The large portion of this shell is very flimsy at this point. Set it aside with the outboard shell (to which it is eventually reglassed) so it won't be damaged, and turn your attention to the banjo. Glass the banjo inside all along the cut line with 3 plies BID at 45°, 1.2 inches wide. Let cure fully.
- 3.6 Make two forward bulkheads and two aft bulkheads per print. Grey tape a flat area on your work bench about 7 X 8" for the forward bulkhead and about 9 X 10" for the aft bulkhead. Then grab some strake foam (blue) which is .35" thick and cut some strips one-inch wide. Sand the cross section to an arc, round off the ends and miter the strips where they cross in the middle. Place them as indicated on the print, grey tape them on top of the grey tape you have already laid down on your work bench. Lay up one ply UND parallel to one bead, one ply UND parallel to the other bead, and finally one ply UND oriented vertically. Save yourself some sanding by putting peel ply down around the bulkhead outline BEFORE you make the UND layups. Free bulkhead after cure and trim to print.
- 3.7 Now get that "flimsy" part of the inboard shell you set aside and reposition the banjo to it like it was before you cut it out. Dead flush. Align the witness marks. You can tape/bondo them together. Working on the inside, grey tape the banjo along the reinforced edge. Now layup 4 plies BID at 45° lapping 1.2 inches onto the banjo and 1.2 inches onto the shell. Be sure the shell has been sanded. This forms the outboard-shell-to-banjo joining flange. Let cure then drill #30 holes at fastener locations. Separate the banjo and shell and trim the flange to 0.7" per plan. Fill inside corner of flange with flox. LEAVE NO EXCESS.
- 3.8 Get the outboard shell you set aside in 3.4 above. Get the correct pyramid you made in step 2, flox it in place inside the shell at the axle center-line being sure the concave face is forward and slot in washer down. The pyramid can be keyed into position with a well-waxed $\frac{1}{4}$ " bolt. Glass in place with two plies BID, lapping one inch onto shell on three sides, and covering the area of the valve-access hole for reinforcement for the Wilke button. After cure remove the keying bolt and remove the glass covering the 970-4 slotted washer so the washer will bear metal-to-metal with the end of the axle when installed. You now have three pieces. A banjo with a reinforced edge; a "flimsy" shell with a flange; an outboard shell with the pyramid in place. You are now ready to glass the "flimsy" shell and outboard shell back together. Set the banjo aside. You won't need it for a while.

- 3.9 Be sure the "flimsy" shell and outboard shell are well sanded inside at the joining edges (at least $1\frac{1}{2}$ " wide each half). Also, be sure to sand these shells where the bulkhead-attaching tapes will be laid up. Tape or bondo the two shells together, using the witness marks you made in 3.3 above to insure perfect alignment and form. Along the parting line inside glass the two shells together with 2 BID tape 2" wide. Wet the tape on Saran Wrap on the bench first, then apply tape with Saran in place. Remove Saran when tape is worked into place. BID tape must have 45° orientation. After this tape is in place and still wet you can install the bulkheads. Trial fit and trim as needed. If they come within 1/8 to 1/4" they're OK. (That is clearance between bulkhead and shell.) Use 2" wide BID tape at 45°. One ply will do it. To make this layup easier, use four separate pieces of tape on each bulkhead rather than trying to go all the way around with one tape. Lap at least one inch. Beads on the bulkheads must face AWAY from wheel well, not into it. Let cure fully.
- 3.10 Now your pant is in two pieces: The large outboard part with bulkheads installed having an attaching flange running around a rather large opening...and: the inboard part we call the banjo which has its edge nicely reinforced. Now the outboard part has a nose and tail compartment which are all sealed up. To vent these compartments drill #30 in the bottom of the pant two places. One just ahead of the forward bulkhead and one just aft of the aft bulkhead. Make certain these remain clear. Cleco the banjo in place and drill the #30 holes up to #10 (9 places). C'sink the banjo 100° for the MS24694-S50 screws. Install K1000-3 nutplates behind the flange using c'sunk pop rivets. Note: The outboard half of pant is retained on the axle stud with an MS21042-4 nut and an AN960-416L washer.

STEP FOUR MOUNTING AND ALIGNING THE PANTS

- 4.1 You are now ready to mount the wheel pant. Before you bolt the axle in place(you removed it for step 2.3) check on the "pitch" orientation of the spider. This can be done by putting up the wheel assembly temporarily in place with brake calipers in place and seeing how the spider relates. Short leg is down. The spider's pitch orientation is not critical as far as mounting integrity is concerned but is very important for your individual set-up as far as providing clearance is concerned around your brake line and maybe even your brake caliper bolts. Once you decide on the spider's pitch orientation, back-drill through the axle-mounting holes (4) $\frac{1}{4}$ " dia. Be sure the 3/16" dia hole in the center of the spider is in the center of the four holes. Remount the axle permanently with the spider bearing directly against the existing aluminum plate on the inboard side of the main gear strut. Toe-in alignment must be right at this time. If you haven't drilled a 3/16" dia hole in the banjo at the axle center-line now is the time to do it. Slide the outboard shell over the axle stud and fit the shell around the main landing gear strut by trial and error. Also, make a preliminary trim around the tire hole in the bottom. Try to leave yourself about a $\frac{1}{4}$ " clearance all around. Don't forget to maintain pitch, roll and yaw very closely as you fit. Fit up the banjo at the same time by using every-other screw on the flange.

4.1 (cont'd)

With the banjo screws in place around the flange, insert a 3/16" dia cold rolled steel rod (with a 1/64" chamfer on the end) through the center hole in the banjo and engage it with the hole in the center of the spider. Aligning the rod will then align the pant. Once you are happy with the clearances you have around the strut on top and tire on the bottom (preliminary clearances) you are ready to align the pant finally and drill mounting holes at the tips of the spider. **LEVEL YOUR AIRPLANE.** Project the fuselage center line to the floor. Measure the camber of the axle in degrees. Camber is the angle the tire is in "roll" from vertical. (The Long EZ is bow-legged!). Measure toe-in ("yaw") in degrees, just for the one wheel.. NOT the total toe-in of both wheels. Remember the 1/16" dia holes at the LE and TE center-lines? We are going to use them now for pitch and yaw alignment. Alignment is an iterative process.. so hang in! First, pitch. Pitch is correct when the LE hole is 1.6" closer to your level floor than the TE hole. Second, yaw. Yaw is correct when the LE hole is closer to the fuselage center plane than the TE hole by this amount:

$0.027 \times \text{degrees of camber} + 0.50 \times \text{degrees of toe-in.}$

Example: You measure 5° of camber and 1° of toe in.

$$0.027 \times 5 = 0.135$$

$$0.50 \times 1 = 0.500$$

Total 0.635 inches

In this example your LE should be 0.635" closer to the fuselage center plane (Zero butt line) than the TE.

Third, roll. Set roll by inserting a 3/16" dia rod through the banjo and engaging the center hole of the spider. Correct roll will be obtained when the rod is raised to the camber angle previously measured. Repeat this pitch, yaw, roll routine until all three measurements are simultaneously satisfied. With the pant secured, drill #30 through banjo and through the center of the spider pads. Remove pant. Drill spider up to #10 and mount nut plates (K1000-3) with flush pop rivets. On the inside of the banjo where the three #30 holes are, lay up 2 plies BID 2" square for reinforcement and extra thickness for mounting screws. After cure drill up to #10. Mount banjo to spider with 3 AN525-10R8 Screws and 3 AN960-10L washers. Fill the 3/16" dia hole in the banjo with floc, cure sand flush. Also fill the LE and TE 1/16" holes. The final tire-clearance cut out on the bottom is determined by making a cut out which would just permit a 1/2" dia od 5/8" dia ball to just squeeze through between the tire and the pant.

- 4.2 Now for the cuff. The cuff fairs in the main gear strut to the wheel pant. Since this is not a right-angle intersection it is a high-drag candidate. The idea behind an efficient fairing is to start at the leading edge with a rather small radius and gradually increase that radius toward the trailing edge. Keep this in mind as you shape yours.

Sand a generous area on the two pant parts in the vicinity of the strut opening. Grey tape the landing gear strut in the vicinity of the cuff. Fill the area between the pant (after you have mounted it, of course) and the strut with modeling clay and contour per print. Use a SHARP butcher knife with a nice curved blade for contouring the clay. When you've got it right lay up three plies BID (random orientation) overlapping at least one inch onto the pant body. At knife-trim time trim top of cuff around strut CAREFULLY! (Don't touch strut!) A Dremel saw is great. There should be from .05 to .10" gap around strut per print. Also, dry micro the entire layup for a smooth surface transition. Let it completely cure. The two pant halves are now rejoined, thanks to the cuff, so we'll have to separate them. With a felt pen mark down the leading edge of the cuff beginning at the top center with a line that will come in tangent to the existing cut-line on the banjo. Now, mark another line beginning at the top center of the trailing edge (but NOT following it!) and extending down the inboard face of the cuff and coming in tangent to the existing cut-line on the banjo forward of the topmost attaching screw. Refer to the print. Cut along these lines with a Dremel saw taking great care to cut no deeper than the cuff. Separate the two halves of the pant by completely dismounting it. On the banjo and outboard part of the pant in the vicinity of the cuff on the inside you will discover quite a mess of clay and excess glass. Clean it all up so that when you are finished the cuff and pant look like one continuous piece inside just like outside. Now is the time to do any filling and fairing to make certain the blend between cuff and pant is perfect. Sand all the inside surfaces of the wheel well compartment then primer with any finish that suits your purposes. If you have a relief tube this should be directed out of the banjo side aft of the wheel on the bottom.

STEP FIVE FINISHING

- 5.1 Fill, primer and finish per the rest of your plane. After finishing and before mounting wrap the main gear strut in the vicinity of the cuff with Saran wrap. Mount the pant. Fill the .05/.10 gap at the top of the cuff with white RTV silicone and let set for 48 hrs. After cure carefully separate by slitting silicone at cuff LE and TE with razor. Remove pant, remove Saran wrap, reassemble and, voila!.. you have a neat seal bonded to the pant at the top of the cuff.

MILLER TIME!

About HEAT! Wrap strut and brake lines with Fiberfrax or asbestos insulation and aluminum tape.

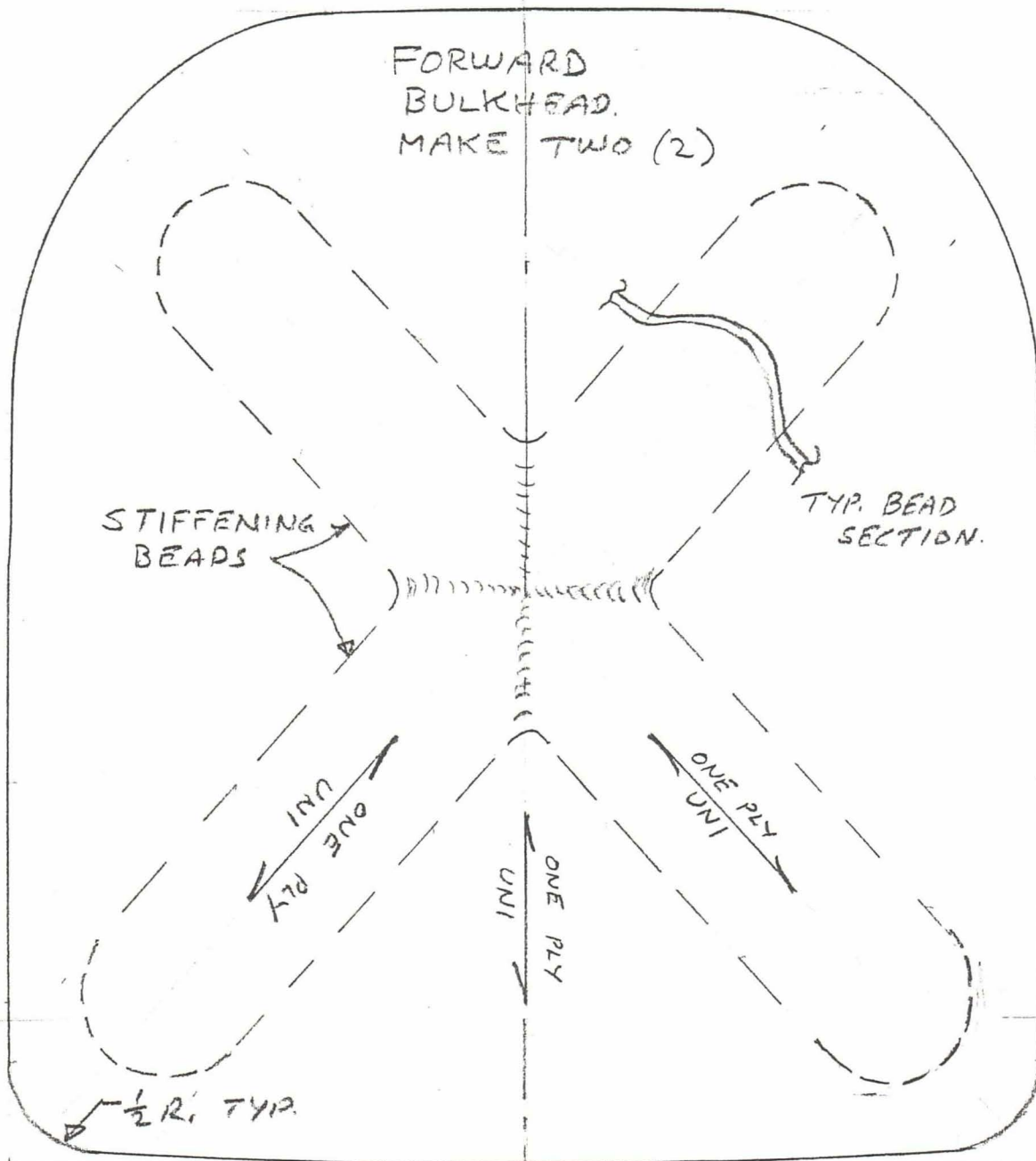
HEAT, (cont'd)

Do a good job of protecting these critical components from heat. There is an alternate heat vent indicated on the plan on top of the pant if you want to incorporate it to help vent out the heat when taxiing or parking after a panic stop. Judicious use of your brakes is your best defense against overheating and hot shut downs.

SERVICING TIRES

A Wilke plug of $1\frac{1}{4}$ " dia is used to cover the valve-access hole. Schrader makes a steel 4" valve extension (P/N 4430) which can be inserted through the access hole in the pant and screwed onto the tire valve stem for pressure check and inflation. The valve stem dust cap can be removed by using a rubber tubing length and reinstalled the same way.

STEP 3.6



C SYMM.

STEP 3.6

AFT
BULKHEAD
MAKE TWO
(2)

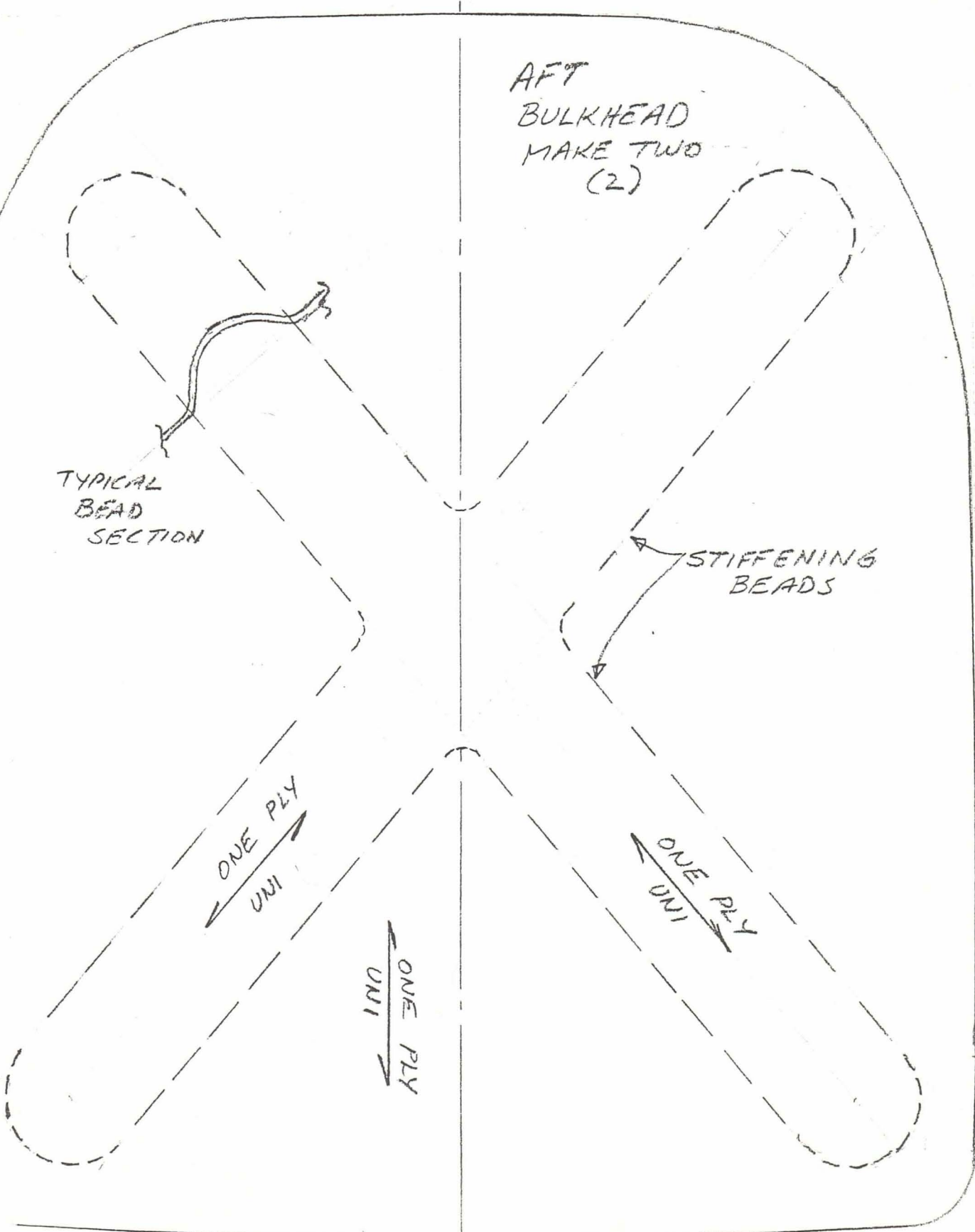
TYPICAL
BEAD
SECTION

STIFFENING
BEADS

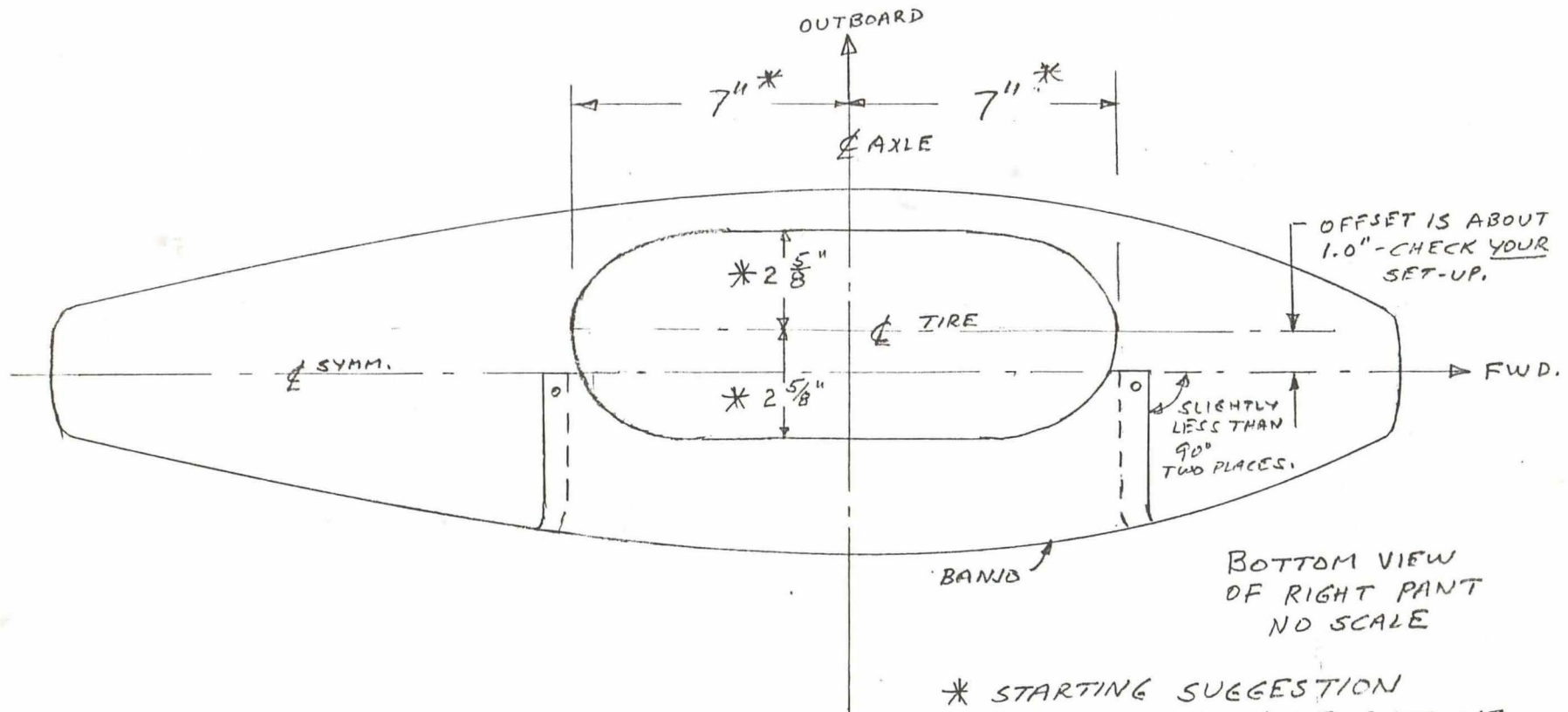
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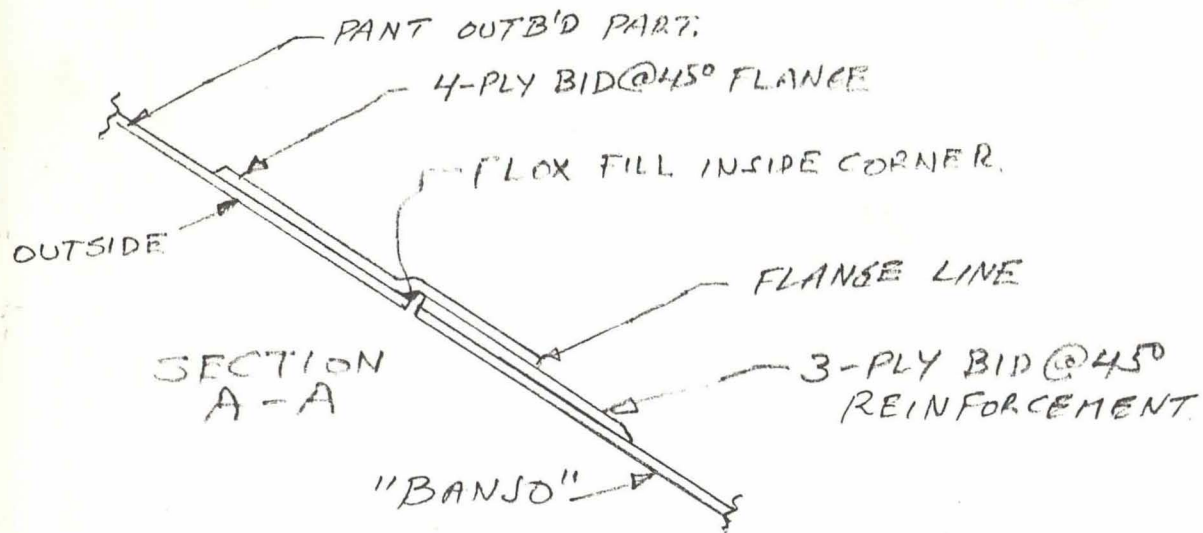


TIRE CUT-OUT & BOTTOM BAND ATTACHMENT DETAIL.

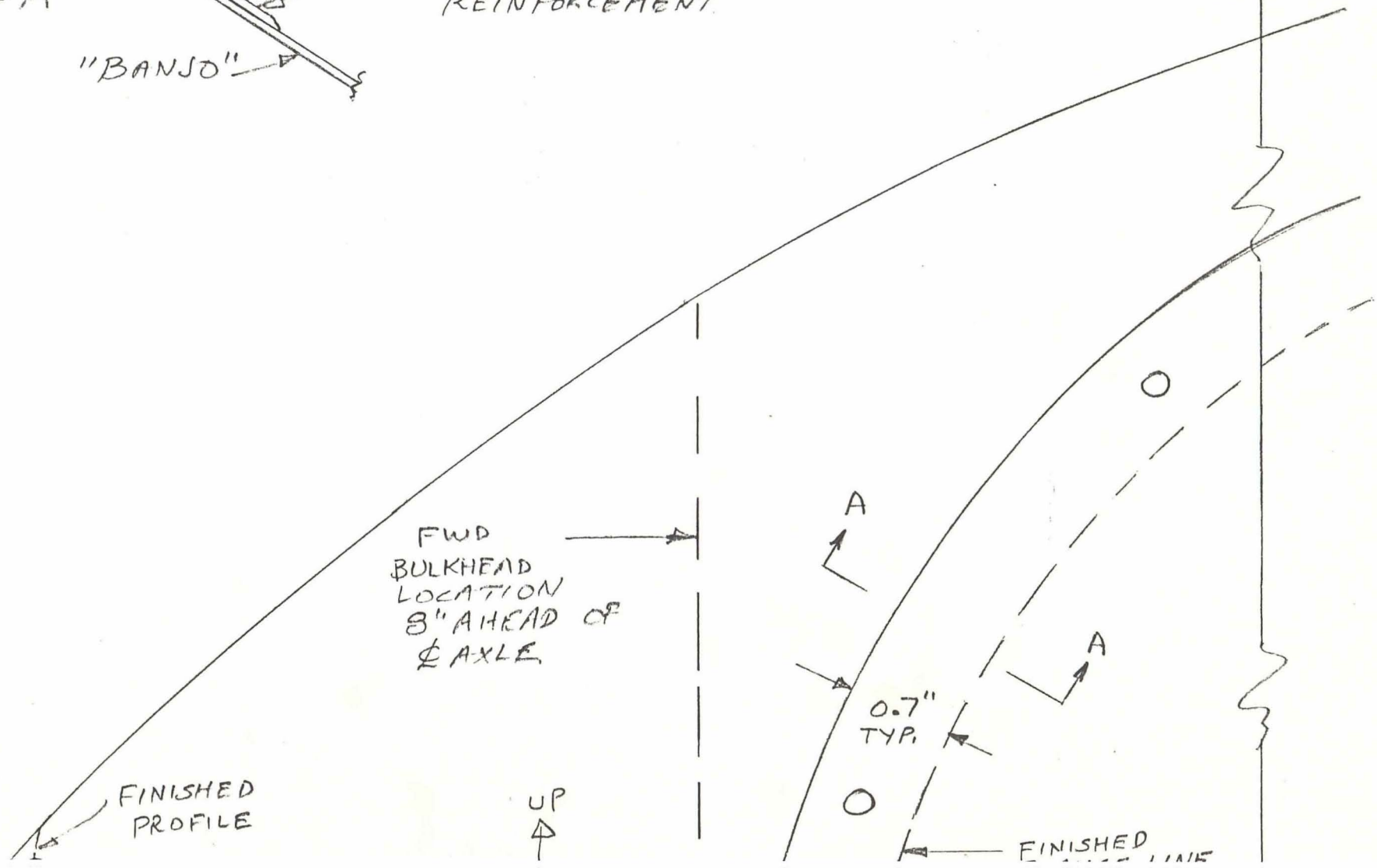


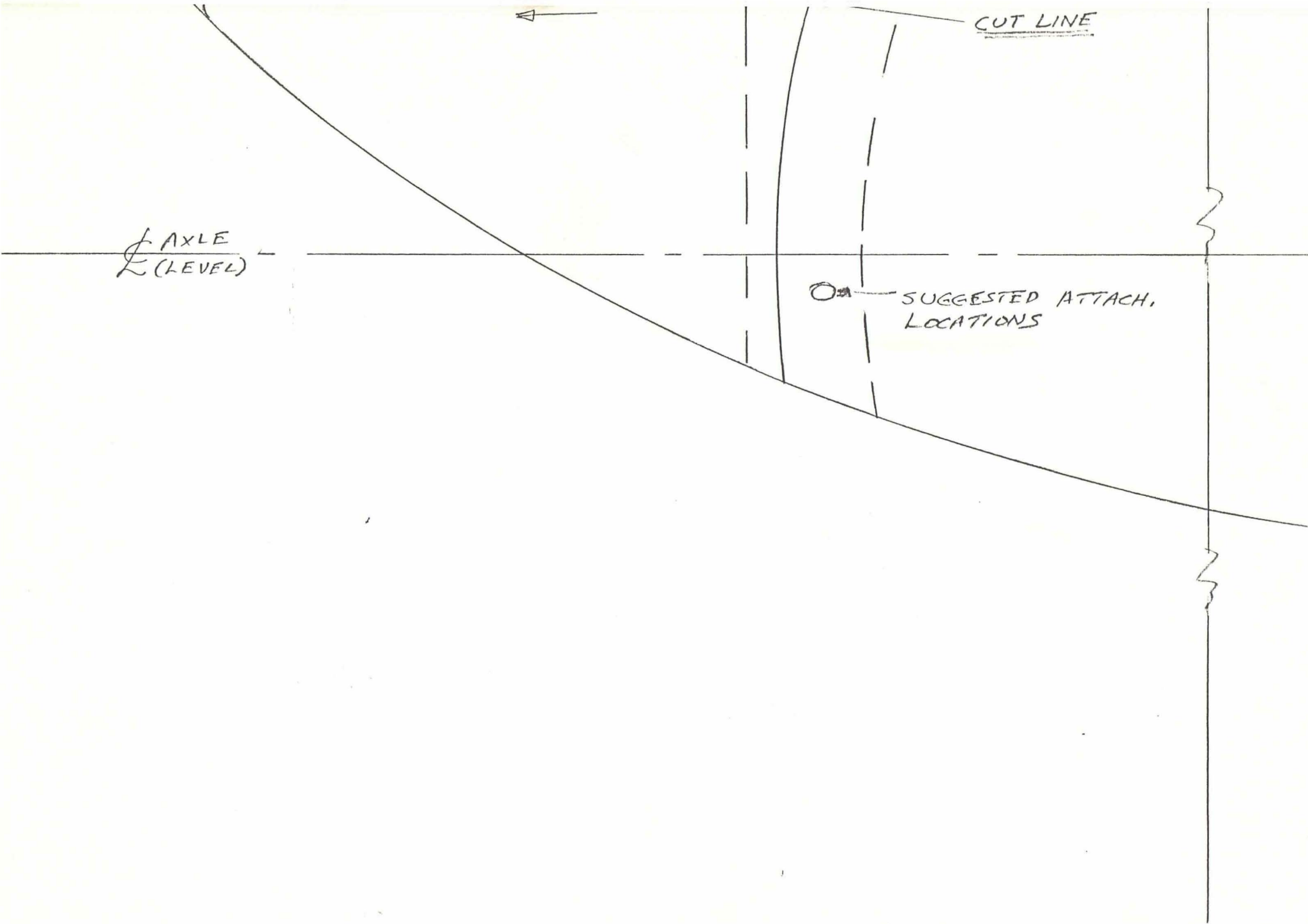
* STARTING SUGGESTION
FINAL WHEEL HOLE OUTLINE
DEPENDS ON YOUR INSTALLATION
& TIRE PROFILE. SUGGEST CLEARANCE
BETWEEN PANT & TIRE BE 1/2" TO 5/8"
I.E.: A 5/8" DIA. BALL WOULD JUST
SQUEEZE BETWEEN TIRE AND
OPENING AT ANY POINT.

PANT VERTICAL PROFILE =
SHEET 1 OF 4



MATCH PAGE 2
PATTERN HERE





PANT VERTICAL PROFILE
SHEET 2 OF 4

MATCH PAGE 1
PATTERN HERE

MATCH PAGE 3
PATTERN HERE

TEMPORARY CUT-OUT
FOR MAIN GEAR
STRUT

END OF FLANGE

FINISHED FLANGE LINE

END OF
FLANGE

SUGGESTED
ATTACHMENT
LOCATIONS

WARNING!

REMEMBER - CUT LINES
SHOWN HERE ARE
PROJECTIONS, NOT
FLAT PATTERNS.
CUT LINES ARE NOT
A CONSTANT RADIUS
AROUND AXLE.

FINISHED
FLANGE LINE

DRILL $\frac{3}{16}$ " DIA IN "BANJO"
DRILL $\frac{1}{4}$ " DIA IN OUTB'D PART

HOLE SAW $1\frac{1}{4}$ " DIA.
FOR VALVE ACCESS,
OUTBOARD PART ONLY

AXLE
(VERTICAL)

FWD ←
↑ UP

AXLE (LEVEL)

"PYRAMID" LOCATION,
OUTB'D PART ONLY.
BE SURE SLOT IN
WASHER IS DOWN.

$1\frac{3}{4}$ "

PANT VERTICAL PROFILE
SHEET 3 OF 4.

MATCH PAGE 2
PATTERN HERE

HEAT

OPTIONAL OPENING IN
TOP OF PANT TO VENT
BRAKING HEAT BY CONVECTION,
 $1\frac{1}{2}$ " WIDE.

MATCH
PAGE 4
PATTERN
HERE

AFT
BULKHEAD
LOCATION
8" AFT OF AXLE ϕ

SUGGESTED ATTACHMENT
LOCATIONS

CUT LINE

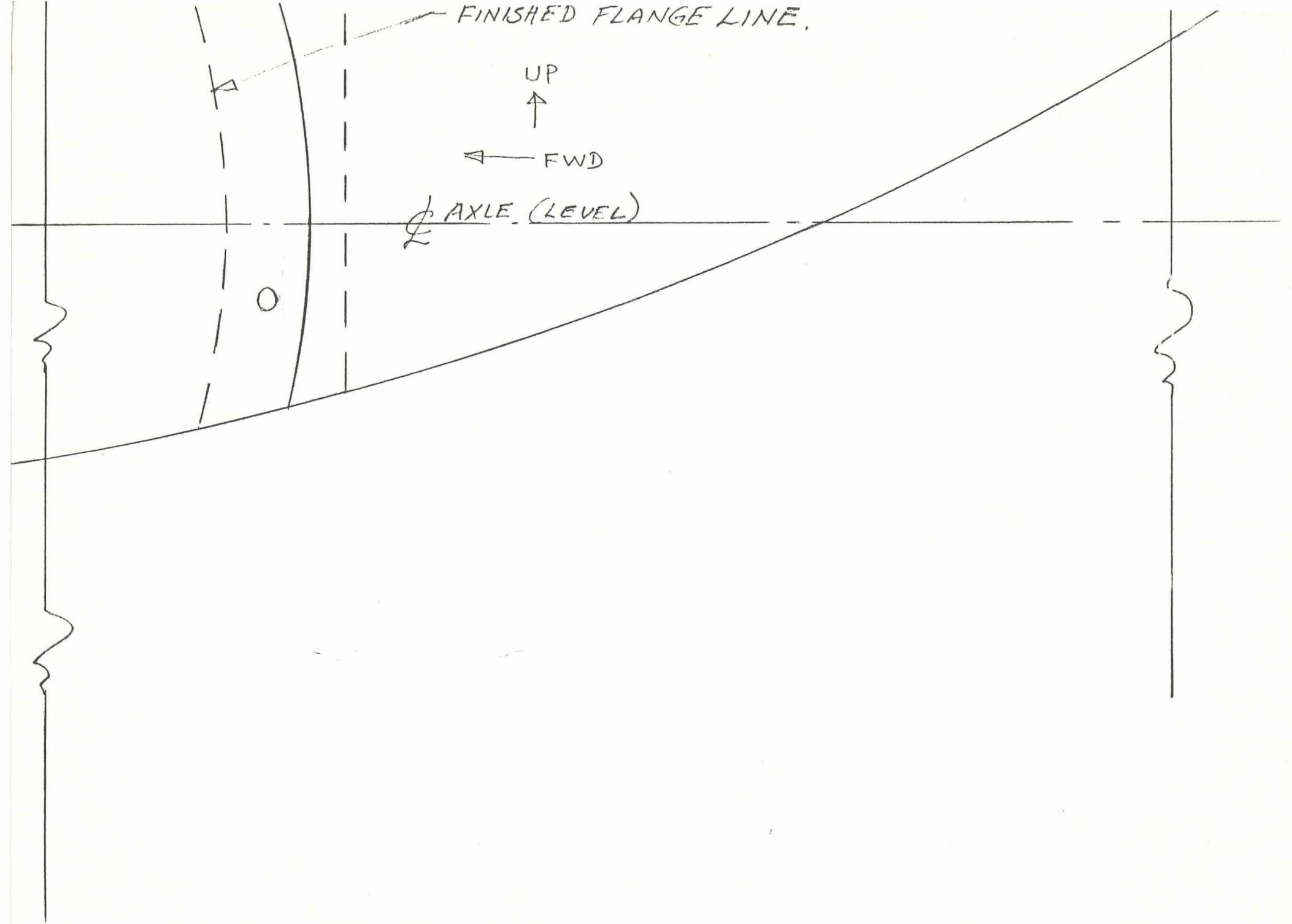
FINISHED FLANGE LINE.

UP
↑

← FWD

AXLE (LEVEL)

0



9512

TEMPLATE FOR TOP & BOTTOM
CONTOURS. STEP 1.3

ϕ SYMM.

LEVEL

CAL
ATE FOR SIDE CONTOURS
STEP 1.3

LEVEL

TEMPLATE FOR FINAL
CONTOURING. STEP 1.4

USE TEMPLATE AT VERTICAL
AXLE ϕ . FAIR FWD & AFT.

ϕ SYMM

THIS CUFF IS AN
IMPORTANT DRAG REDUCER,
DO IT RIGHT.

CUFF DETAIL

VIEW OF RIGHT PANT
LOOKING OUT B'D.

REFER TO STEP 4.2 IN
INSTRUCTIONS.

FULL SCALE. NOT A FLAT
PATTERN!

4
AXLE

