CHAPTER 1
REVISION LIST

The following list of revisions will allow you to update the Lancair IV construction manual chapter listed above.

Under the "Action" column, "R&R" directs you to remove and replace the pages affected by the revision. "Add" directs you to insert the pages shown and "R" to remove the pages.

Page(s) affected	Current Rev.#	Action	Description
1-1 thru 1-13	1	R&R	Expanded chapter
1-14 thru 1-77	1	Add	Expanded chapter

CHAPTER 1
INTRODUCTION

REVISIONS

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 When such revisions are made, you should immediately replace all outdated pages with the revised pages. Discard the outdated pages.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

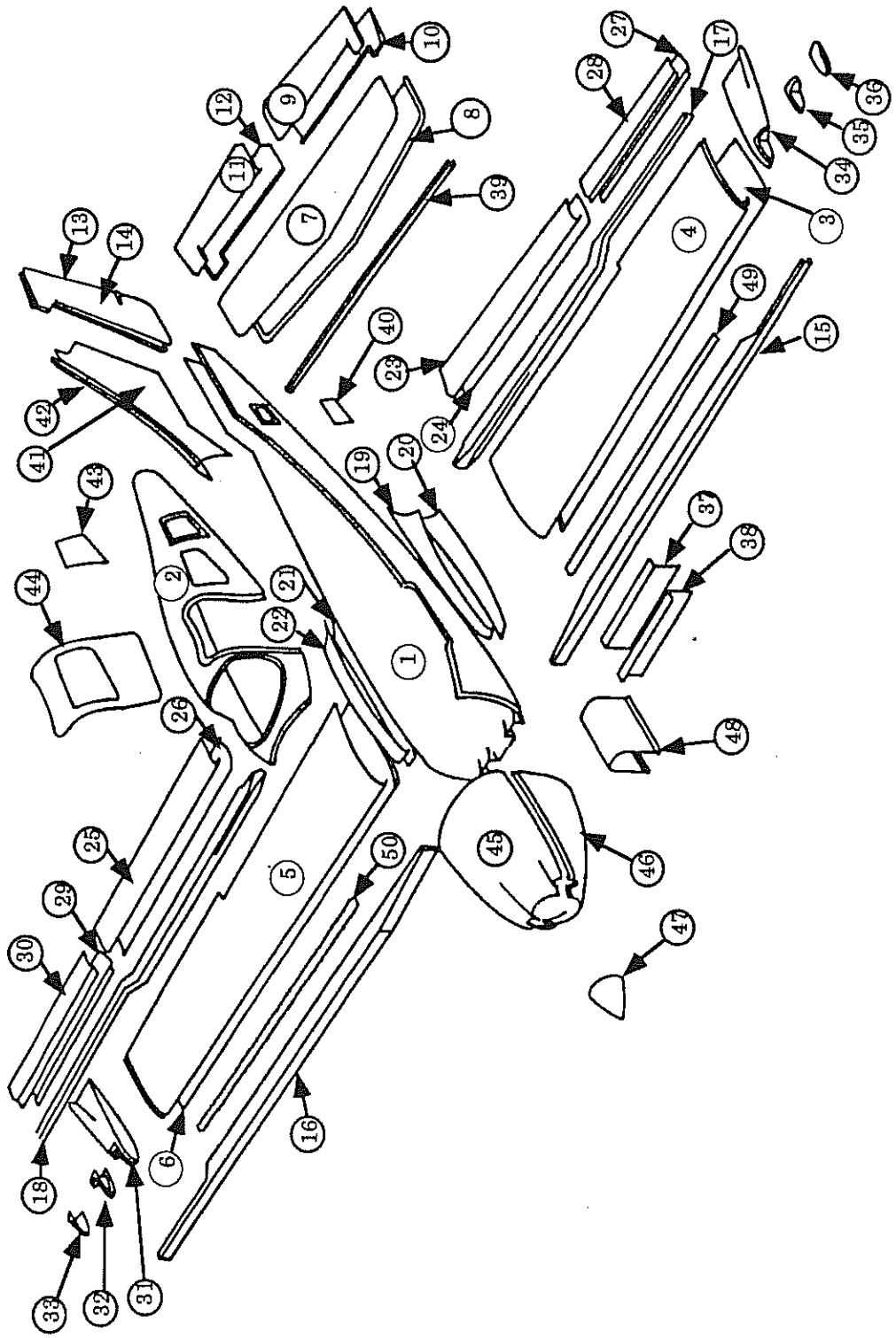
Arrows

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

CONTENTS

Parts for Lancair IV

Figure 1-1



Parts Descripton

1. Fuselage bottom
2. Fuselage top
3. Lower left wing skin
4. Upper left wing skin
5. Upper right wing skin
6. Lower right wing skin
7. Upper horizontal stabilizer
8. Lower horizontal stabilizer
9. Upper left elevator skin (may come as one piece with upper right side)
10. Lower left elevator skin (may come as one piece with lower right side)
11. Upper right elevator skin
12. Lower right elevator skin
13. Right side rudder skin
14. Left side rudder skin
15. Left side main wing spar (may be already installed in left upper wing skin)
16. Right side main wing spar (may be already installed in right upper wing skin)
17. Left wing aft spar
18. Right wing aft spar
19. Left upper wing root
20. Left lower wing root
21. Right lower wing root
22. Right upper wing root
23. Left upper flap skin
24. Left lower flap skin
25. Right upper flap skin
26. Right lower flap skin
27. Left lower aileron skin
28. Left upper aileron skin
29. Right lower aileron skin
30. Right upper aileron skin
31. Right wing tip
32. Right wing light base
33. Right wing tip lens
34. Left wing tip
35. Left wing light base
36. Left wing tip lens
37. Main spar/fuselage brace, aft
38. Main spar/fuselage brace, forward
39. Horizontal stabilizer shear web
40. Aft inspection panel
41. Left vertical stabilizer skin
42. Right vertical stabilizer skin
43. Luggage access door
44. Canopy latch
45. Upper engine cowling
46. Lower engine cowling
47. Prop spinner
48. Nose wheel bay liner
49. Left main wing spar closeout
50. Right main wing spar closeout

3. TERMS & DEFINITIONS

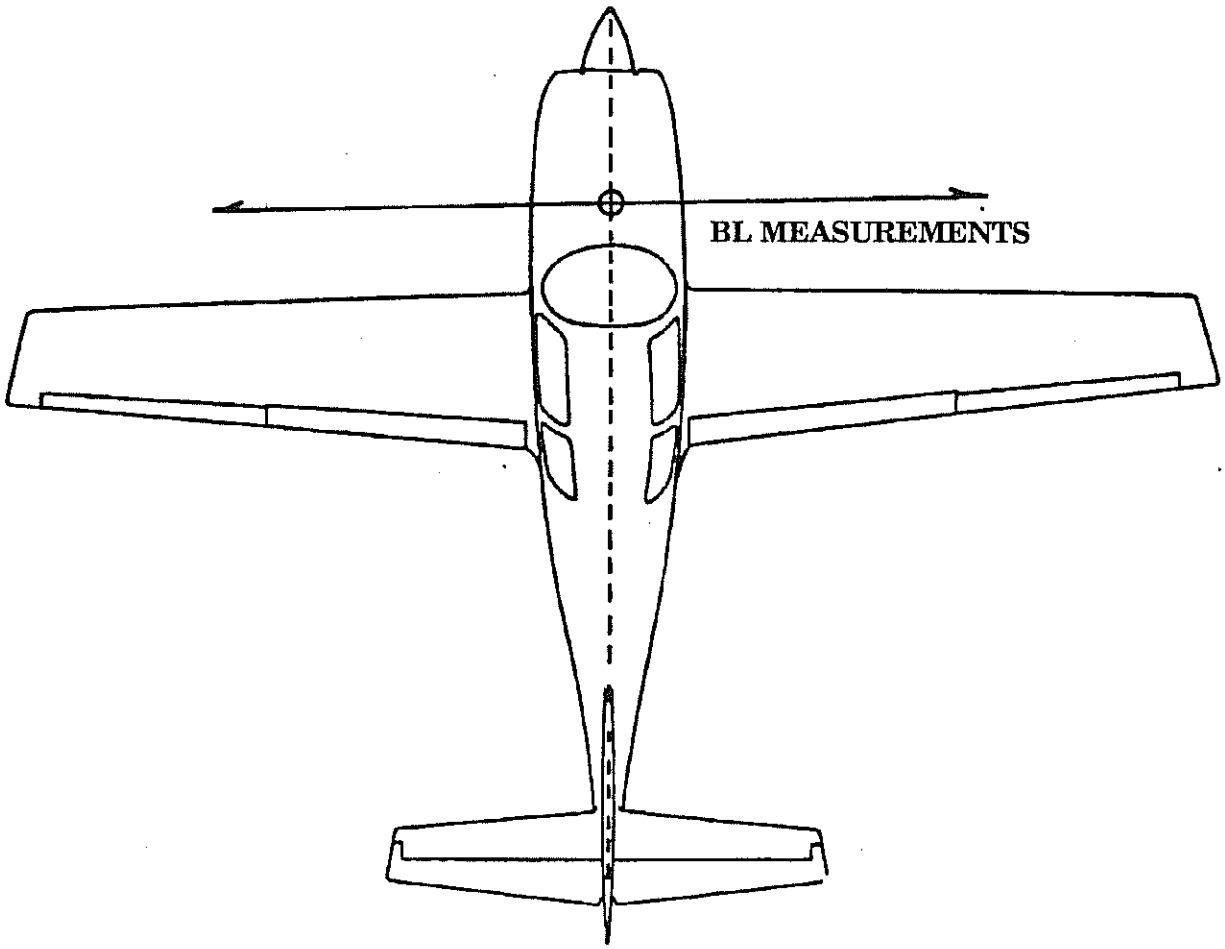
Aft Back side or measured back

Bidirectional Glass Cloth Bidirectional glass cloth (BID) means that it has 50% of the fibers running in one direction and 50% running 90° in the other direction. The typical roll of fiberglass cloth is bidirectional and the weave orientation 0-90° meaning that half of the strands run parallel to the edge and half run perpendicular to the edge.

BID tape A strip of bidirectional cloth cut on the bias, usually 2-4 inches wide.

BL Butt line. This is used to measure distances outward from the centerline of the fuselage. Thus butt line 0 (BL 0) is the actual center line.

BL (butt line) Measurements
Figure 1-2



CFC: Carbon Fiber Composite - This is a material that uses graphite or carbon fibers in place of the usual fiber glass material for greatly increased strength, and is much lighter (and of course, much more expensive). It is black in appearance, instead of the tan or greenish color of most fiber or "E" glass.

Chord Length of the airfoil; from the leading edge to the trailing edge of the wing.

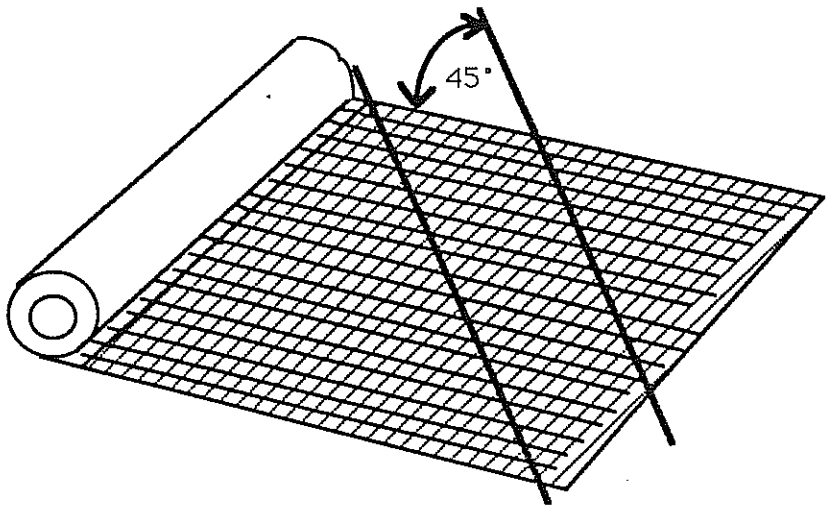
Cotton Flox: Cotton flox is finely chopped cotton fibers which are in appearance nearly as fine as micro balloons. The big difference is that they are structural when combined with epoxy. USE: They are mixed similarly to micro and used for strengthening glass to glass corners and bonding of cured glass elements to one another, etc. They can fill small gaps where pure epoxy might run out and leave a void, also large amounts of pure epoxy are heavier and too brittle. Flox, when mixed into a typical epoxy paste is quite heavier than micro thus it is used sparingly.

Ctr: Center

Cutting on the bias: Cutting BID cloth on the bias is to cut in such a nature as to leave the fibers on a 45° angle to the resultant cut edge. See Drawing below. You can wrap a smaller radius corner when the fibers are running on a 45° angle to the corner.

Cutting on a 45° bias

Figure 1-3

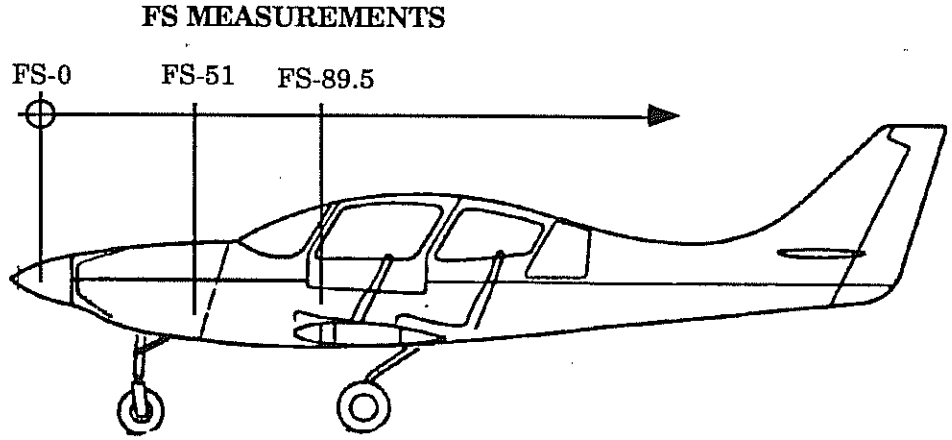


Dihedral
Figure 1-4

Dihedral Looking at the front of the aircraft, most non-swept wings form a positive angle to the horizontal. That is called dihedral. The Lancair IV has 3° 10' of dihedral, meaning that the wings are slanted upward at a little over a 3° angle from the horizontal. Dihedral improves roll stability on non-swept wing aircraft.

FS Fuselage Station. This imaginary line is used to measure distances forward or aft on the fuselage. FS-0 is established at a point fwd of the aircraft so that all stations will be positive (+) numbers. Example: FS 89.5 is defined as the fwd face of the main spar's fwd shear web face. FS 51 is defined as the bottom center of the firewall (Fwd face).

FS (fuselage station) measurements
Figure 1-5



Fslg Fuselage

Ftg Fitting

Fwd Forward

Inbd Inboard

Joggle Many of the pre-molded parts have a specially preformed edge where they will be attached to other parts. This 'joggle' provides for the addition of BID tapes to strengthen the joint between the parts.

Joint: Adjoining parts are attached with bonded, overlapping joints reinforced with fiberglass strips. Figure 1-27 on page 1-33 shows the overlap prior to assembly (the dimensions shown in the figure are approximate). As supplied, the part edges may have excess material. To obtain the dimensions shown, any excess material must be trimmed by the builder as explained below.

> **NOTE:** Before trimming, single and double joggleed surfaces may look familiar. To learn what each looks like, place the upper and lower leading edges of one of the wink sections on the floor and temporarily position them, upside down, as they will be when being assembled later. The upper wing skin is the one with the formed leading edge. Looking at the joggled surfaces on the upper wing section, you will notice two joggles, compared to only one on the lower section.

MC Methylene Chloride - Cleaning agent for removing unwanted contamination. You will find the usage of cleaning agents throughout this manual. We have found that Methylene Chloride (MC) cleaner is very good in its ability to remove impurities from surfaces. As with all cleaners, be sure to read and follow the safety directions. Acetone is a good cleaner but Methylene Chloride (MC) is superior. *MEK should not be used.*

When cleaning parts in preparation for bonding, always allow parts time to dry before attempting to bond. The MC can combine with the adhesive, weakening it at the bond interface, and could result in structural failure.

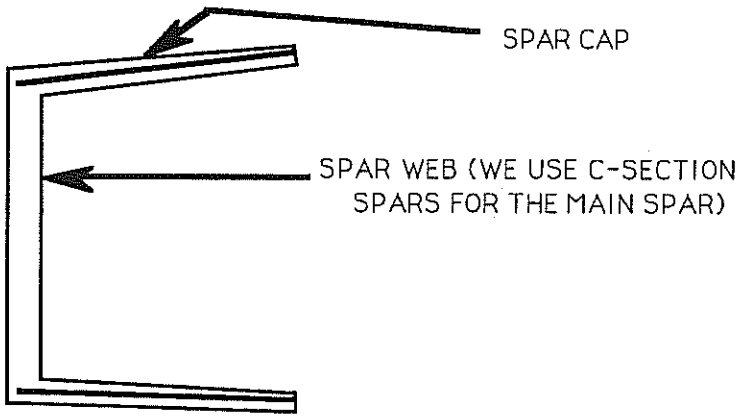
Micro / Micro-balloons: They are very small, thin-walled glass bubbles. Being extremely light for their volume, they can be added to resin to produce a very light-weight filler material that is easy to shape and sand. They are typically used with epoxy when closing out a piece of honeycomb core in a panel, etc.

Outbd: Outboard

Peel-ply: Molded parts are shipped with a protective coating of "peel ply" material on their inner surfaces. This material will interfere with bonding and must be removed. The peel ply usually sticks out from the edge of a part in at least one area and looks like white cloth. Where the peel ply meets and lays on the part surface it becomes transparent.

Shearweb (or just "web"): Typically the part of the wing spar that runs vertically.

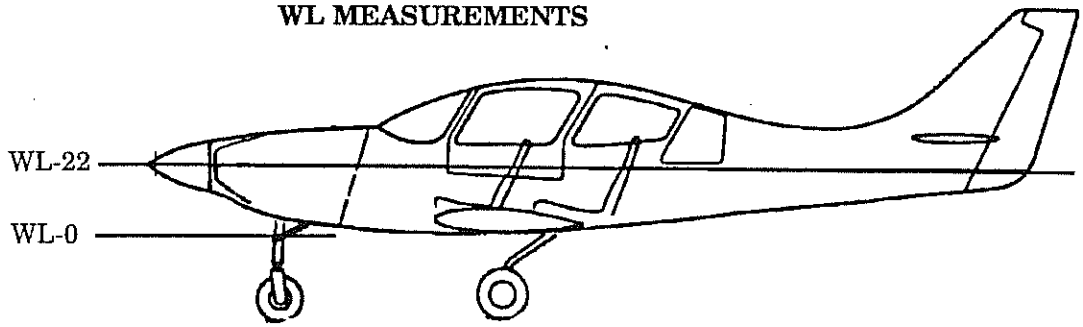
Spar showing cap and web
Figure 1-6



Spar cap: The top and bottom members of a spar, generally orientated horizontally. They are held in alignment by the spar's shear web.

Typ: Simply means "typical" when seen on a drawing.

WL (waterline) measurements
Figure 1-7



WL: Water Line. Refers to an imaginary point that is level with the fuselage and used for locating vertical points typically along the fuselage. With the Lancair IV, water level 22 (WL 22) is the engine thrust line for the Continental 550 engine installation. The bottom of the fuselage is WL 0.

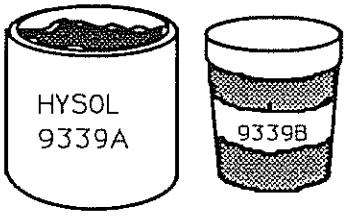
4. EPOXIES

CAUTION: During aircraft assembly, two types of bonding systems are used: A "laminating epoxy" and a "structural paste adhesive". These materials can not be used interchangeably and the mixing ratios, handling techniques, etc. are completely different from each other thus they must not be confused or substituted without approvals from Neico Aviation.

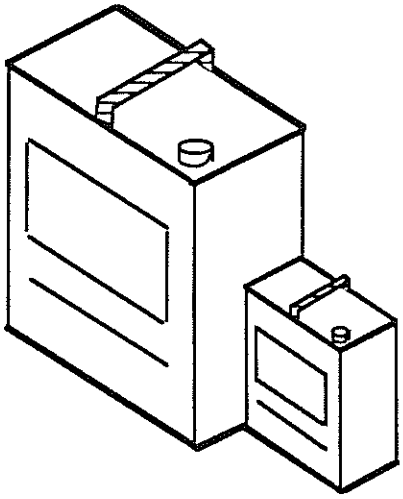
Structural and laminating epoxies

Figure 1-8

Structural Adhesive



Laminating epoxy
(may also be supplied in pails for larger amounts)



NOTE: Although Hysol 9339 is illustrated on the left, other structural adhesives may be supplied instead of this type. Mixing ratios will also differ.

WARNING: BE SURE TO CHECK FOR PROPER MIXING RATIOS OF STRUCTURAL ADHESIVES SUPPLIED. FAILURE TO PROPERLY MIX STRUCTURAL ADHESIVE PROPERLY COULD RESULT IN BOND FAILURES.

A. Structural Adhesive

These are "paste" type epoxies and are considerably thicker than the laminating epoxy. They are mixed by weight using an accurate ounce scale. Instructions for general mixing are provided. These structural adhesives are primarily used for the bonding of overlapping "joggle" joints in premolded parts, but are not used exclusively for this purpose.

B. Laminating Epoxy

These are much thinner epoxies which are used for saturation of fiberglass cloth or "BID" tapes. The laminating epoxy is also used with micro and flox as filler material for specific applications. An epoxy "pumper" is suitable as a means of dispensing measured amounts of part A and B of these epoxy systems.

Shop & floor area

Since parts will likely be placed on the floor occasionally, oil, grease and dirt must be removed from the floor to prevent contamination of the parts. Many builders use old carpeting on the floor in work areas. The carpeting not only covers the soiled concrete floor, it is also much more comfortable to stand on for extended periods of time. A word of caution, though. When you get to the point in building where you are working with the electronics, be aware that static electricity can destroy much of your gear if small precautions are not taken. One of the most effective anti-static floor sprays (and certainly one of the cheapest, too) is to put a couple of teaspoons of regular laundry style fabric softener (any of them will do) in a spray bottle, fill the bottle with water, and spray the carpet once or twice a week lightly, as needed to control the static.

In addition, a second work bench is very handy for making subassemblies, etc. Make such a bench or benches to what ever size is convenient.

6. BASIC SHOP TOOLS

The tools listed are not mandatory for your shop, but we have found them extremely useful in ours. The tools we feel are most important are marked with an asterisk (*).

You probably won't be familiar with some of the tools listed, but the purpose and description of these items will be explained.

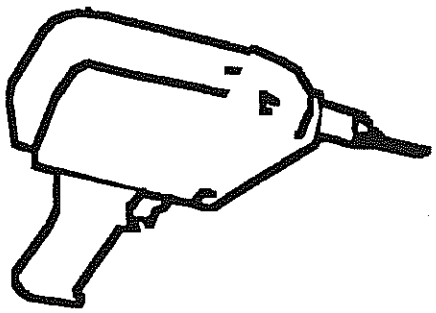
- **Saber jaw (jig saw)**

Very handy for cutting out large or complex shapes from pre-preg material. You can use a manual saw, but it won't be fun. Or a very pretty sight. Either way, be sure you get sharp blades, and change them often. Dull blades will chew up the edges and make for more sanding/smoothing work later. We use carbide tipped blades exclusively for composite cutting. They work great.

- **Hand drill or drill motor***

Most of the material you would have to drill on a glass kit is fairly soft and thin, and should require no more than a small drill motor with at least a 3/8" chuck. If you don't already have one, go buy one with a variable speed (variable, not two speed), and get one with a 1/2" chuck. The extra couple of bucks they cost will be worth it in the long run, and some of the stuff you need to drill, like plastic parts, must be drilled at a very slow speed that is below the range of all single and most two speed drills.

Drill motor
Figure 1-11



- **Drill press**

Here's a tool that most people don't have, but no one that's ever had one will be without again. For precision drilling it is a must, for instance in drilling out broken bolts, and it can be used with a fly-cutting tip for cutting holes large enough to amaze your neighbors. I wouldn't run right out and buy one just for building the plane, but I would make friends with that guy down the street that has one gathering dust in his garage.

- **Drill bits (Numbered AND Fractional)**

It takes a lot of cheap drill bits to make a lousy hole that one good bit could have made quickly and perfectly. If you have a vault to keep them safe in, bite the bullet and buy a good set of numbered drill bits. If cared for, they will last you longer and give you better service than your foreign made car. Unfortunately, a good set will seem to cost about as much as that car.

- **Rotary sander (rotary or orbital type)***

This I would go out and buy for building a kit plane, unless you want arms like Arnold Schwarzeneggar. It will definitely make sanding and smoothing the rough edges a lot easier, and a good orbital can be had with a trapper bag to keep a lot of the "stuff" out of the air. And your clothes. And your nose. And everywhere. We don't use one with a bag here, which is why sometimes even in July it looks like it just snowed in the shop.

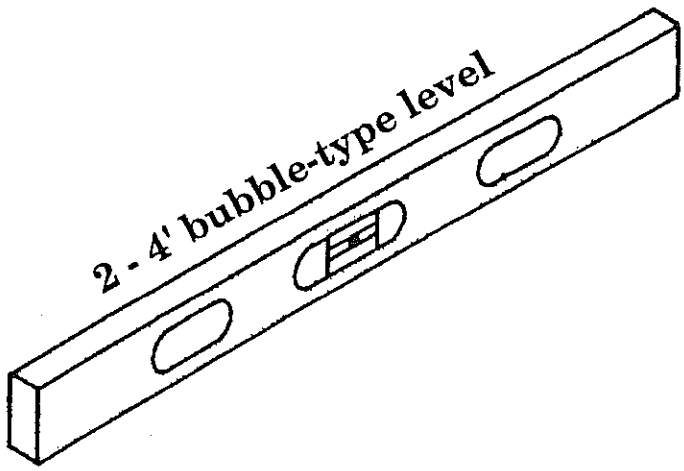
- **Die grinder (angle grinder)**

If you have one, bravo. This is a powerful tool that can custom fit your ribs and bulkheads quickly. Be very careful though, if the high speed grinder surface gets away from you, it can quickly customize everything in the general vicinity. While not a necessity, if you have a used tools store in the area, it would give you an excuse to browse around.

- **2 & 4 ft. carpenter's levels**

If you want a plane to fly straight, you should build it straight. These are indispensable in a good shop. Get the good aluminum ones (you'll be holding them up, down and at various angles in between for hours at a time), make sure they start out life in your shop with straight edges, and round the sharp ends a bit so you won't gouge any holes into precious prepared surfaces. Just little easily filled dents.

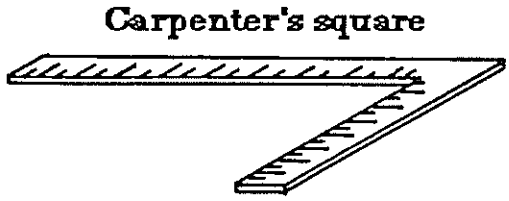
Carpenter's level
Figure 1-12



- **Carpenter's square**

Buy this when you get the carpenter's levels, and for the same reason. Don't round these ends, just be careful.

Carpenter's square (framing square)
Figure 1-13



- **Clamps** (Vice grip clamps, spring clamps and "C" clamps)

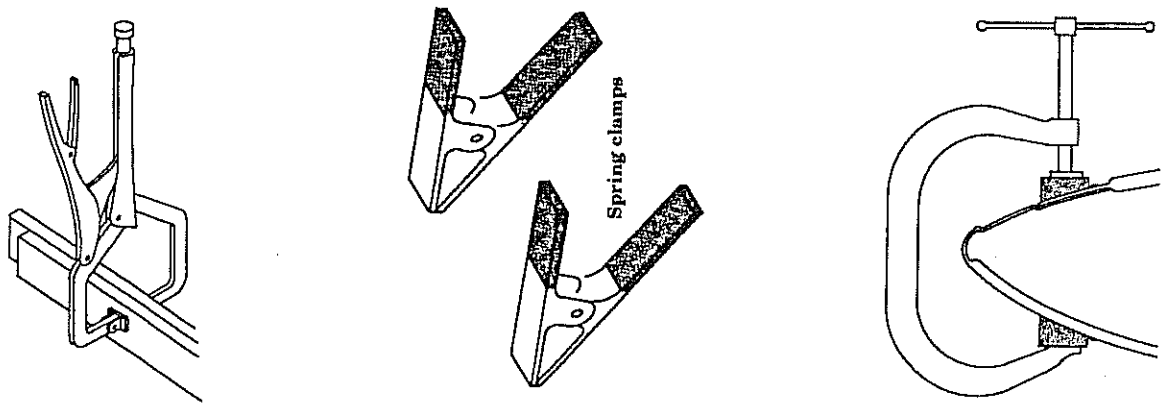
Here's the clamps you need.

A couple of the vice grip clamps for really forcing things together (never - stress again, never - use these on any fiberglass, prepreg or carbon composite parts. They grip with enough force to do great damage to the parts, which may not be visible to the naked eye.).

Spring clamps - get a bunch of these when you wander through the used tool store. Three or four large ones like Arnold uses for strengthening his grip, and about a dozen that you can work with one hand while you try to hold the six other parts in exact proper position with the other.

"C" clamps. These should be in the bin next to the spring clamps in the used tool store. If there is an assortment, get three or four of each. Again, use caution when applying these to any glass parts. Tighten slowly, and only until just snug. If you hear any cracking and popping when putting these on, remember who has to fly in what you have just damaged.

Clamps, assorted
Figure 1-14



Now that you have clamped the parts together and drilled the holes, the instruction book tells you that you need to insert pop rivets. The best thing to do this with is a pop rivet tool. The second best thing to do this with doesn't work. Get the pop rivet tool. It should come with three extra tips for use with all four common sizes of pop rivets, 3/32", 1/8", 5/32" and 3/16". Three cheap ones will get you through most any project, but a good one will last a lifetime. Get the good one. Besides, it's cheap if you buy it at that used tool store you've been spending so much time in lately.

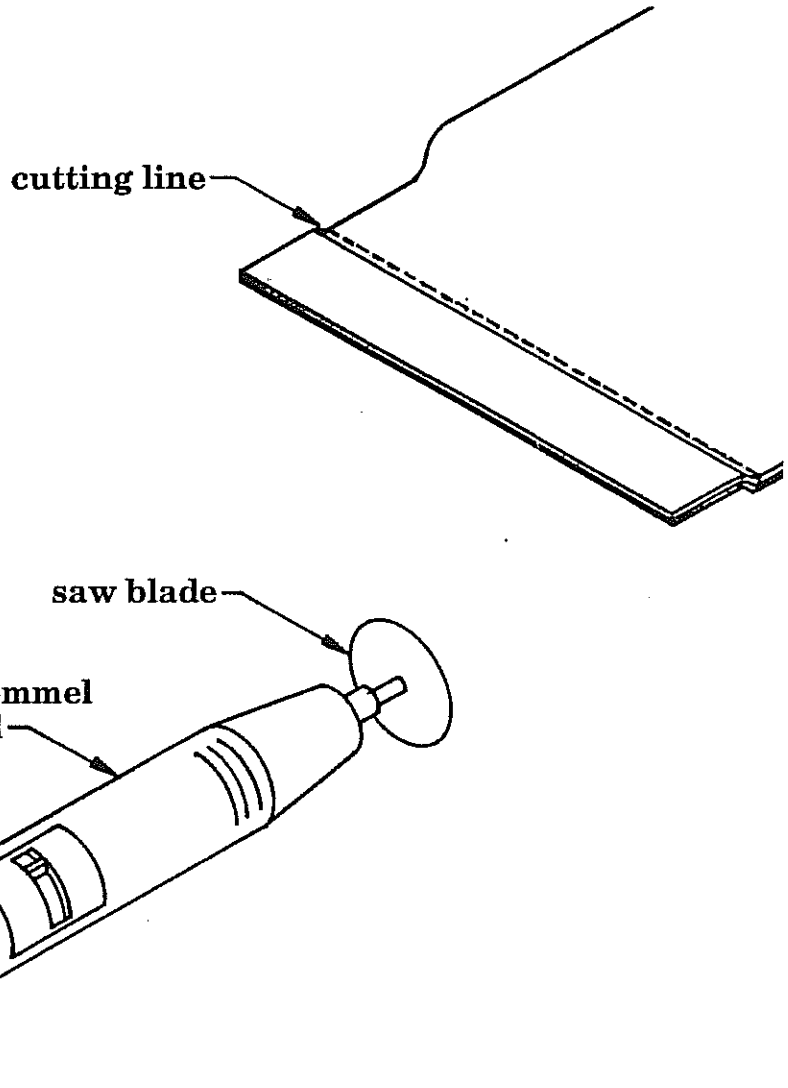
7. SPECIALIZED TOOLS

We called them specialized shop tools because it makes it a little easier to swallow the higher price tags on these items. Again, the tools listed are not mandatory for your shop, but we have found them extremely useful in ours. The tools we feel are most important are marked with an asterisk (*).

- **Dremel™ tool ***

The one we have shown here has a saw blade installed, but they come with a fantastic array of special bits (there's that special word again). We can't imagine building a composite aircraft without a Dremel tool. You'll use this tool more than any other in your growing collection.

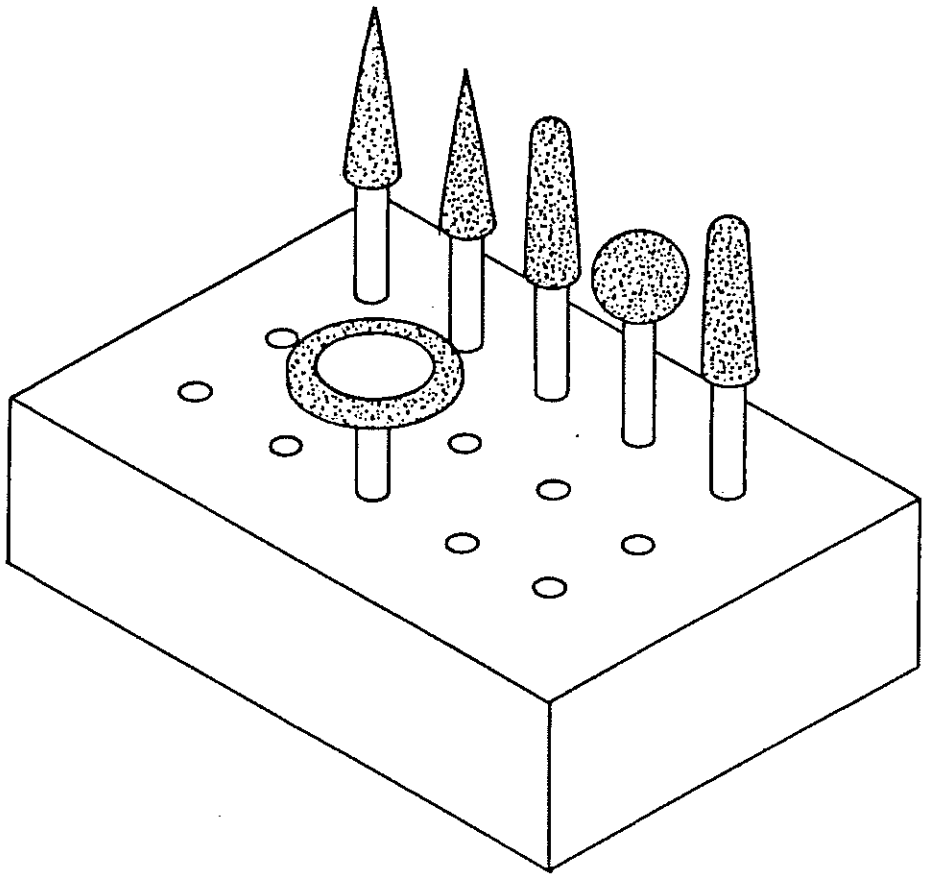
Dremel™ tool
Figure 1-15



- **Tungsten carbide bits for Dremel tool ***

During construction of the prototype IV we were in need of a Dremel bit that could easily cut carbon fiber. The carbon fiber is very easy to work with, but it eats power tool blades/bits for breakfast. Marvin LaBrot, a local 235 builder, suggested Dremel's tungsten carbide cutters. These bits come in various shapes and sizes, some Dremel part numbers to look for are 9931 through 9936. We now use these bits almost exclusively because they really cut. As long as you don't use them on aluminum or Kevlar™, which tend to gum them up, the carbide bits last a long time. They're expensive, though. We paid about $12.00 for a single bit, but they're worth it in the long run. For availability check hobby stores, hardware stores, Sears, etc. They offer cutting, grinding, buffing, polishing, etc. bits for this thing, too. If they have them at that used tool store, get one of each. You may never use them all, but they'll sure impress your neighbors. Especially if you make one of these snappy little holders to display them in. You can make it out of a piece of 2x4, drilling holes as you add bits to your collection.

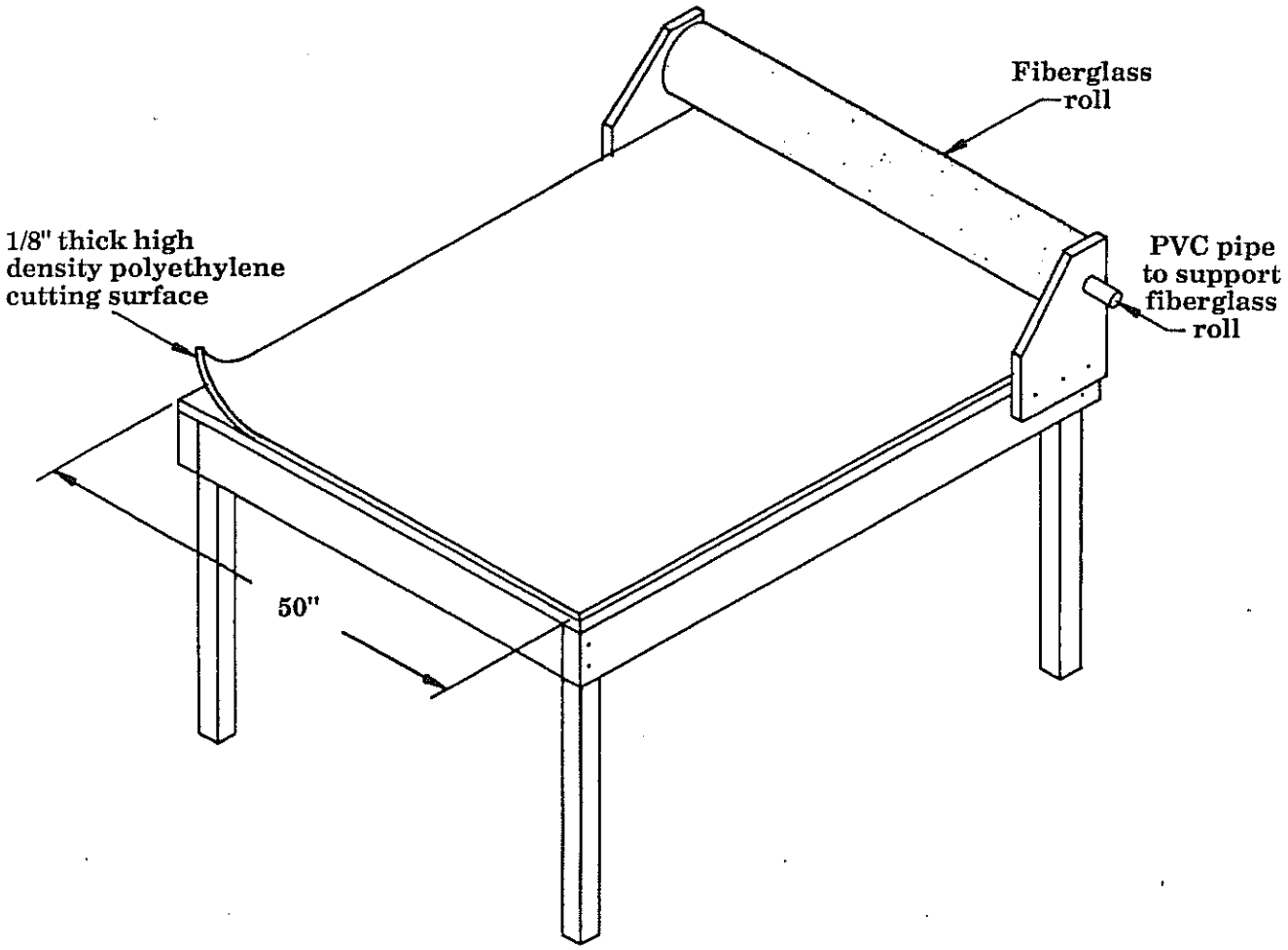
Tungsten carbide bits and snappy little holder
Figure 1-16



- **Fiberglass cutting table ***

No self respecting builder would be without one of these. We furnish complete detailed instructions a little further into this book.

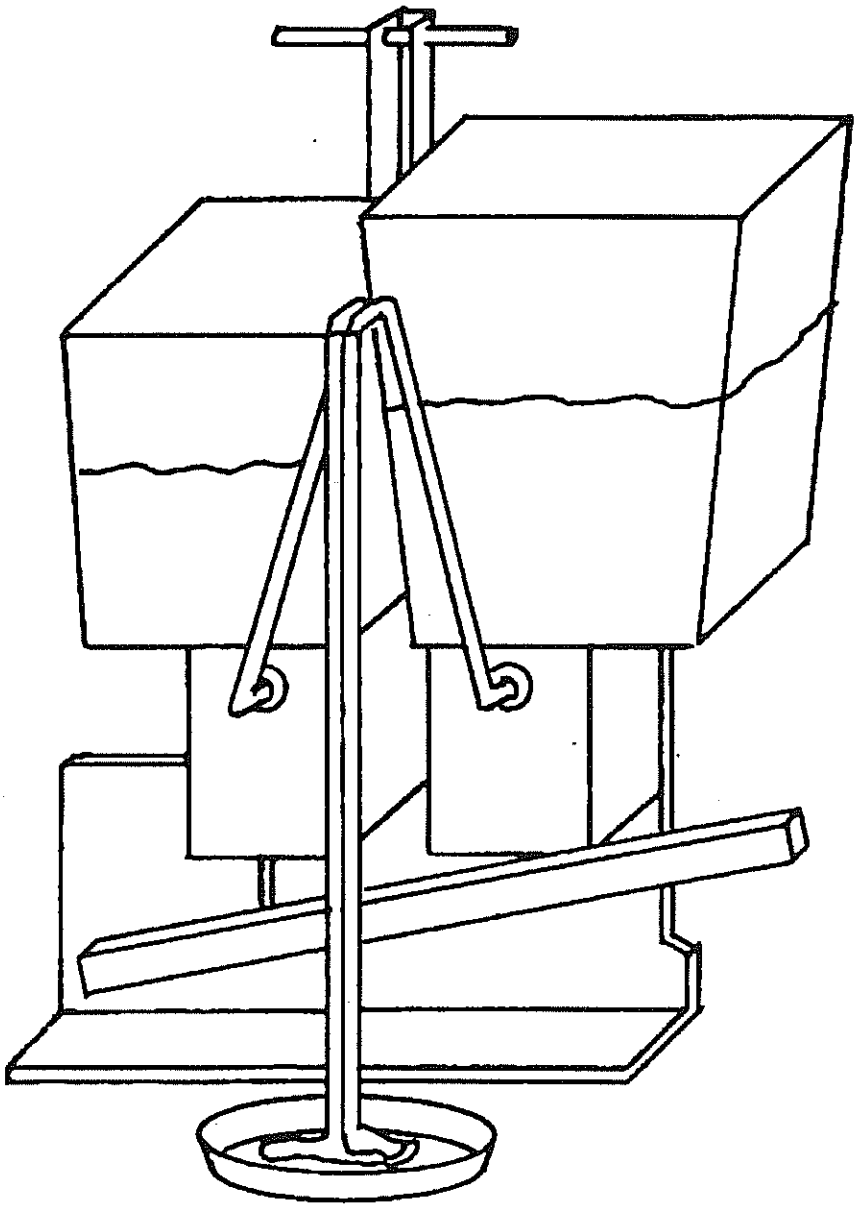
Fiberglass cutting table
Figure 1-17



- **Epoxy pump (Sticky Stuff dispenser) ***

The Sticky Stuff epoxy dispenser will pay for itself in saved epoxy. With every pump of the handle, you receive the proper amount of resin and hardener, no weighing, no measuring. With practice you'll know the proper number of pumps needed for the size of lamination you are doing. We offer this item in our catalog, and highly recommend it's use.

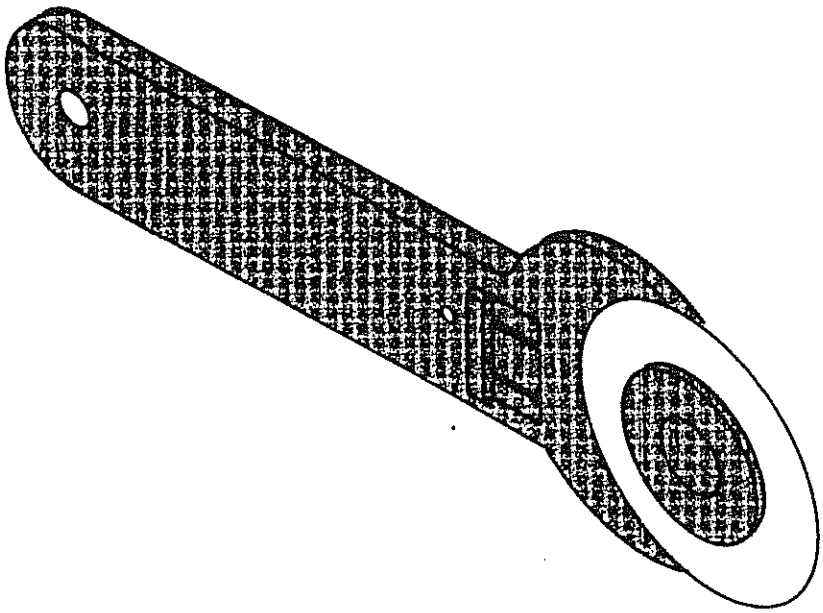
Epoxy pump
Figure 1-18



- **Roller blade for cutting fiberglass ***

Don't even think of using scissors to cut the fiberglass you've just unrolled on your new cutting table. That's like using a 1/2" brush to paint the Golden Gate Bridge. Use a roller blade (looks like a pizza cutter, but it ain't) and you'll cut the time you spend cutting cloth in half (at least!). These roller blades are available through Aircraft Spruce, Wicks, or your local fabric store. They sell under the names of roller blades, rotary cutters, and fabric cutters, but all models closely resemble each other. Pick up a couple of extra blades when you buy it and save yourself a trip later.

Roller blade
Figure 1-19



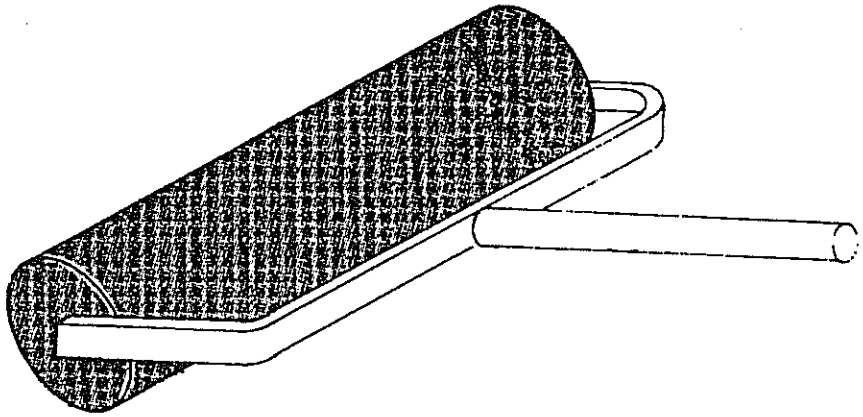
Here at Neico, our pet name for the roller blade was "Pizza cutter". As word spread to our builders of this handy tool, sure enough, we started getting complaints that these vaunted "Pizza cutters" didn't cut fiberglass worth a s@*t. Yes, they were using true pizza cutters, not actual blades. Sorry for the mix-up, guys, and abondanza!

- **2" wide paint roller (without furry part) or wallpaper roller ***

Another simple but handy tool in our shop is the roller. We use a small, 1 1/2" wide paint roller (without the furry paint sleeve), and a larger, 3" wide roller for pushing the air bubbles out from under laminates. Try sliding a length of PVC tubing onto the paint roller to get a smooth, hard rolling surface. Common paint rollers work okay, but we made a solid aluminum roller that works even better. Wallpaper rollers are also good for this application.

Smooth, hard faced roller

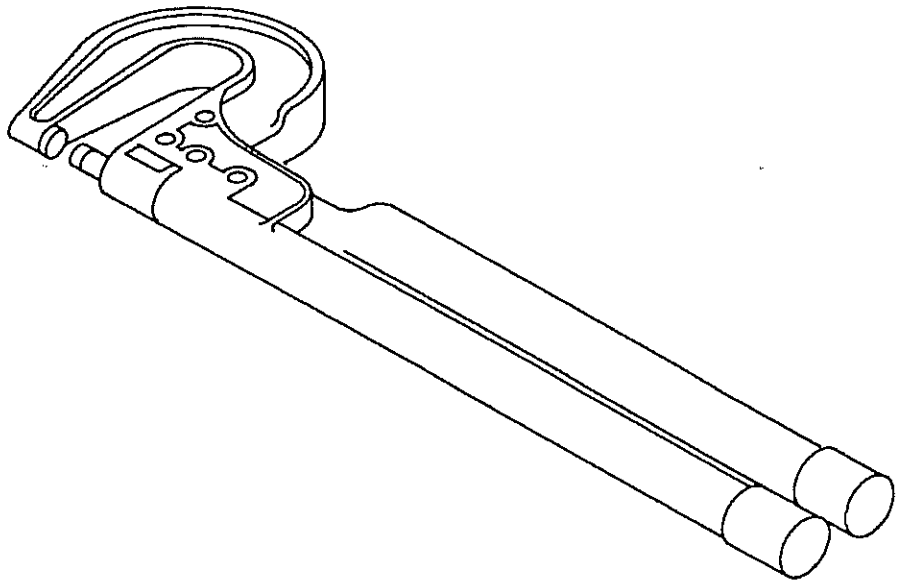
Figure 1-20



- **Rivet squeezer**

This tool will save hours whenever you are installing rivets. Next trip to the used tool store, get one of these, too.

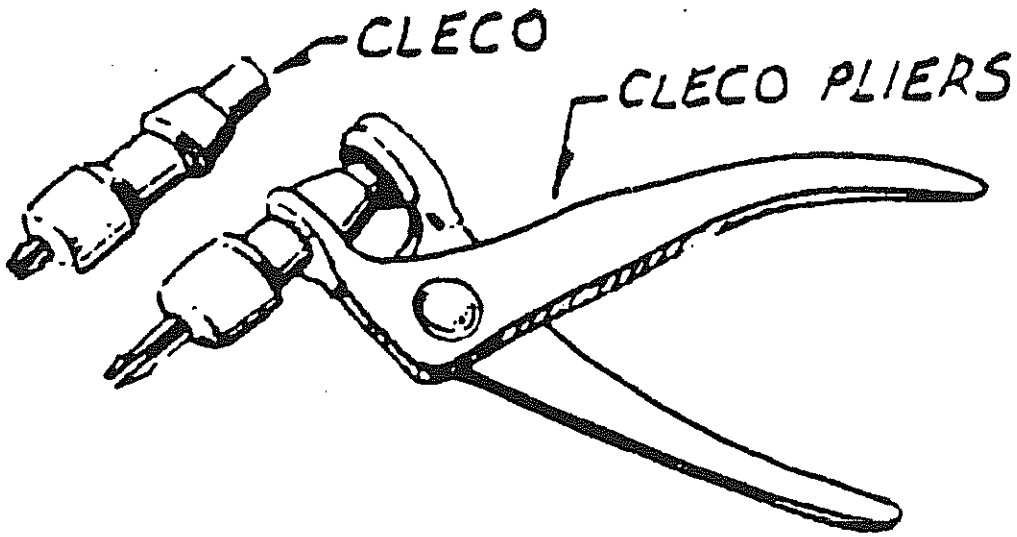
Rivet squeezer
Figure 1-21



- **Cleco™ pliers and clecoes***

These things are very handy. You should have the tool and about a dozen of the Cleco bits. We sell them, use them and recommend them to all of our friends.

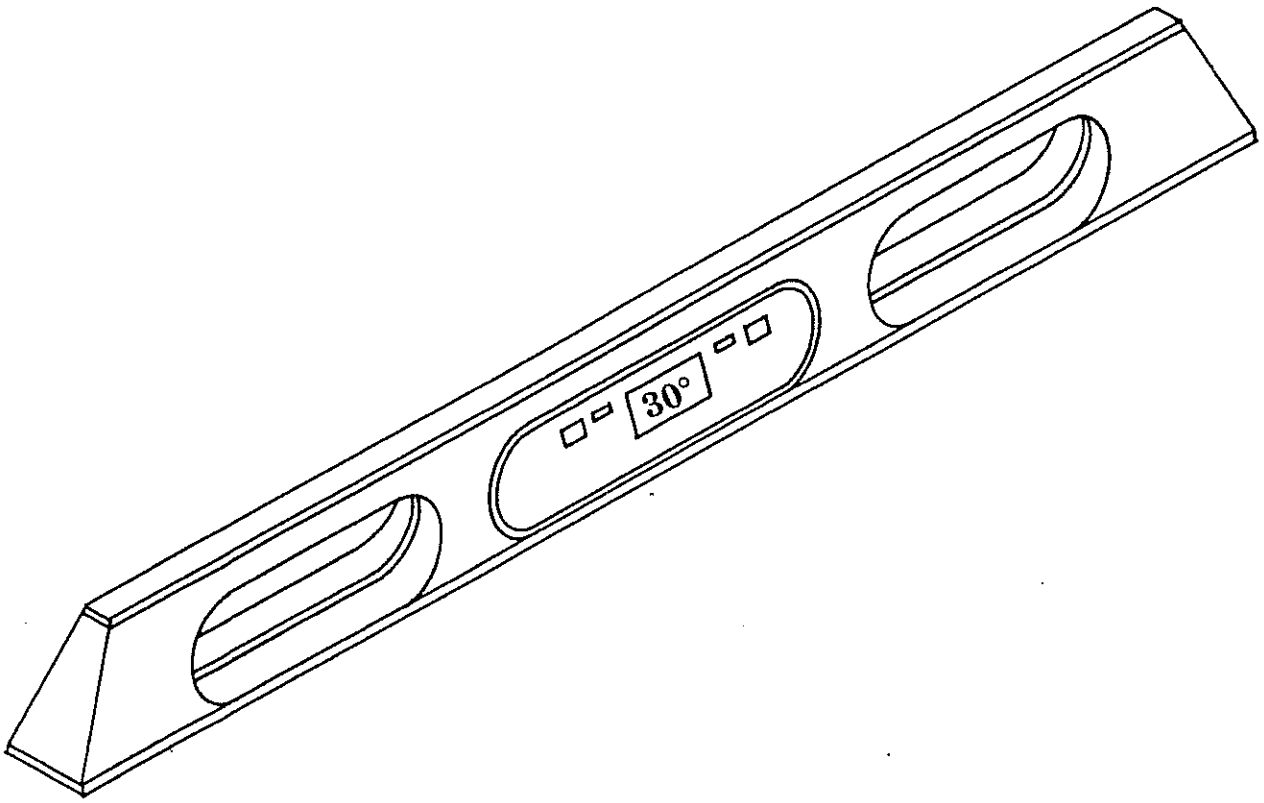
Clecoes and Cleco pliers
Figure 1-22



- **Digital SMART level***

You aren't very likely to find one of these at that used tool mart. Try calling the hardware store. The Smart Level is made by Wedge Innovations and has an LCD readout instead of a bubble. The center of the Smart Level pops out to become a small, six inch level that's extremely handy for measuring control surface throws, seat back angles, firewall angles, engine thrust lines, etc., all with an accuracy of 1/10th of a degree.

The SMART level
Figure 1-23



We've received a few inquiries where to buy Smart Levels. Superflite is one of a few mail order outfits that carry the Smart Level. It's not cheap, $90 just for the center module, progressively more expensive with the longer rails. This is a great tool, but always remember to re-calibrate the level module when you turn it on, otherwise you could be off by a couple of degrees.

SUPERFLITE
2149 E. Pratt Blvd.
Elk Grove, IL. 60007
1-800-323-0611

- **Tubing bender**

This will be there at the used tool store, where you should be on a first name basis with the owner by now. Tell him you just need one for 1/4" tubing. It should be in the bin right next to the 37° flaring tool.

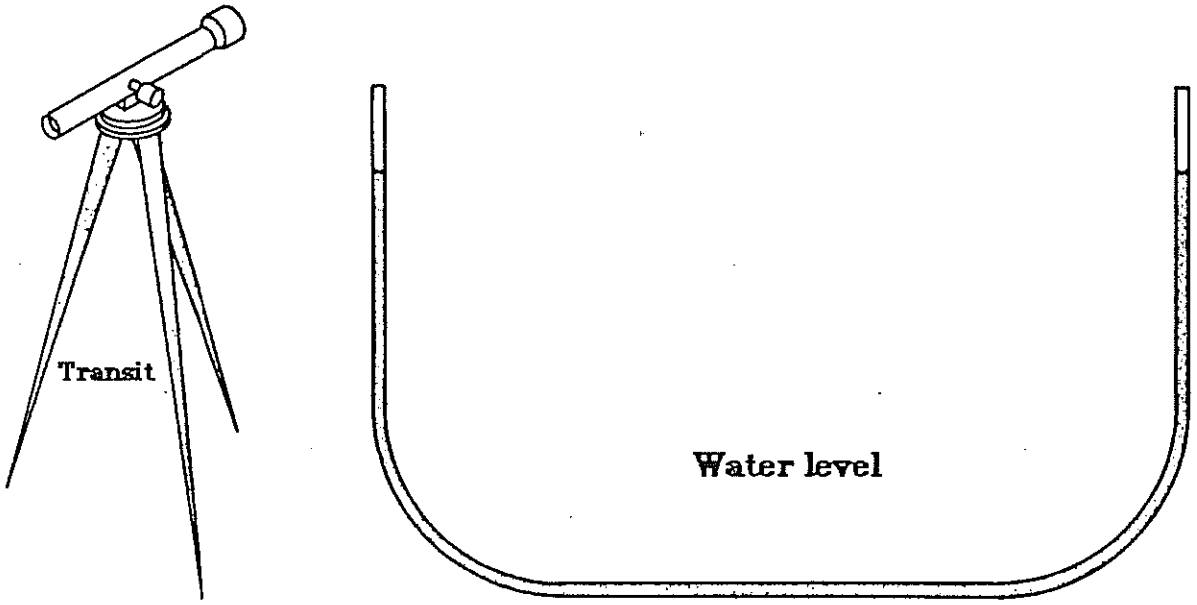
- **37 degree flaring tool**

Keep this with your tube bender. You won't need it often, but when you do nothing else will work. Don't use automotive type flaring tools - they have a different flaring angle.

- **Surveyors transit**

If you love gadgets, this one will be fun, but a water level would work just as well for a whole lot less money (just keep a mop around). It may save you an hour or two in set-up time, and can usually be rented from surveyor/construction suppliers. Like the water level, it still takes two people to use it effectively, but you can quickly level fuselages, wings, horizontal stabs and jigs, staying dry in the process.

Transit and water level
Figure 1-24



- Water level

A cheap and simple means of checking wing washout, horizontal stab position, and other big jobs on the airframe. We use 1/4 inch I.D. clear tubing, available at the hardware store. I've heard that dying the water in your water level tube with food coloring can make it easier to read, but when I tried it, the coloring didn't help much, it just messed up the tube.

- **Plumb bob***

These should be laying around the tool store somewhere. Since you will be (hopefully) working indoors out of the wind, you will only need a small one for measuring things for vertical.

- **1" Makita belt sander**

A real handy item, you might score one of these at the local tool shop (isn't your wife starting to wonder about all the time you've been spending there lately?). Get an assortment of different grit belts for it, they'll all come in handy before this is over.

- **Heat gun**

If you have one of these, it can help to warm a couple of parts you want to bond, to straighten a warped part or a lot of other jobs. It can also destroy parts if care is not taken. Take care when using. The heat gun is a well used tool in our shop, not only for heating parts but for gently heating slow to cure epoxy, shrinking "heat shrink tubing on electrical connections, etc., etc..

8. SUPPLIES

- **1 mil thick plastic drop cloths**

You can use a lot of these. Fortunately you can probably get them at most hardware stores for about a buck a roll. They're not only great for covering things, but you'll be using them in the preparation of BID tapes and other fiberglass layups. Get several, but be sure they are all the 1 mil thick ones. Thinner, and they won't be easy to handle, thicker and they will be to hard to work with when we do the BID tapes. More about that later.

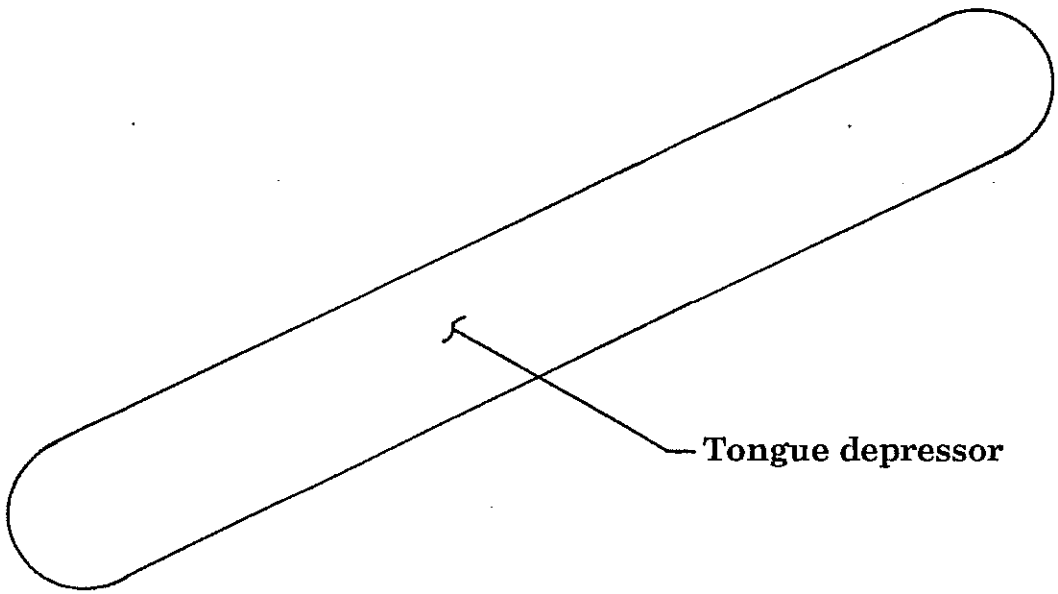
- **Paper towels**

If you have a lot of storage room, buy these by the case. If not, keep at least 3 or 4 rolls on hand. You'll be using them for cleaning up a lot of drips and dribbles of this and that, as well as using them for some other trick things we'll talk about later in Chapter 5.

- **Tongue depressors**

We supply these in the kit, and there should be enough to complete the project with a few left over. You'll be using them mostly for mixing sticks to mix up the epoxy you pump from your nifty Sticky Stuff epoxy dispenser (you do have that on order now, don't you?). You will also be shown how to make a neat little tool out of one later, that you will want to cherish and hang from a special hook on your shop wall.

Tongue depressor
Figure 1-25



- **Brushes (1" wide)**

These too are supplied in the kit. There's a whole bunch of them in there, but don't give them away, you'll need most of them for the project.

Brush, 1" wide
Figure 1-26

- **Rubber squeegees**

Hit the auto parts store up for a set of the plastic Bondo™ smoothing paddles - there should be 3 or 4 different sizes in the package. They will all come in handy for getting excess epoxy and air out of layups, applying and smoothing out micro, and any number of other things. They clean pretty easy and should last through the project.

- **Sandpaper (40-320 grits)**

You will need a lot of the 40 grit stuff for working with the wing ribs, all the spar webs, etc. Nearly every time you have to apply epoxy or BID tapes to something, you will have to rough it up with 40 grit first. Get some for your belt sander, your sanding blocks, put it everywhere. You'll use all of it. The other grits you can just get a couple of sheets of each and set them aside for a while.
If you can find it, 3M Production Paper Sheets are the best we've seen for preparing fiberglass/carbon fiber. The sheets start out life as 2 3/4" x 17 1/2" and are meant for longboard sanders. By cutting them in half, they fit perfectly into most rubber hand sanding blocks. 3M calls them "The Green Corps" and, of course, the paper is green. Auto body supply and auto paint stores should carry it.

- **Instant glue**

You'll find some of this in the kit, and it will come in handy for many of the steps called out in the manual. You can use it to temporarily tack most any parts together, it is void-filling, and it can become permanent if you use too much. Just a drop or two will suffice for any of the steps in the manual. You can use it to glue piano hinge in place for test and measuring when clecoes would get in the way. You can test the placement of brackets, you can find your wife using it to repair broken fingernails, you can lose it to the rest of your household if you don't keep it hidden somewhere. If they do get it, just call us. We keep it in stock, along with the accelerator spray.

- **Instant glue accelerator**

The ultimate stuff for impatient people, this makes instant glue even faster (more instant?). A quick spray of this stuff and the glue is set, right now.

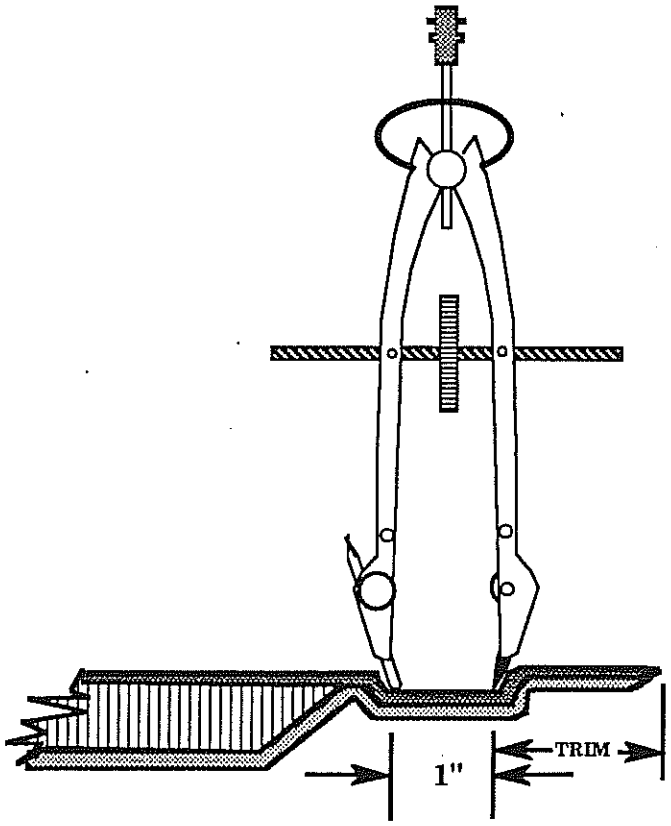
9. CONSTRUCTION METHODS
A. Trimming molded parts

This section describes an easy method for trimming the single and double joggled surfaces you will find on many of the parts to be assembled. We will use the horizontal stabilizer as an example.

CAUTION: EDGES OF PARTS MAY ME SHARP, HANDLE WITH CARE, USE GLOVES, OR FILE OR SAND OFF SHARP EDGES.

Place the top of one wing on a convenient working surface. Mark a line on all single joggled surfaces as shown in figure 1-27. On double joggled surfaces (wing leading edges only), mark a line as shown in figure 1-28.
If you happen to have a drafting compass lying around, reverse the centering pin so the blunt end is out, and adjust the compass for the proper dimension. See figure 1-27.

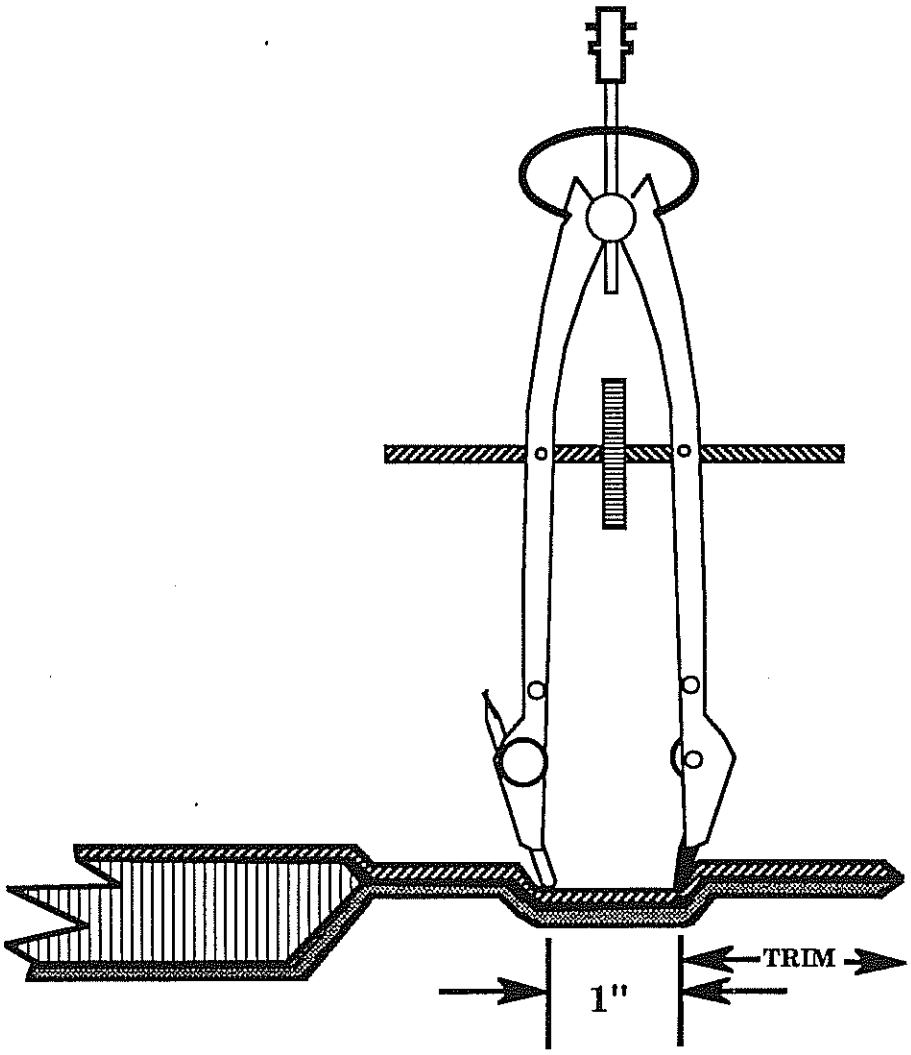
Trimming joggle
Figure 1-27



Marking trim line, Single Joggle

NOTE: Joggles should always be overlapping 7/8" to 1". It is a good idea to initially trim the joggles slightly oversize, then sand them down straight and to the proper width. **Don't trim any joffles at this time, wait until you get to the proper chapter and are instructed to do so.**

Marking joggle with compass
Figure 1-28



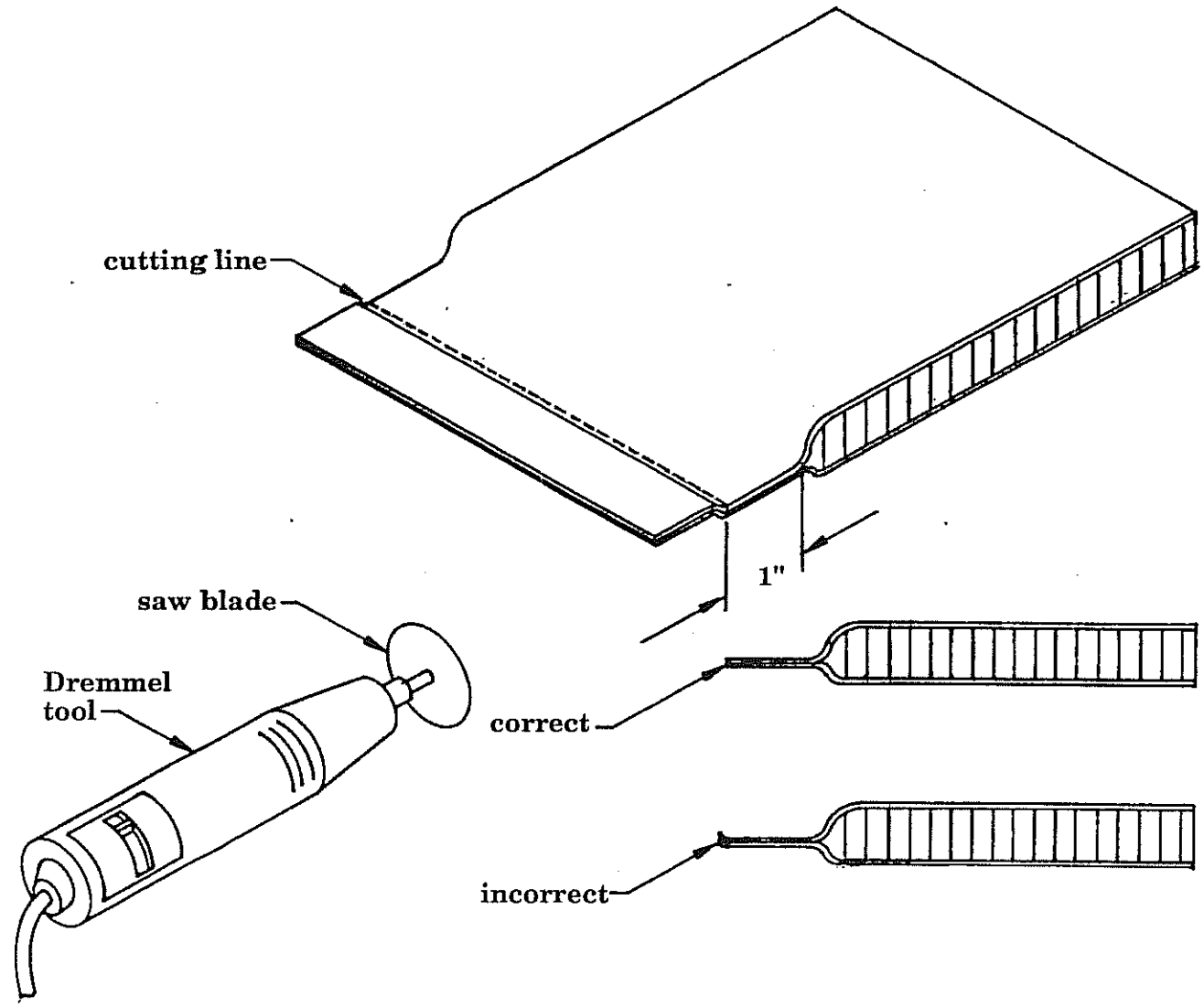
Marking trim line, Double joggle

Use a Dremel tool with a cutting wheel, or saber saw to cut along the lines. Refer to figure 1-29 for proper appearance of the edge after trimming. If necessary, trim additional material to obtain correct edge shape. Sanding may be used for a final trimming and to smooth the edge.

Unless called out otherwise in the instructions, you can use this trimming procedure for all joggles.

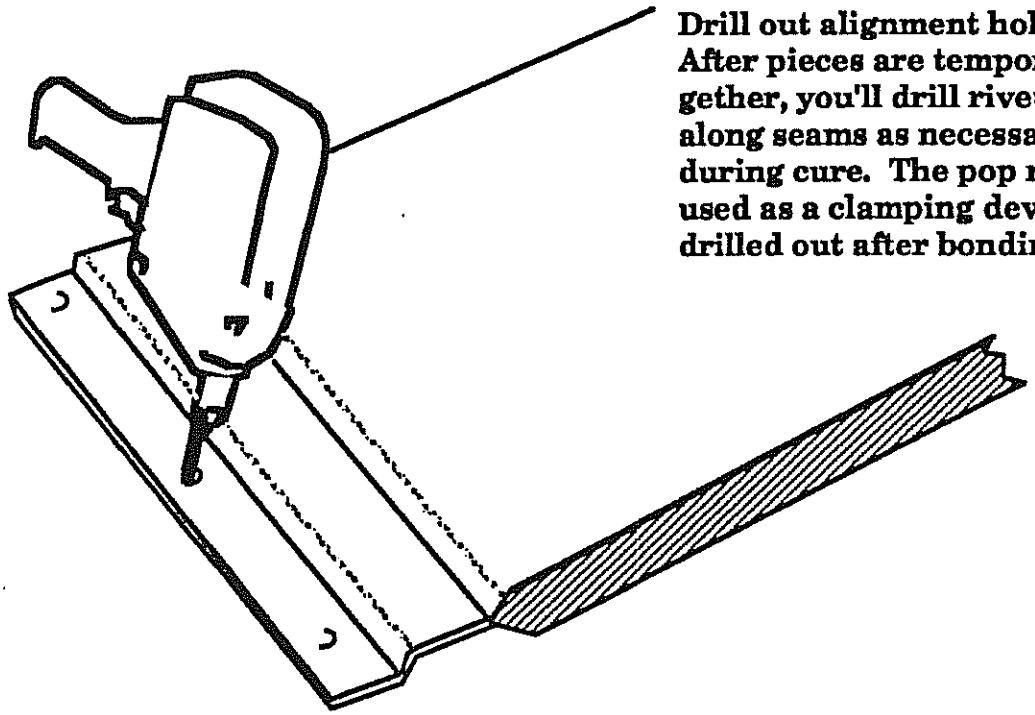
Drilling alignment holes: To achieve and hold proper overlap of parts during bonding, you first place the parts to be bonded in their exact proper position and drill alignment holes through the joggles of both parts simultaneously.

Trimming joggle
Figure 1-29



Use a 1/8" drill bit to drill the alignment holes (see example, figure 1-30).

Drilling alignment holes
Figure 1-30

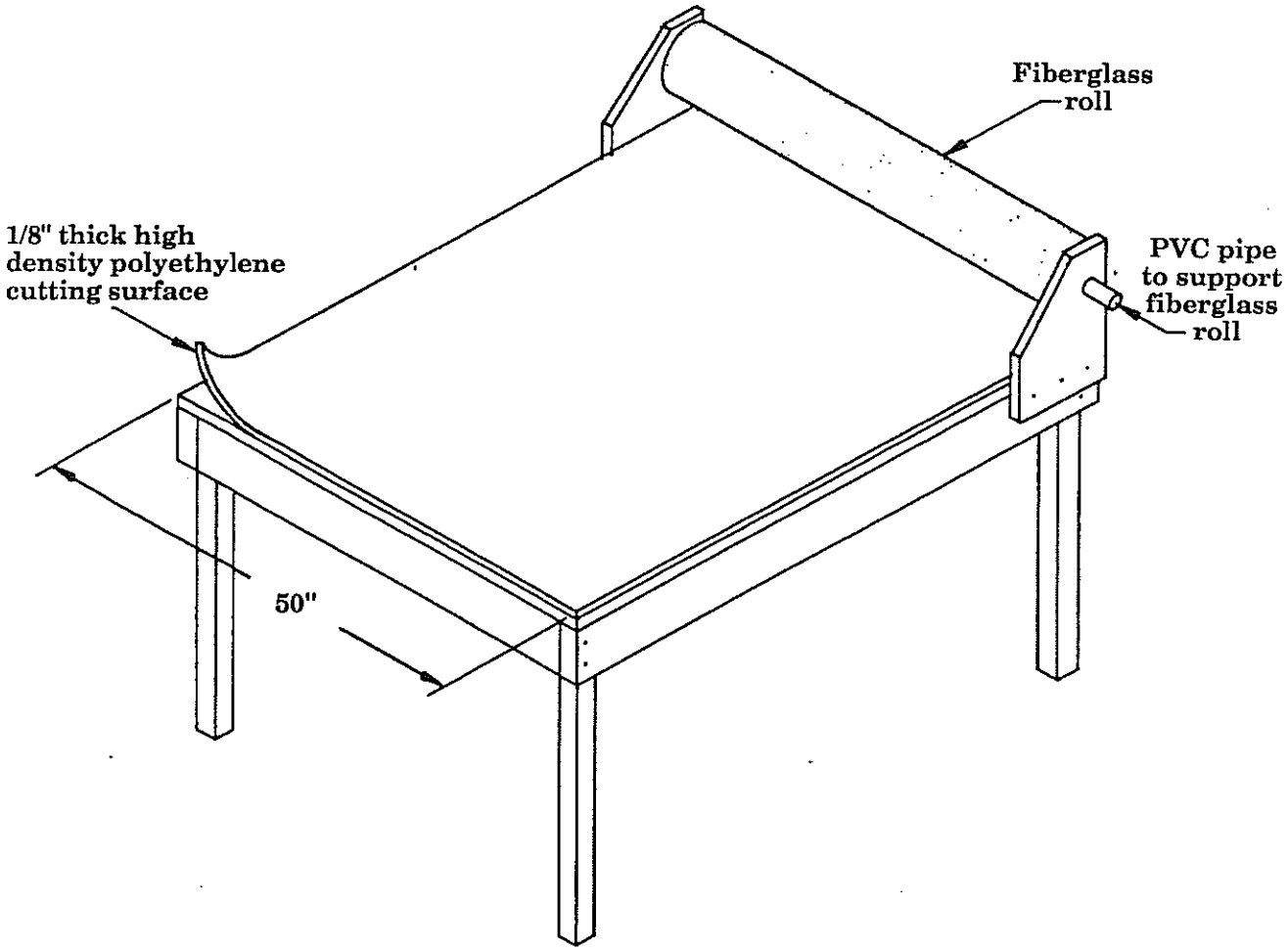


Drill out alignment holes with 1/8" bit. After pieces are temporarily clecoed together, you'll drill rivet holes (1/8") along seams as necessary to hold parts during cure. The pop rivets are only used as a clamping device, and will be drilled out after bonding.

NOTE: Please keep in mind that this is a general information section. Don't drill any alignment holes until your parts have been aligned later in construction.

Cutting table

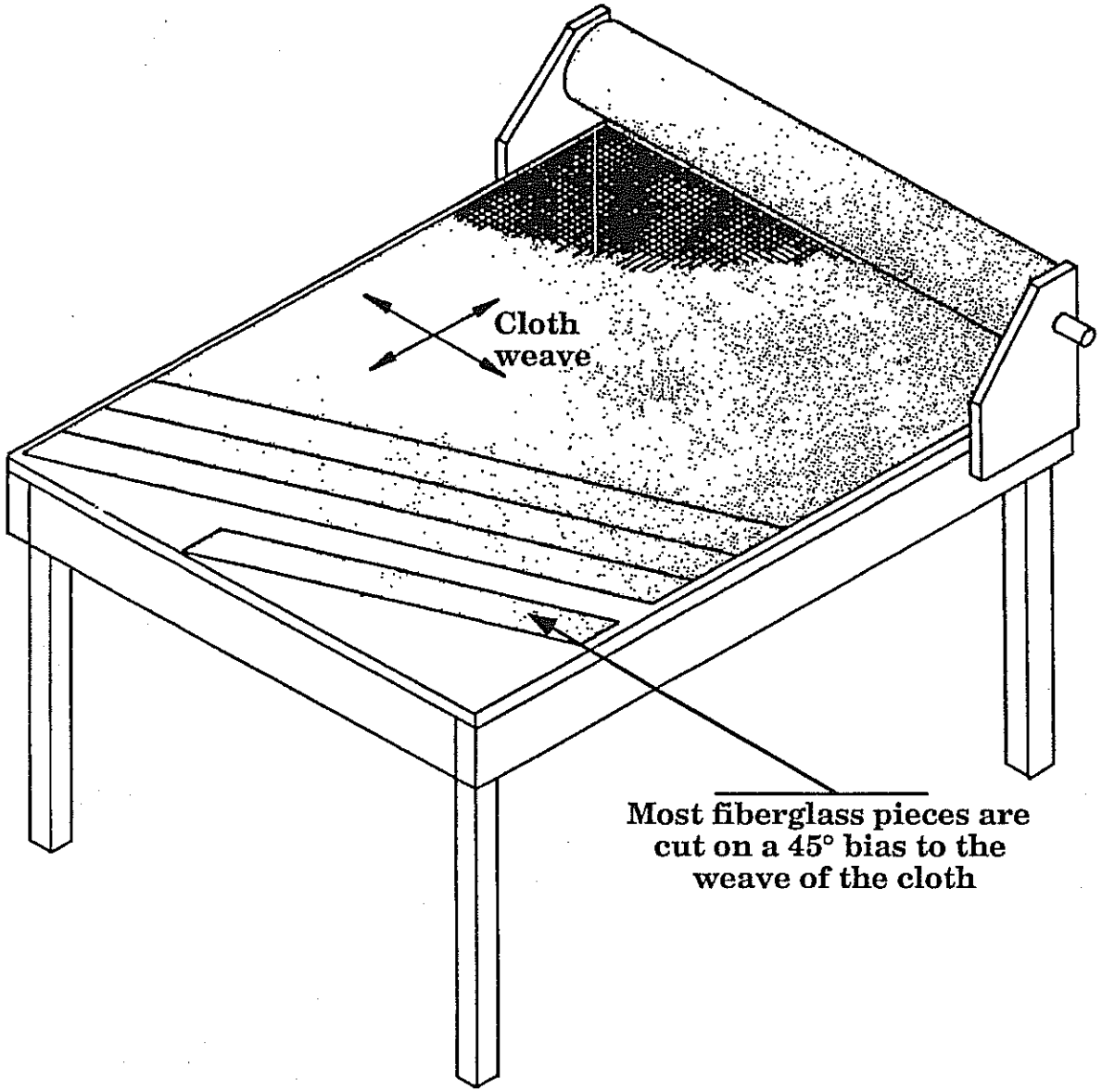
Figure 1-31



D. CUTTING ON A BIAS

When cutting your cloth with that wonderful roller blade, please pay attention to the weave bias specified for the part you are glassing. There are very few fiberglass parts in the Lancairs that are cut on a 0 degree bias. Nearly every piece of fiberglass you apply will be cut on a 45 degree bias. The weave orientation arrows in the construction manuals are there for a reason, please use them.

Weave orientation
Figure 1-32

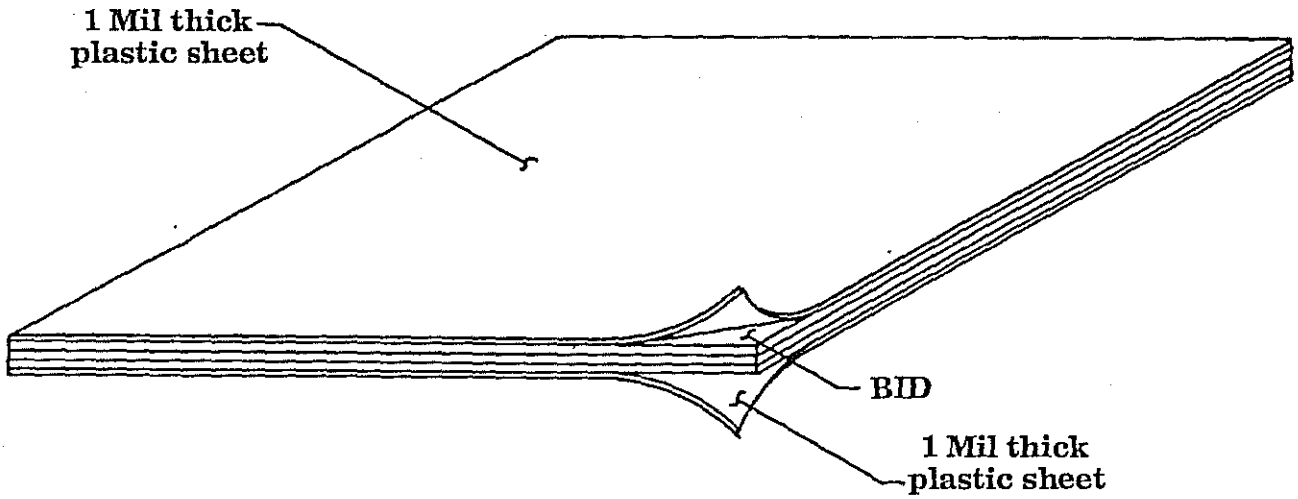


E. THE PLASTIC SANDWICH

This method of wetting out cloth is simple and invaluable. Many hours can be knocked off your project by using this technique.

At the hardware store, buy a few rolls of 1 mil thick, plastic drop cloths. Cut two sections of plastic bigger than the piece of fiberglass you are about to apply. Tape one piece of the plastic to your fiberglass cutting table and lay the fiberglass piece (up to 4 BID thick) on the plastic. The cutting table provides an excellent surface for this technique. Wet out the fiberglass cloth with plenty of epoxy. Gravity is your friend, it will allow the epoxy to soak down through the layers of cloth. No need to stipple the BID with a brush, just lay the other piece of plastic over the wetted out cloth and roll the air bubbles and excess epoxy out of the laminate. See the next section for more information on rollers and rolling techniques.

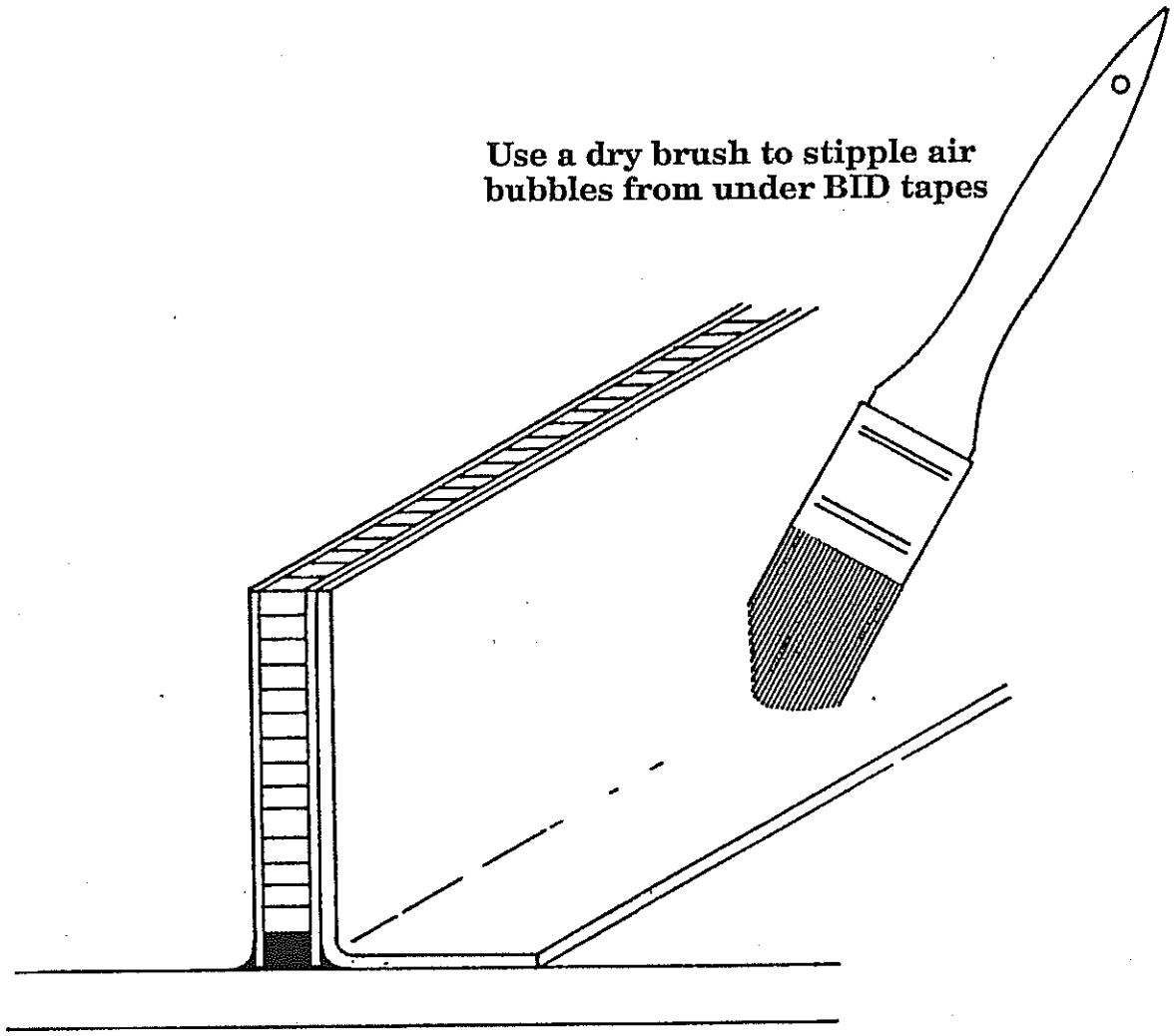
Plastic sandwich method of wetting cloth
Figure 1-33



Using a roller blade, cut out the shape of the laminate you need. Remove the shape. See how easy the piece is to handle with the plastic on both sides? Peel the plastic off one side of the sandwich and lay the laminate in position (of course you've already prepared the surface by sanding, cleaning, and painting on a light coat of epoxy). **PLEASE DON'T APPLY THE LAMINATE WITH THE PLASTIC SIDE DOWN, STRUCTURAL INTEGRITY WILL BE COMPLETELY LOST.**

Applying plastic sandwich laminate

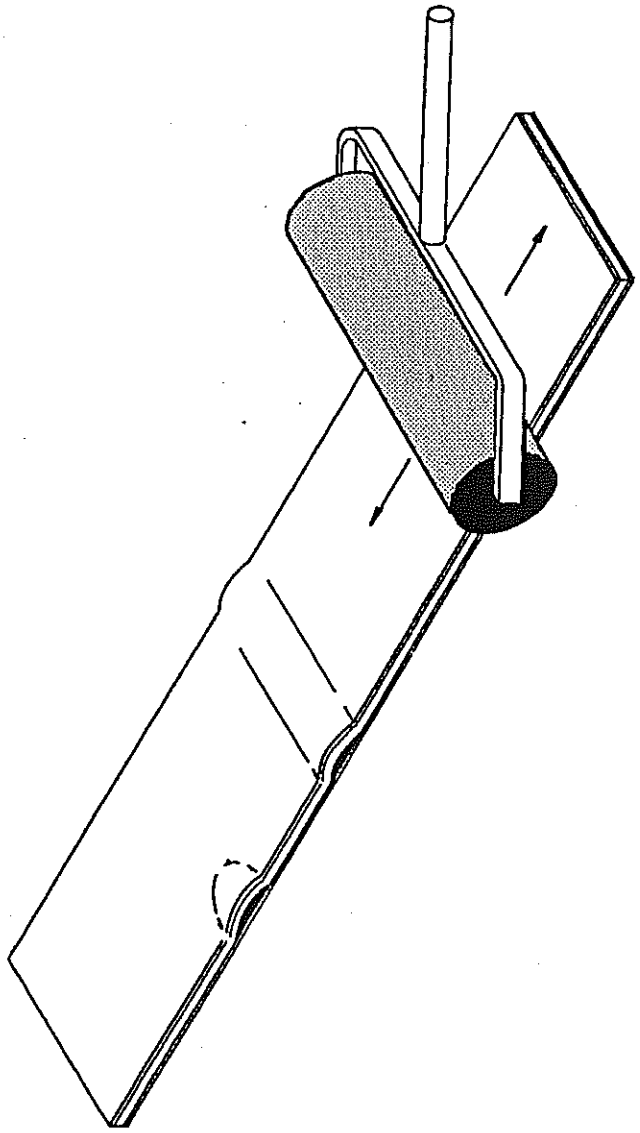
Figure 1-34



Stipple or roll against the side of the laminate still covered by plastic to squeeze the air bubbles out from underneath. Remove the remaining piece of plastic. You should now have a bubble-free laminate with a good epoxy content. A little extra stippling might be necessary if air bubbles were formed when you removed the plastic. Easy, right?

Using rollers to remove air bubbles (and excess epoxy)

Figure 1-35

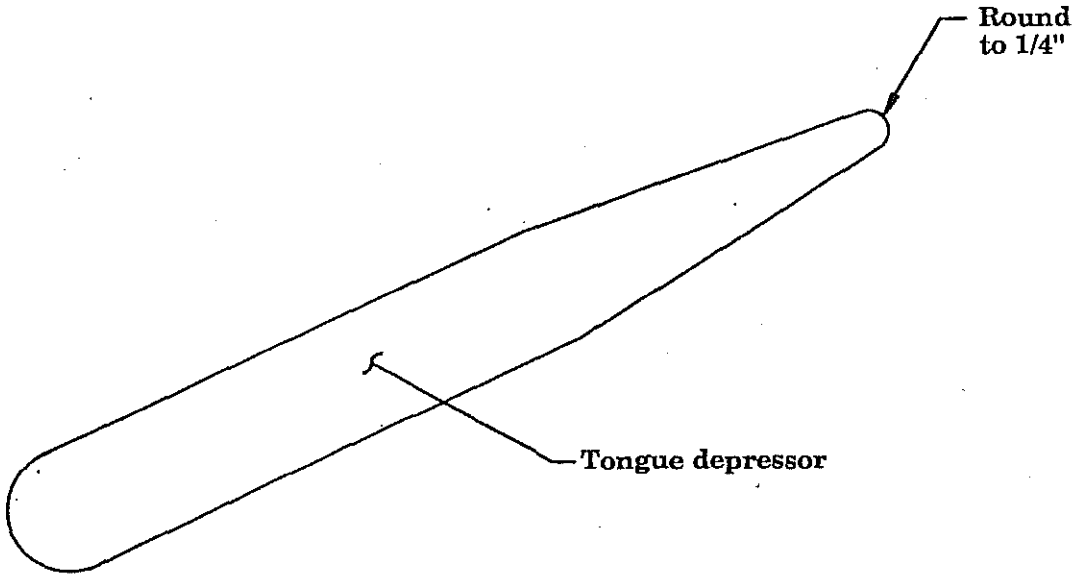


When using the plastic sandwich method of wetting out your fiberglass, simply roll out the bubbles from between the plastic and you have an air free laminate. Peel off one side of the plastic and apply the laminate to whatever you're working on. Before you peel off the second layer of plastic, use the roller to help push the air out from under the laminate. This works especially well on flat laminates, such as capstrip releases on the wing skin.

F. TONGUE DEPRESSORS and MICRO RADII

Someone asked me recently what was the most important tool in the Neico shop. Let me think, the milling machine, the high capacity air compressor, the super-trick mini grinder? Naw, the tongue depressor. That's the most important tool. But not just any tongue depressor, the Neico special modified tongue depressor.

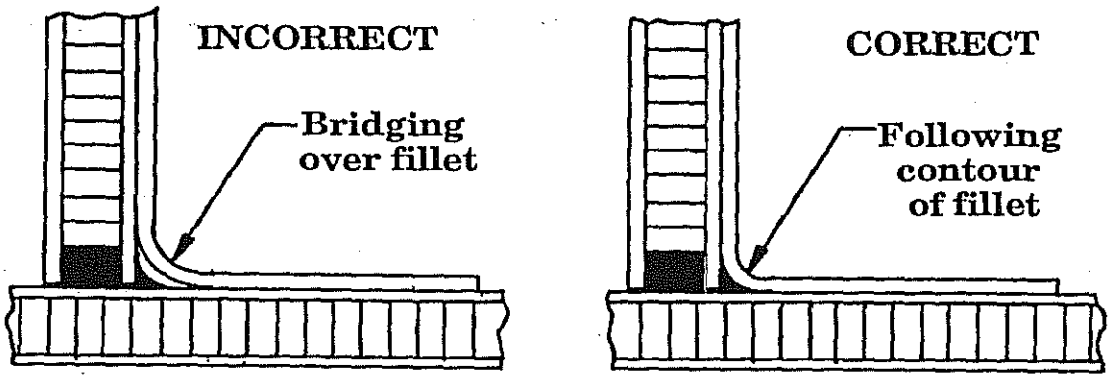
Modified tongue depressor
Figure 1-36



Developed in the late 1980's because of a demand for smaller microballoon radii, the Neico tongue depressor is a necessary tool for any Lancair builder. You see, the problem with normal tongue depressors is the large radius on each end. If you were to use this radius for all your microballoon filling of joints, your Lancair will be heavier than one with proper joint radii, not by much but every pound counts, right? By sanding down the tongue depressor to a smaller radius, the micro joints on your ribs, bulkheads, etc., will look much more professional. Don't think that more micro will make the joint stronger, in fact it's just the opposite. Microballoons are not structural, so the more fiberglass tape you have bonding the actual part, the stronger the bond will be.

A word of caution. If you get carried away with smaller and smaller micro radii, the fiberglass will want to "bridge" over the microballoons, not bonding as it should. Bridging is fairly easy to detect, the air is visible under the laminate. A little practice will have your micro joints looking great.

Bridging fiberglass over a radius
Figure 1-37

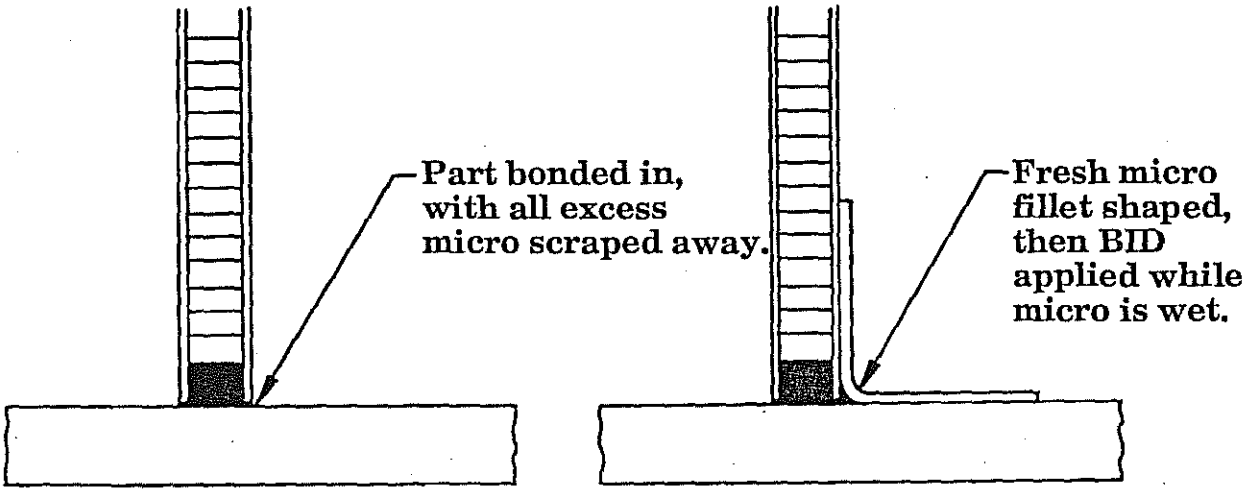


ABOUT THOSE MICRO RADII

The subject of how to best apply microballoon radii is a hotly debated topic around the shop (hey, we're bored sometimes, alright?). Eventually we settled on two methods:

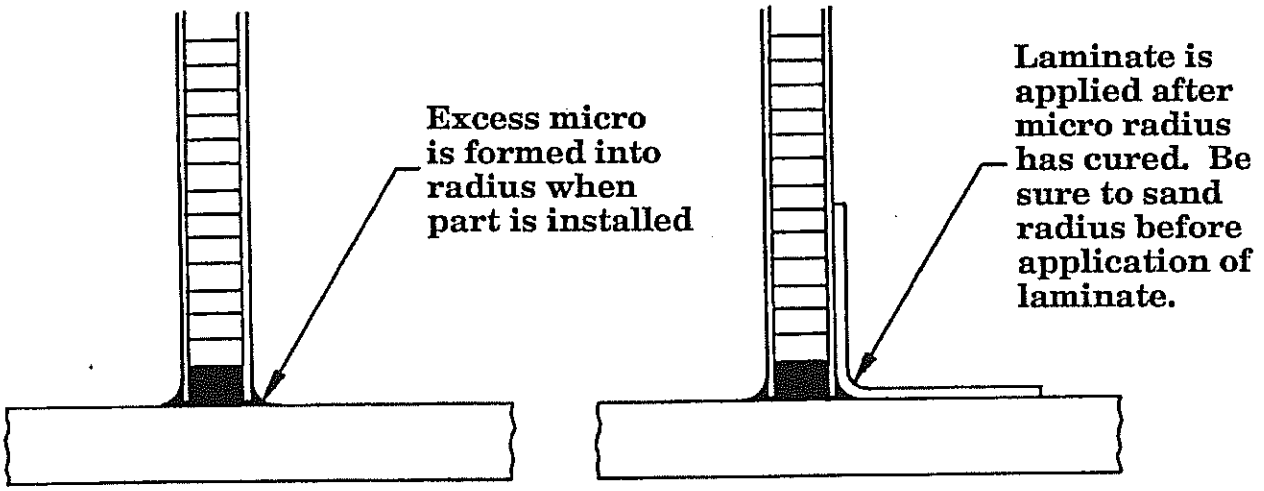
Method #1 - Some believe that the rib/bulkhead should be bonded in and all extra micro scraped away leaving no radius. After the rib/bulkhead is cured in position, another batch of micro can be used to make the radius and the BID tapes applied while this micro is still wet. This method makes application of the micro radius easier because the part is already held firmly in position, but when pure resin is painted onto the area where the BID tapes will be applied, the micro can sag and become runny. When this condition occurs, it is easy to get air bubbles trapped underneath the BID tapes.

Method #1 of forming micro radii
Figure 1-38



Method #2 - Others, like myself, believe that the micro radius should be formed when the rib/bulkhead is first installed. Care must be taken to hold the rib/bulkhead in it's proper position while forming the radius with your modified popsicle stick. After curing, the BID tapes can be applied over a solid micro radius. I feel this method helps eliminate air bubbles forming under the BID tapes because the resin that is used to saturate the tapes will not dissolve the micro. Plus, you can stipple the air bubbles out from under the BID tapes without destroying your beautiful radius. Be sure to sand the areas, including the micro radius, where the BID tapes will be applied.

Method #2 of forming micro radii
Figure 1-39



All this talk about something as simple as micro radii, you say? Well, you'll be making a lot of these buggers in the process of building your Lancair, and paying attention to details such as this will ensure confidence and pride in your aircraft. As for which method to use for applying micro radii and BID tapes, either will work, but the second method is safer to avoid air bubbles and get a good radius.

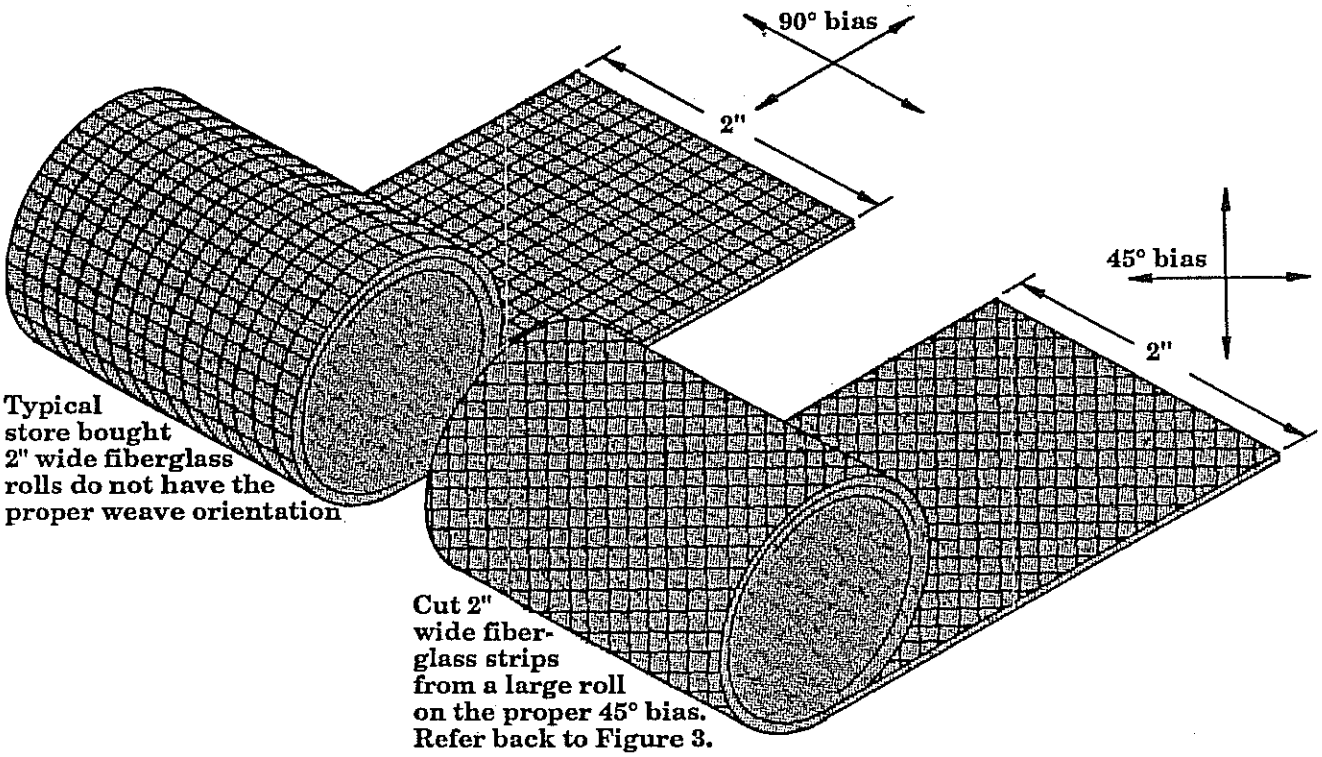
G. THOSE ANNOYING 2" WIDE BID TAPES

On the subject of glassing in ribs and bulkheads, we've received a few enquiries about using 2" wide, pre-cut fiberglass tape, such as available through Aircraft Spruce, instead of cutting your own out of the 50" wide roll provided in the kit. This is fine, as long as the cloth is cut on a 45 degree bias. THIS IS IMPORTANT! If you use cloth that is cut 90 degrees, it will only be half as strong. Most commercially available tapes are cut 90 degrees and unsuitable for structural areas such as ribs and bulkheads.

The safe way to glass is to cut your own. At Neico we cut 20 or 30 tapes at a time, all on a 45 degree bias. Then we roll the tapes up, carefully so as not to shrink or expand the 2" width, and set them aside in a clean place to use as needed. If you do buy pre-cut tapes, be very sure they have a 45 degree cloth weave.

Difference in BID tape weave

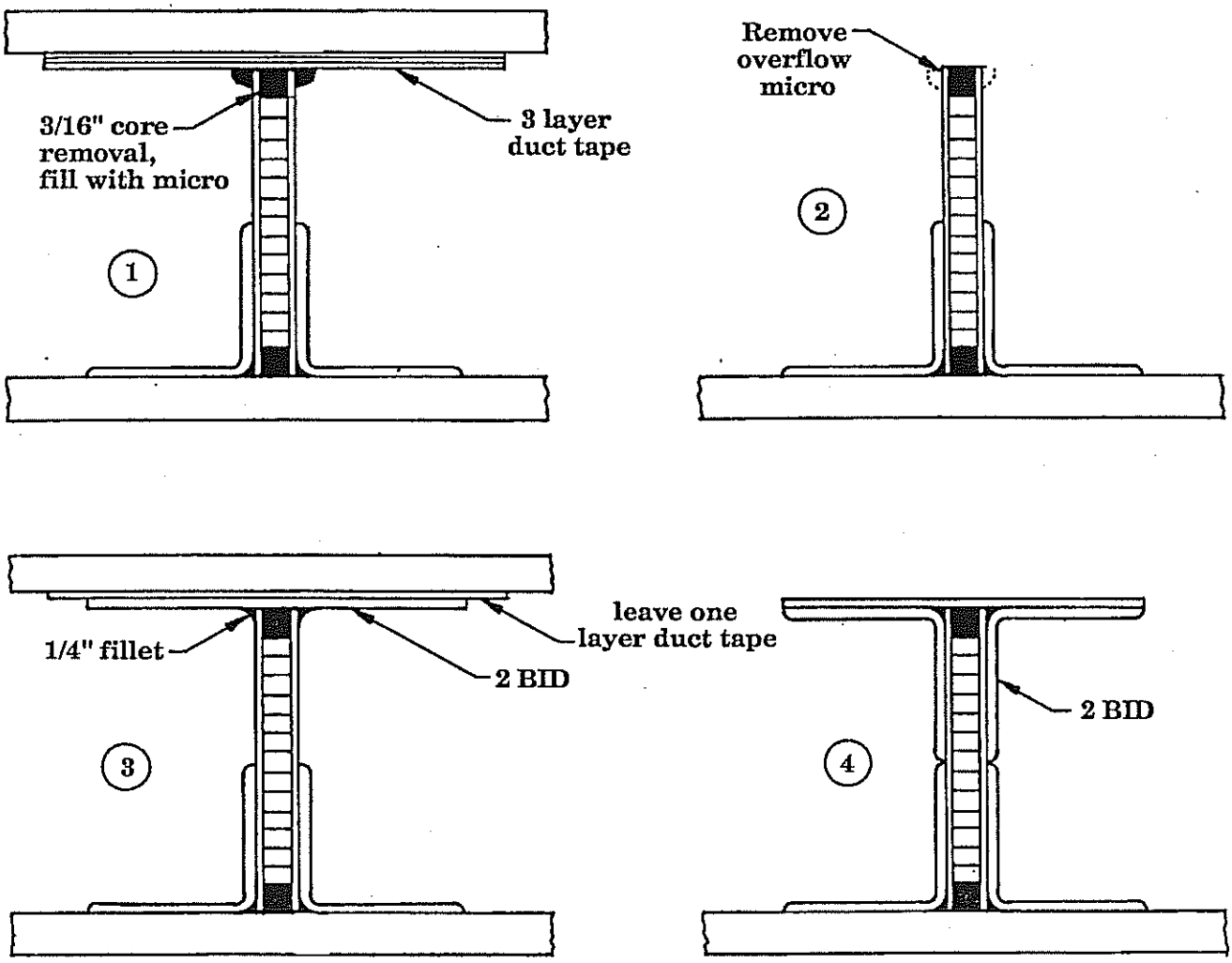
Figure 1-40



H. CAPSTRIPS

We've become capstrip happy here at Neicoville. We like the idea of all that extra bonding surface when closing out a flap, elevator, wing, etc.. You Lancair IV builders out there will get real good at forming capstrips because every one of your flying surfaces have them. You 235/320 builders might want to use capstrips on your wings and tail also, so here's the latest and greatest capstrip construction method.

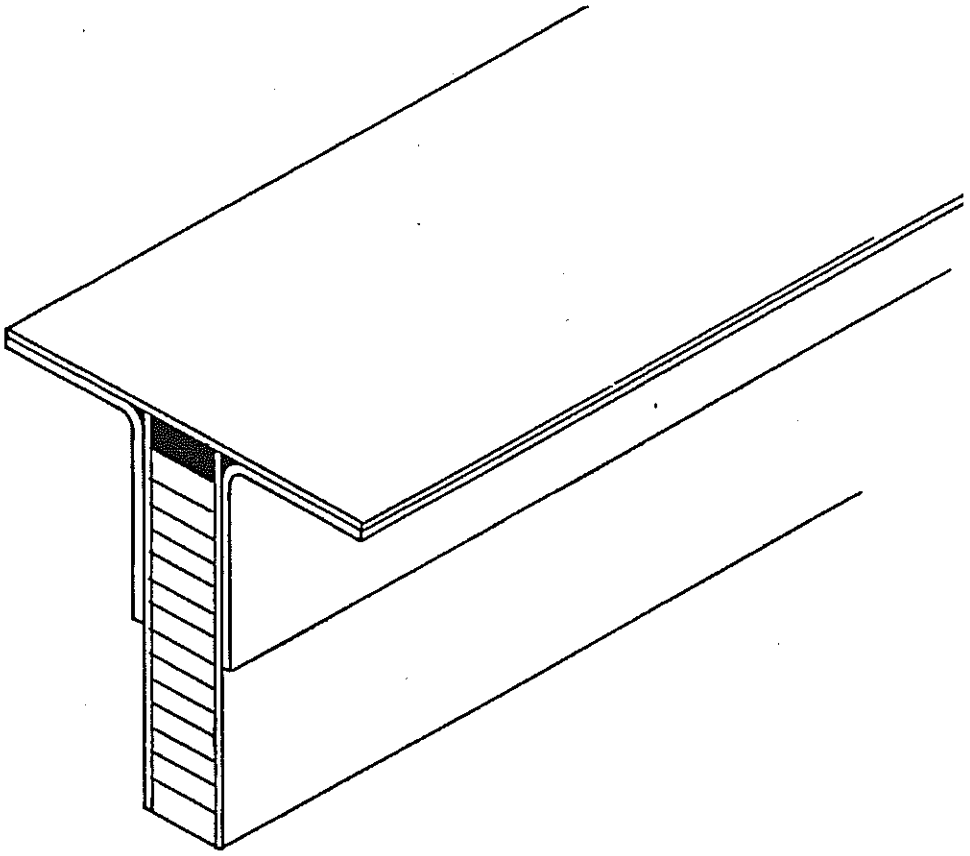
The capstrip
Figure 1-41



Your ribs (in whatever surface you are capstripping; flaps, wings, etc..) should be sized down no more than 1/8" from the skin. The capstrips need at least .020" clearance between rib and skin. Draw accurate reference marks on the inside surface of the wing or stab skin, where the ribs contact the skin and where capstrips will be located. Now apply 3 layers of duct tape where capstrips will be located. Be sure the release tapes are wide enough to prevent the 2" wide capstrips from becoming prematurely permanent.

Forming capstrips

Figure 1-42



Trough out the core of the ribs to the standard 1/8 - 1/4" depth. Mound up micro in the ribs so it will contact the 3 layer duct tape release. This is only the first release, on the second you will apply the capstrips. Set the skin in position and check the contour just like you would if you were closing the surface out for good. After the micro has cured, pop off the skin and remove 2 layers of the duct tape release. The remaining duct tape layer will act as a release for the capstrips. Now your ribs should be sized to within .020" of the skin, perfect for the 2 BID capstrip. Sand the excess micro flush to the sides of the ribs.

Apply the 2 BID, 2" wide capstrips to the inside surface of the skin (see the previous sections for tips on cutting and rolling out the capstrips). Be sure your capstrips are only applied to the release tape areas. The capstrips will be bonded to the ribs with a small amount of micro. Again, lay the skin in position just as you would if closing out the surface.

Pop the skin off for the last time. Because of your earlier microfit, the excess micro squeezeout under the capstrips should be minimal. Sand the ribs and the underside of the capstrips where the 2 BID capstrip reinforcement BID tapes will be added (on some areas of the IV, 3 BID reinforcements are necessary, but on the 235/320, 2 BID is a good, universal number).

Add a small micro radius where the capstrips join the ribs and apply the reinforcement BIDs. The BID should overlap onto the rib by 1". When cured, trim the capstrip's edges straight.

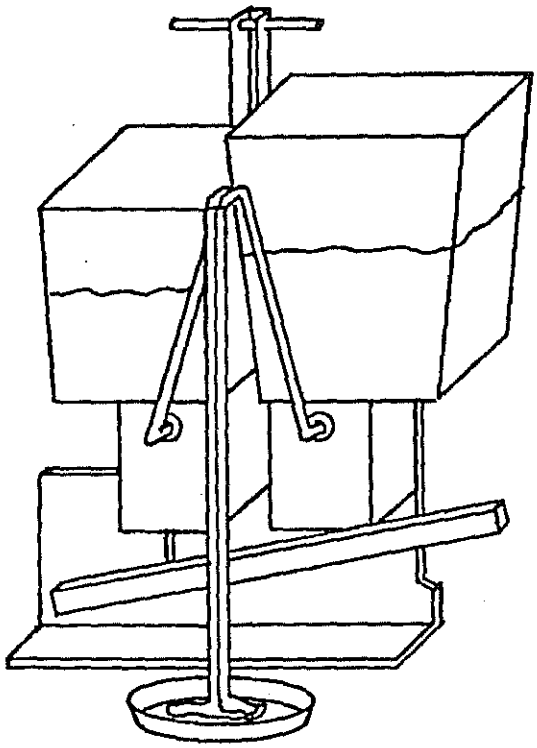
Yes, capstrips are a lot more work than just bonding the skin in position with flox in the rib trough. But in areas where peace of mind is important, such as the fuel bays, the extra bonding area and accuracy of capstrips are worth the trouble.

I. Storing and Using Epoxies

Most epoxies have a manufacturers recommended shelf life of typically one year. In some cases this is quite conservative. However, the manufacturers recommendations should obviously be followed.

Many builders opt to purchase a "pumper", such as the "Sticky Stuff" dispenser shown here (and available from Neico), which dispenses laminating epoxy in measured amounts. These units generally pay for themselves through the savings of expensive epoxy, since you can dispense exactly the desired amount.

Epoxy pump
Figure 1-43



Many builders are using a light bulb heated box over their epoxy pumps to keep the epoxy warm and thin. This is fine, we do the same, but if you're not going to use the pump for a week or so, turn the light bulb off in the box. Otherwise the volatiles in the epoxy can evaporate out and cause faulty curing or no curing at all. If you are a dedicated builder, using the pump every night (I've heard there are such people) you needn't worry about evaporation and can leave the heat on. Use no higher than a 25 watt bulb in your pump box. With the new Shell 862/Teta epoxy system, you should turn off the light bulb when the air temperature is over 70°. This epoxy cures quickly in the warmer temperature ranges with the aid of the bulb.

J. OUR CHOICE FOR "BEST SANDPAPER"

One essential tool in the Lancair builder's arsenal is good sandpaper. The cheap stuff at the hardware store just doesn't cut it, literally. We've found the best sandpaper for preparing fiberglass/carbon fiber for additional laminates is 40 grit 3M Production Paper Sheets. These sheets are 2 3/4" x 17 1/2" and are meant for longboard sanders. By cutting them in half, they fit perfectly into most rubber hand sanding blocks. 3M calls them "The Green Corps" and the paper is colored, yes, green. Try to find this sandpaper at auto body supply or automotive paint stores.

If there's one main tip in sanding before glassing, it's "No gloss!". BID tapes will not adhere to a smooth surface that hasn't been sanded. When you are preparing the surfaces, sand only until they look scuffed up. If you keep grinding the surfaces, you'll do much more harm than good. As long as the original surface is sanded so it's no longer glossy, and there is no contamination by grease, dirt, beer, salsa, etc., that surface is ready to be glassed. Remember to clean it with MC.

40 grit is the coarsest sandpaper I would consider using. We've tried 36 grit, but it's just too macho and can easily damage too much of the surface being prepared.

K. CARDBOARD TEMPLATES

In an early newsletter, it was suggested that the builder use cardboard to find the shape of ribs or bulkheads before cutting them out of Clark foam or prepreg. Since many of you are new builders, we thought this is worth repeating.

Simplicity and cost is why we use cardboard templates here at Neico. The more complex the rib or bulkhead shape, the more a cardboard template will help. Plus, screwing up a piece of cardboard is much cheaper than a similar piece of prepreg.

L. DRILLING

It takes practice to drill a close tolerance hole in aluminum and fiberglass. We're not all precision machinists here at the shop, but through trial and error we've come up with some drill combinations that work well for various size screws and rivets.

First a note about tolerances. When a bolt is holding a bracket tight against a bulkhead, rib, firewall etc., you needn't drill a .001" tolerance hole, because the bolts' clamping action will keep the bracket from wearing the bolt hole larger. This applies to rod end bearings and bellcrank bearings that are mounted tight with elastic locknuts. In this case, the slop in the bearings are not dependent on the tolerance of the holes.

Here is a list of drills we commonly use for various bolts and rivets:

AN 426 rivets are .097" diameter, use #40 drill.

1/8" rivets are .125" diameter, use 1/8" or #30 (.1285") drills.

#6 screws are .137", drill a sloppy #29 (.136) hole or a tight #28 (.1405").

#8 screws are .161", #20 (.161") and #21 (.159") both work well.

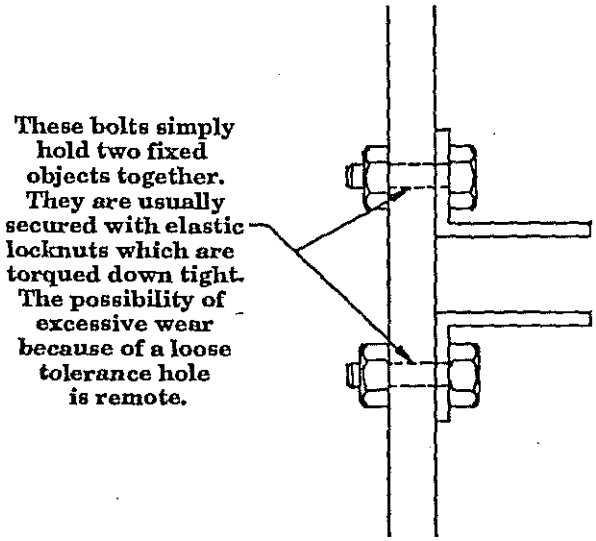
3/16" (AN3) bolts can use, in addition to the obvious 3/16" drill, a #13 hole with reaming to get a tight fit, (See above section when and where this is necessary). A #12 hole is sometimes too sloppy but can be used for unimportant, quick and dirty holes.

1/4" (AN4) bolts use 1/4" drill, of course. Also handy are lettered drills, like "E" (.250") or D (.246") with a reamer.

When drilling, creep up on your final drill size. If you want a tight AN4 hole and simply use a 1/4" drill first, the hole will be loose and usually triangular shaped. Try drilling a 3/16" hole first, then 7/32", then 1/4". The extra one minute spent changing drills is well worth it, especially if you're drilling a hole that needs a tight tolerance (See above).

Bolt holes not requiring tight tolerance

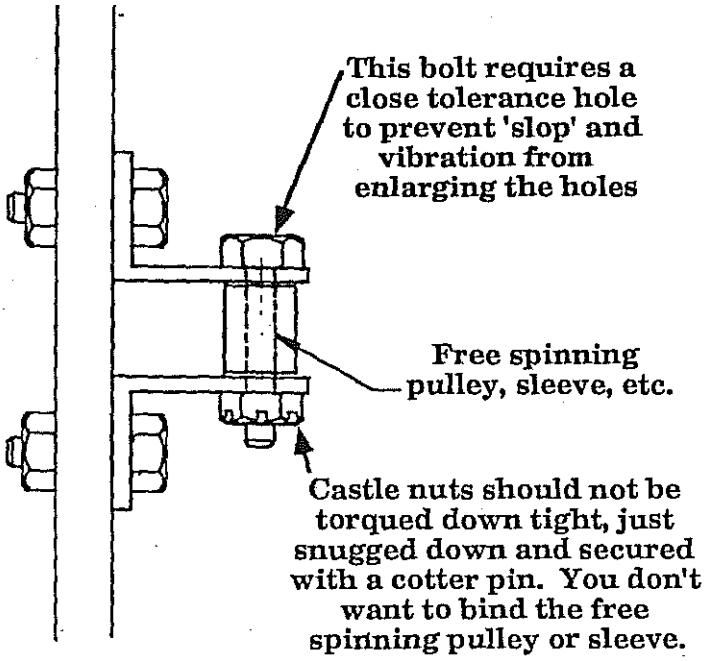
Figure 1-44



One the other hand, bolt holes that require close tolerance are those in which the bolt can rotate freely. When a castle nut and cotter pin are called for, it means the nut and bolt will not be tightened against a fixed object but will allow the object to float between the brackets. A loose tolerance bolt hole will allow the bolt to vibrate and slowly enlarge the hole.

Bolt holes requiring tight tolerance

Figure 1-45



M. Building Light

How much resin should I put on my laminates? The worst enemy to a light, high performance airframe is too much resin. Here at the Lancair factory, we wet out almost all our glass on 1 mil thick plastic, place another plastic sheet over the wetted cloth, and use a roller to squeeze out the excess resin (the plastic sandwich method). Use a fair amount of pressure when rolling to get a good squeezeout of resin. Not only will these BID tapes be much lighter than ones wetted out on the airframe, they will save lots of time and look very professional. And remember, when the call for BID is higher than two or three, you will save even more time (and weight) wetting the cloth out on plastic.

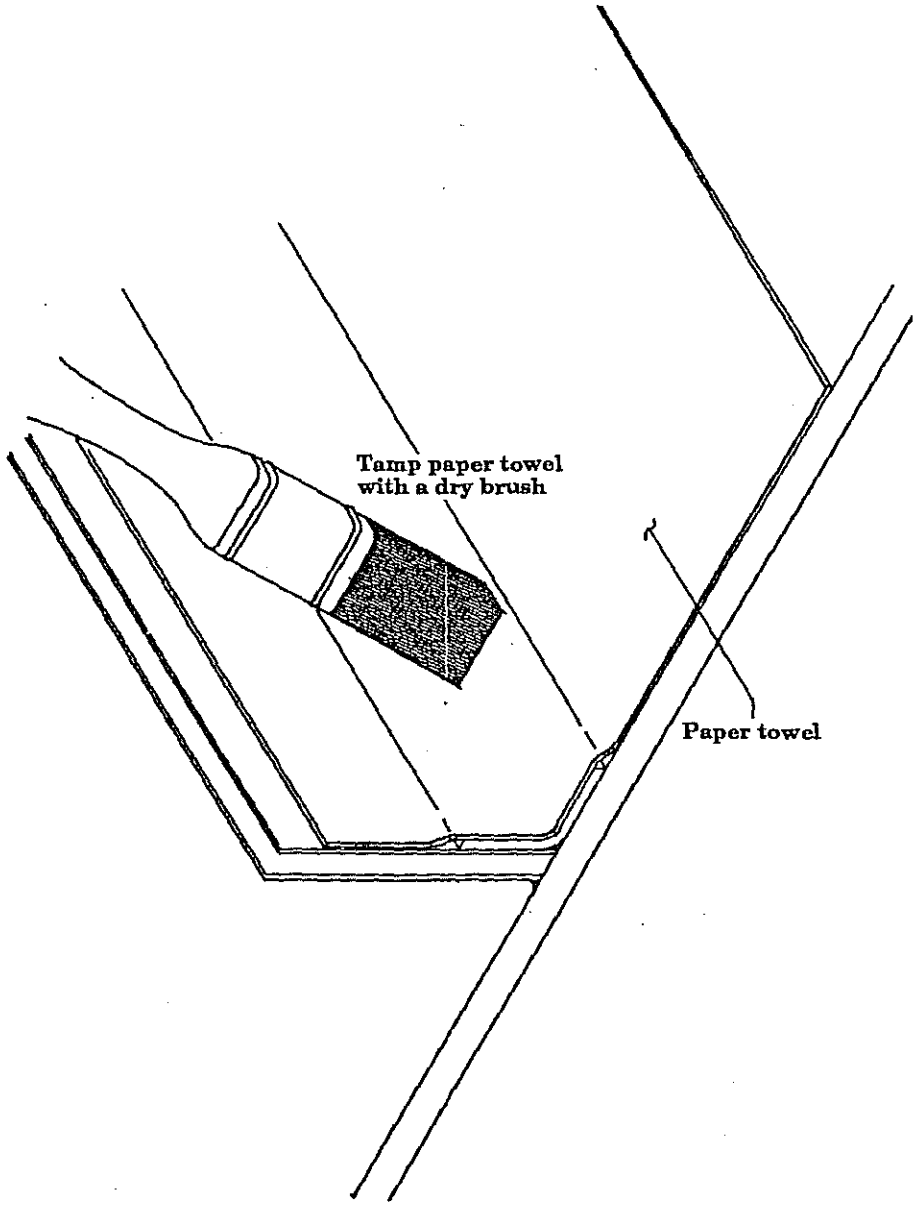
1. BID schedules

About those BID schedules, which are the number of fiberglass layers bonding a structure together. A homebuilder's natural instinct is to make his plane stronger. If the manual calls for 2 BID, three or four must be better, right? WRONG! If you increase the number of BID layers in your aircraft you are decreasing it's strength. A heavier aircraft is quicker to build up G loads, has less payload, and is slower than the one built to spec. The Lancair was stress analyzed by Martin Hollmann, a leader in composite engineering, and fully tested. We've seen a Lancair with such a high empty weight that it is over gross as soon as the pilot steps into the cockpit, with no fuel! Think about it, and stick to the manual.

2. Paper towels

Enough preaching, want to save even more weight? Throw out that peel ply and use paper towels. That's right, paper towels. After pulling the plastic off a newly applied BID tape, place a paper towel directly on the wet glass and tamp it with a dry brush. The towel will soak up excess resin and the tamping will help push out those evil air bubbles.

Soaking out excess resin with paper towel
Figure 1-46



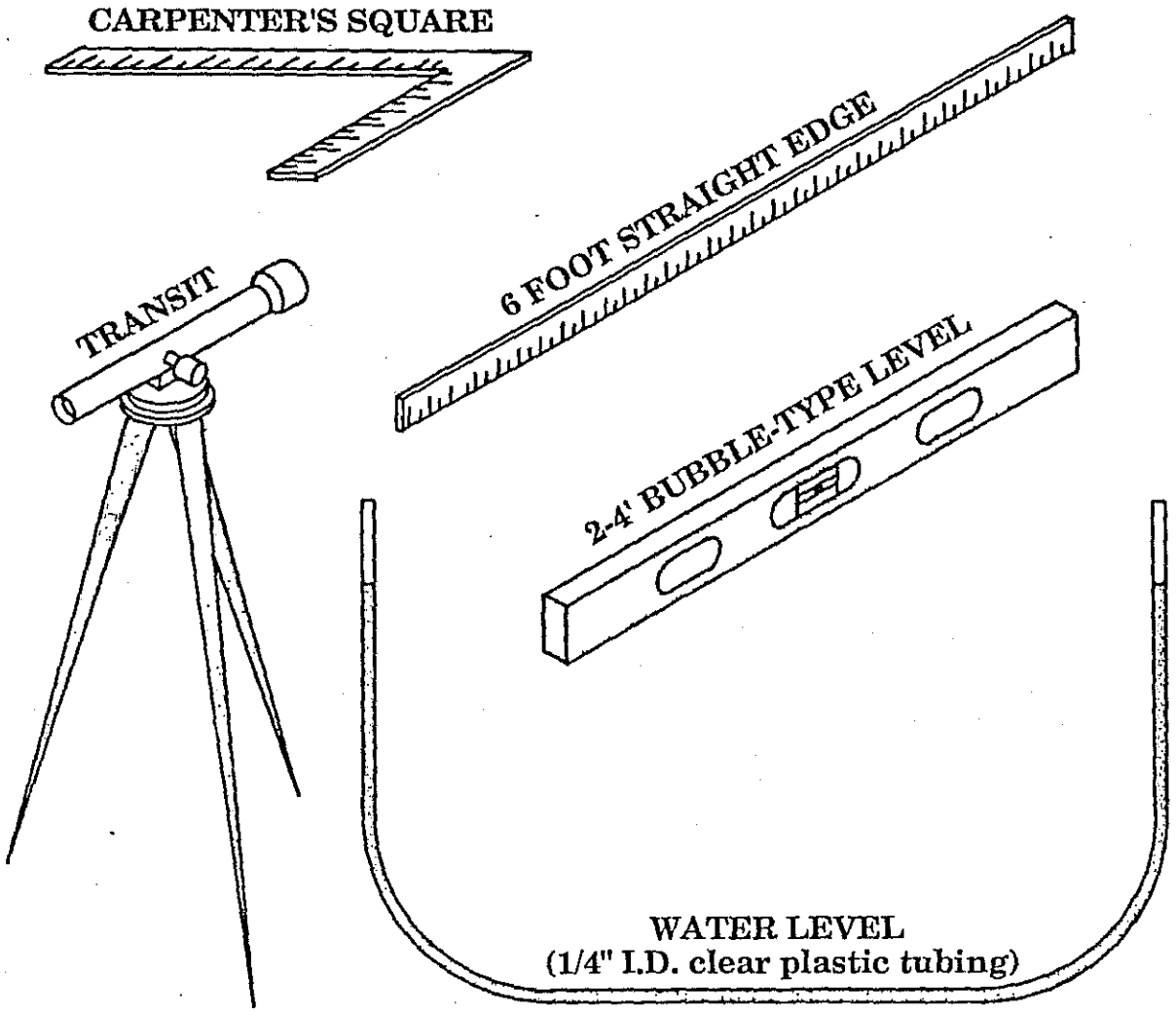
When the towel is soaked through, pull it off and look at the results. If the towel has pulled up or distorted the glass, tamp it with the dry brush further. Does the glass still look glossy, with an uneven resin content? Well, put another paper towel on it and tamp it again. So long as you don't make the laminate look white, meaning it's too dry, there will be plenty of resin in the glass. Try it, paper towels are cheap.

N. Building Straight

Keeping the airframe straight is also important in a good flying aircraft. Your pristine Lancair might weigh in nice, but if it corkscrews through the air in giant barrel rolls when you let go of the stick, you haven't built a straight airplane. Building your plane according to plans and following the advice given in the construction manual, your Lancair should fly straight and true (in Oz.). Back in Kansas and the rest of the world, it seems that one wing is always a tad heavy, or a trailing edge is wavy. Our prototypes never come out exactly straight and true, so we can't expect any of you builders to perform this miracle. Here's some tips and tools that might help.

Tools for building straight

Figure 1-47



1. Tools for building straight

a. Carpenter's levels, squares

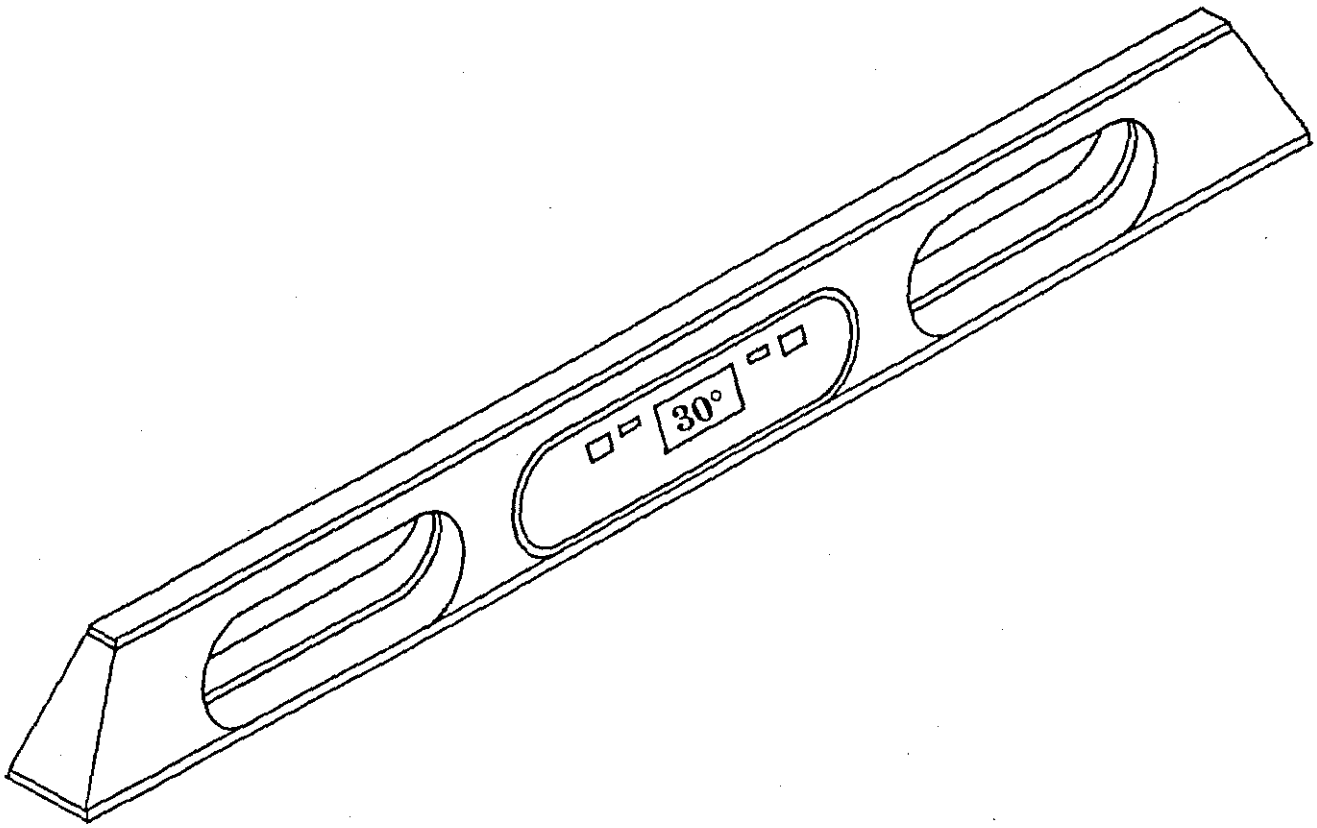
Two and four foot bubble levels are handy and should be a part of any builder's shop. Buy a good six foot straight edge. Hang it on a convenient shop wall because you'll be using it often. Also pick up a carpenter's square for making those 90 degree cuts. These are basic tools but necessary for building a good plane.

b. Smart Level™

A real handy gadget is the Smart Level™, made by Wedge Innovations, which has an LCD readout instead of a bubble. The center of the Smart Level pops out to become a small, six inch level that's extremely handy for measuring control surface throws, seat back angles, etc.

SMART LEVEL™

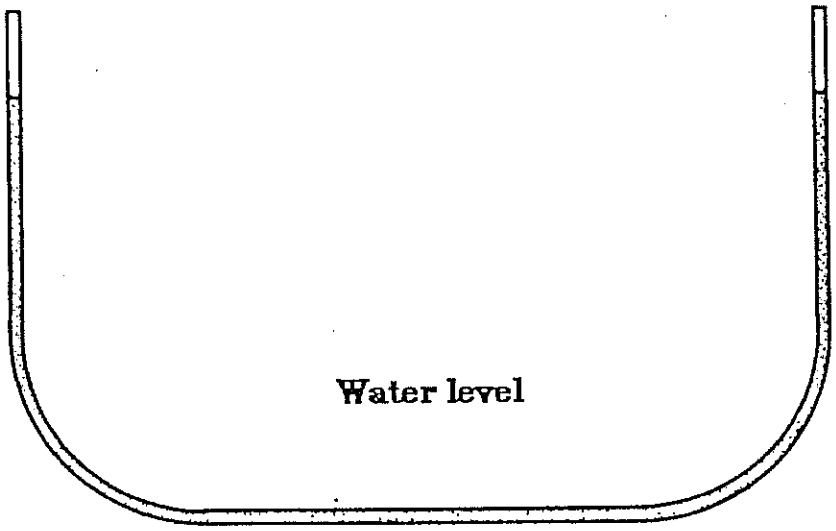
Figure 1-48



c. Water Level

Water levels are a cheap and simple means of checking levels between two points that can be quite far from each other, if you have the patience, and can be done by yourself. If you fill the tube, then tape one end (end "A") even with the point you want to use as a reference, you can take the other end to the remote point, raise the tube until the water begins to run out of end "A", and tape end "B" up above the remote point to be measured or levelled. The water will flow out end "A" until the water at end "B" is level with it. It's a bit messy, but you don't need a second person.

Water level
Figure 1-49

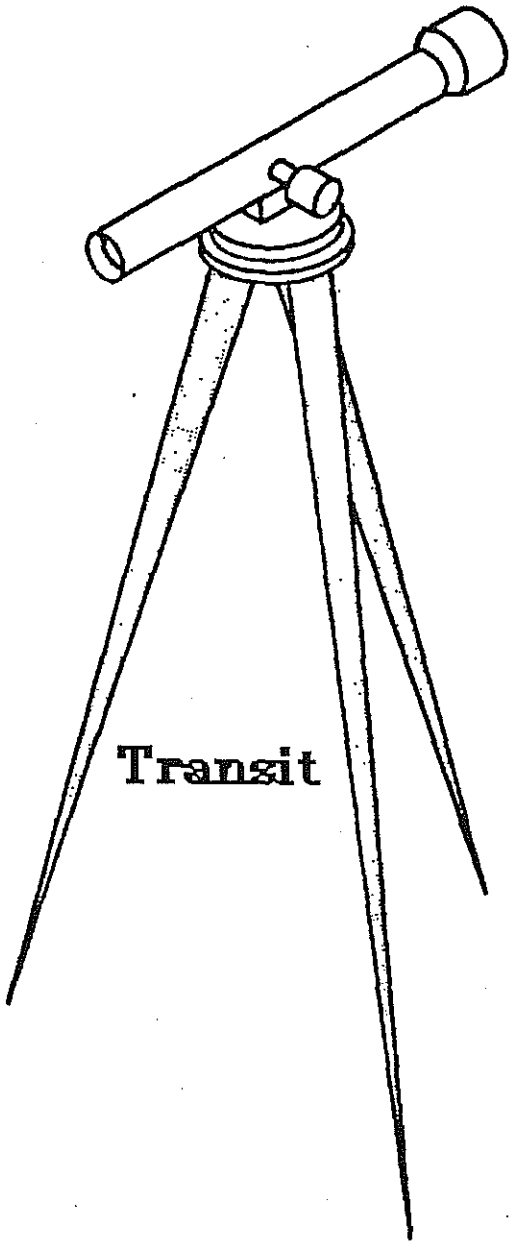


d. Transit

If you're tired of wrestling with the water level and mopping the floor when it spills, try using a transit. Surveyors have used transits for years and they're not cheap, but they can be rented at surveying suppliers, drafting shops, or blueprinting stores. Using a transit, two people can quickly level fuselages, wings, horizontal stabs, and jigs, staying dry in the process.

Transit

Figure 1-50

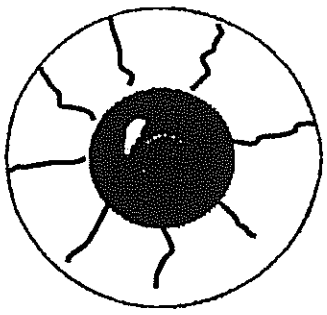


e. The eyeball

Our last tool used to check straightness is the most complicated in design yet the cheapest and most accurate of all. It's called the human eyeball. These eyeballs are widely available and should be used whenever possible.

Mk. 1 eyeball

Figure 1-51



If an edge or surface looks straight to the eye, they are straight enough. Even minor discrepancies in wing tip washout can easily be detected by kneeling down ten feet in front of your Lancair, closing one eye, and swiveling your head. Sight one trailing edge tip above the high point of the wing, swivel your head, and sight the other tip, comparing the two. The eyeball, use it!

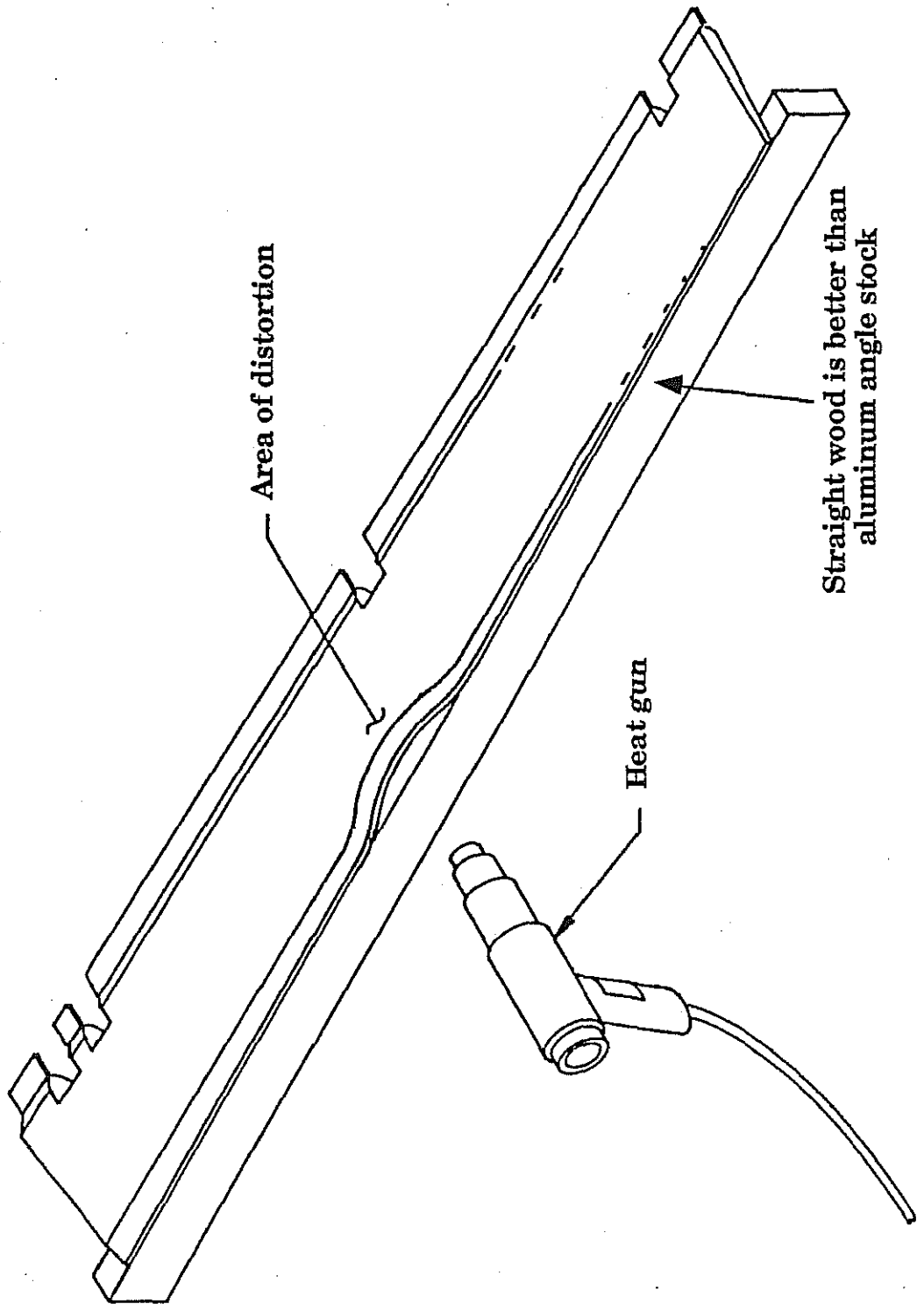
2. Straight trailing edges

Now let's pretend that you've jigged your wings perfectly, leveled and attached the horizontal stab, and plumb bobbed the vertical stab and glued it on. The trailing edges of your Lancair should be straight so the control surfaces can travel freely with a consistent gap. As is usually the case with the plans of all good mice or men, sometimes things aren't quite perfect.

If your wing or tail trailing edge has a slight warp in it, heat the area with a heat gun until it's just too hot to touch. Be very careful not to burn or scorch the fiberglass or carbon fiber. Try heating an extra piece of prepreg material first, just to see how much heat is required to burn it. A piece of straight wood or aluminum angle (the wood is better, because it will cool slower than the aluminum and tend to prevent re-warping the edge) can be clamped to the edge to keep it straight while cooling. Be sure to heat the angle, also. Otherwise the cold aluminum will cool the edge too quickly and the warp will remain. Heat at least an inch forward of the edge and don't discolor or burn the fiberglass (or wood). If the warp still remains, try finding a 1x2 or 2x4 board with the right curvature to warp the edge the opposite way when clamped tight. Heat the edge and let it cool with the board clamped in position. With any luck, the part will spring back nice and straight when the board is removed. See the figures on the next two pages.

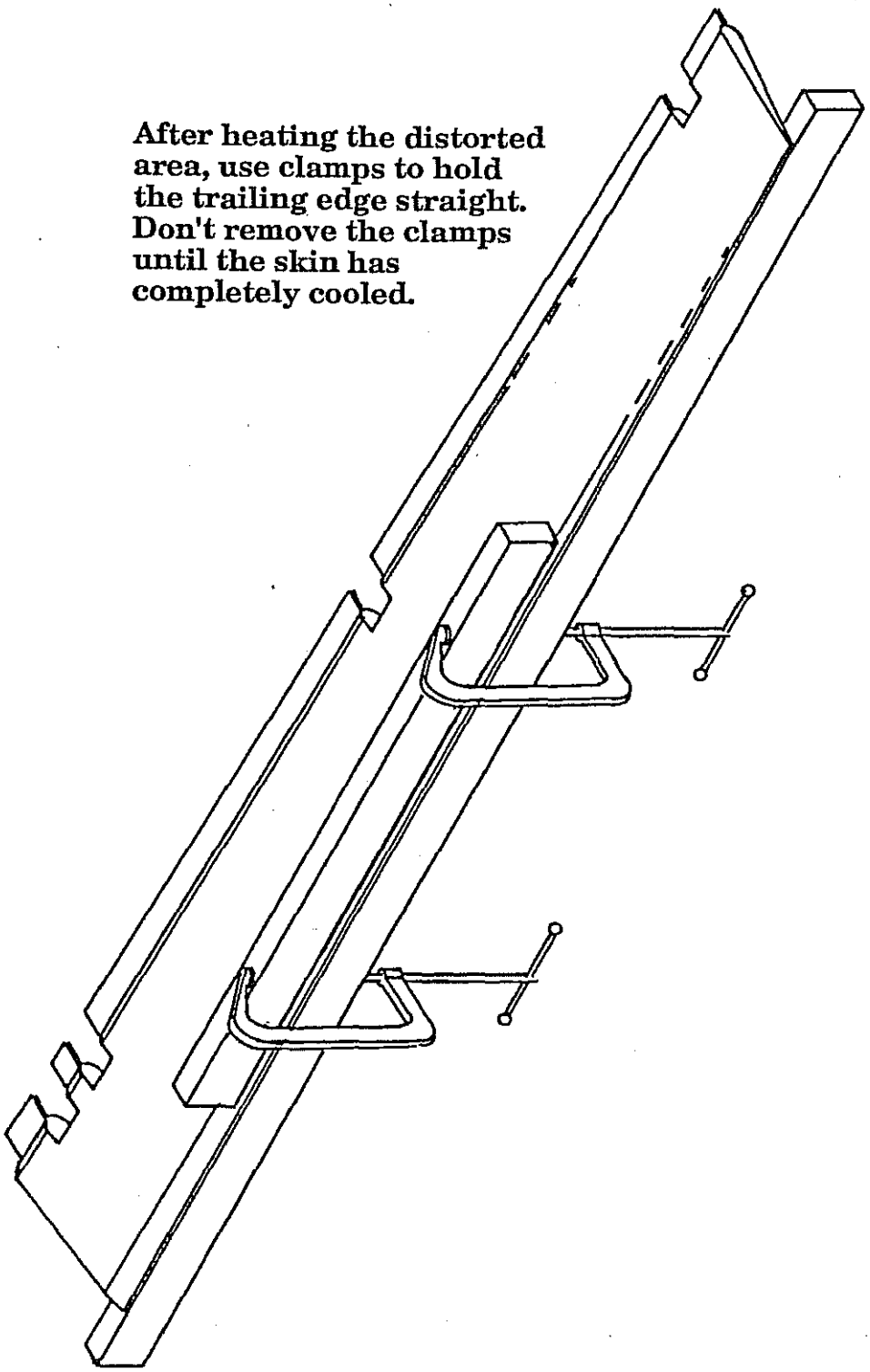
Straightening trailing edges

Figure 1-52



Straightening trailing edges

Figure 1-53



O. CONTROL SYSTEMS

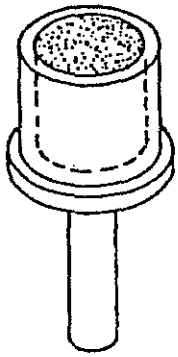
1. Pushrod tips

a. After cutting the pushrod tube to length, don't immediately rivet the rod end in position. It is better to test the pushrod in the system (flap, aileron, elevator) by temporarily securing the rod ends to the pushrod with instant glue. Use only a few drops of glue to secure the rod end or the bond may become more than temporary. Don't cover the rod end with glue then slide it into the pushrod, the bond would be impossible to break free. Once you determine the tube is the proper length, you can break the rod ends free, clean them up, and rivet them in place.

b. Fill the rod ends with a 50/50 micro/flox mixture. This will allow the drill to track straight through the rod end when drilling for the rivets. The solid rod end will also prevent rivets from buckling when they are set in place.

Filling rod ends with micro/flox mixture

Figure 1-54

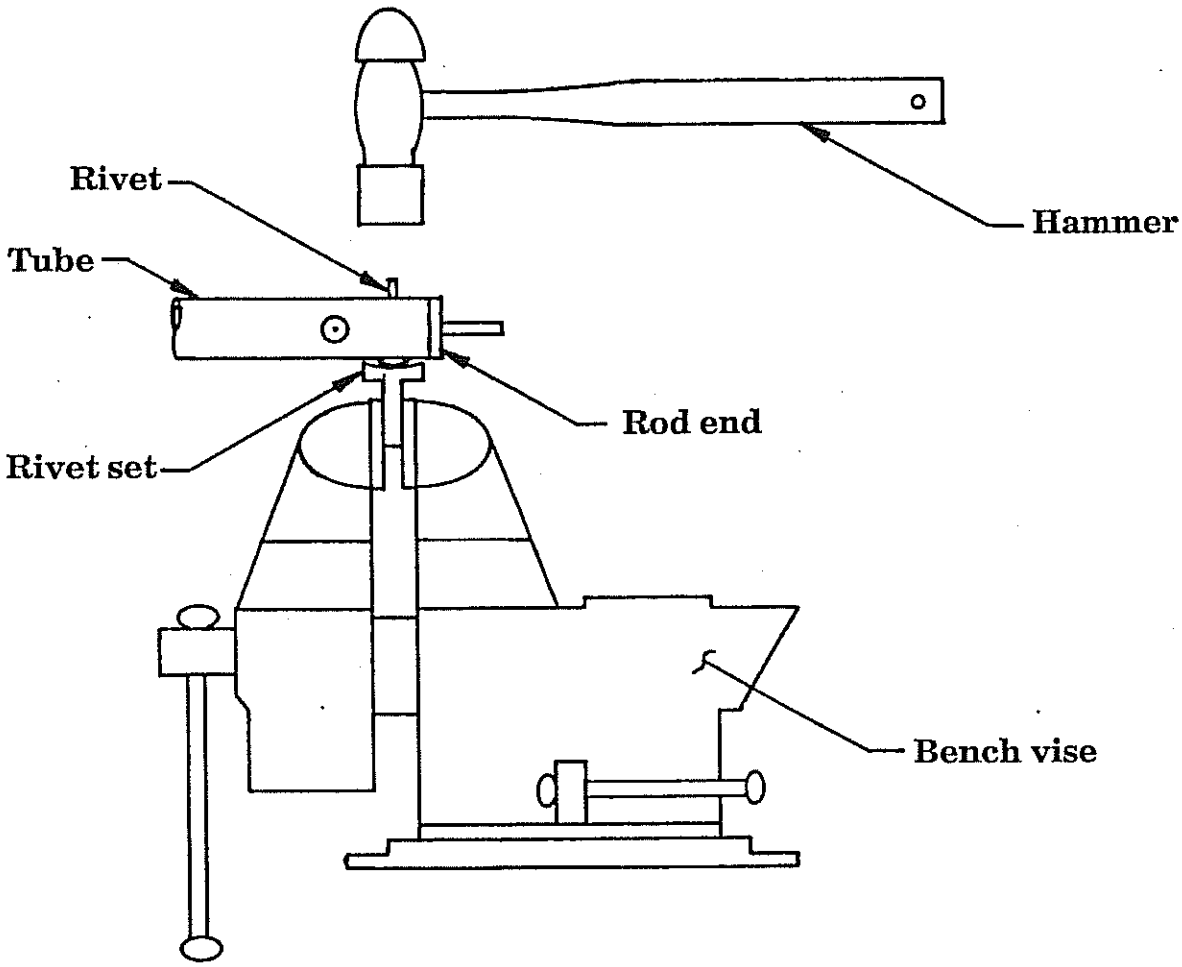


c. When sliding the rod ends into the pushrod tube for the last time (before riveting), coat them with Loctite™ to prevent slippage or vibration wear.

d. A rivet gun is the best method of setting the rivets that secure the rod end. In a pinch, we've used a hammer to lightly tap and expand the rivets. Hit the rivet lightly and accurately to avoid mashing the rivet end to one side. A rivet squeezer is not recommended for pushrod rivets because the rivets may buckle in the center of the pushrod.

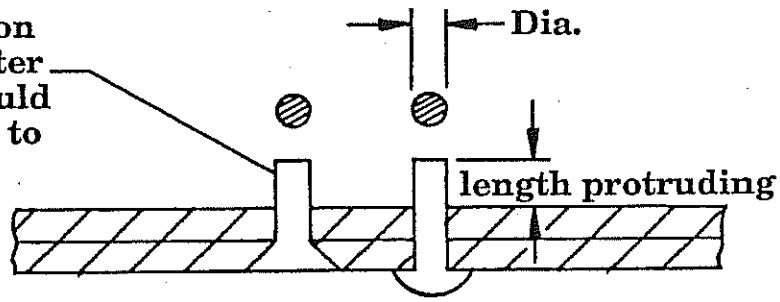
Setting the rivets in the rod end

Figure 1-55



Rivet rule

RIVET RULE:
The correct length of protrusion is equal to 1.5 times the diameter of the rivet, i.e., a 1/8" rivet should extend 3/16" from the material to be riveted.



2. Painting pushrods

At Neico we usually spray paint our pushrods with one coat of Zinc Chromate and one coat of color. Hardware store spray cans are fine for the color coat and you can choose from all kinds of nifty colors.

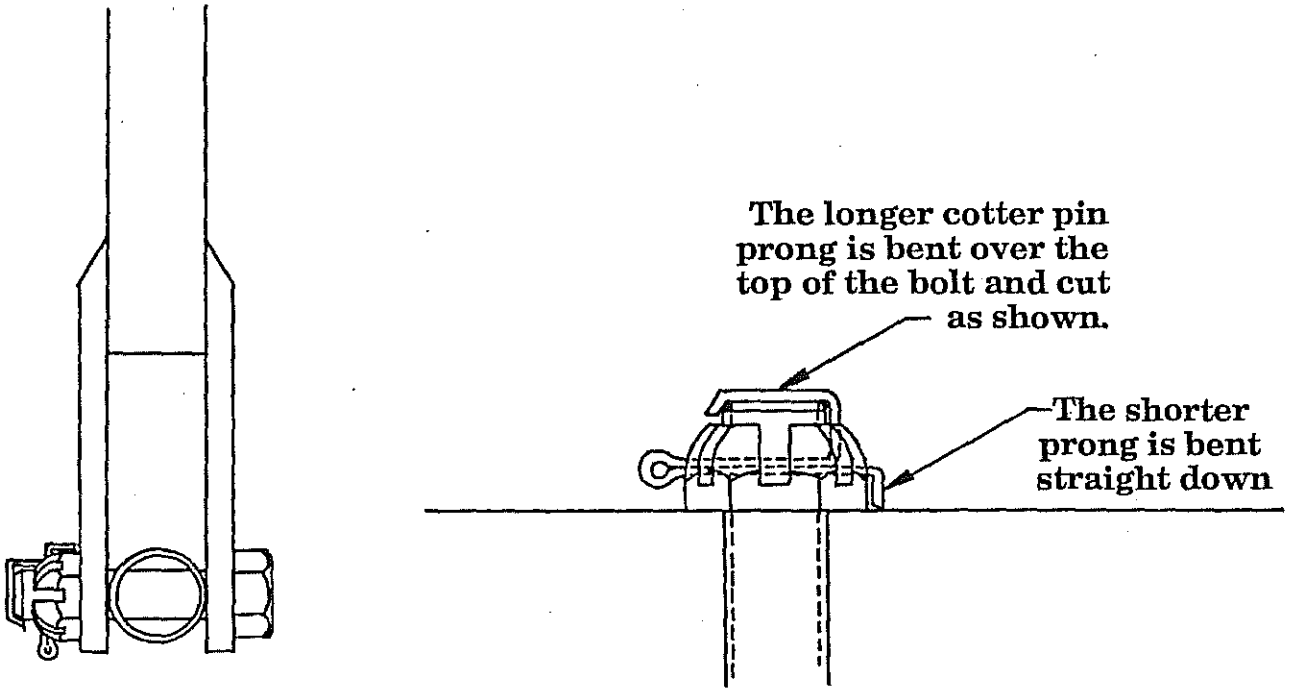
3. Castle nuts and cotter pins

One common error in the Lancairs we have inspected is mis-bent cotter pins and castle nuts without cotter pins.

Castle nuts are commonly called for items in the Lancair control systems. A castle nuts is only used on drilled bolts and MUST be secured with a cotter pin. Castle nuts are usually snugged down, not tightened like an elastic locknut and the cotter pin will prevent the nut from loosening!

Properly pinned castle nut

Figure 1-56



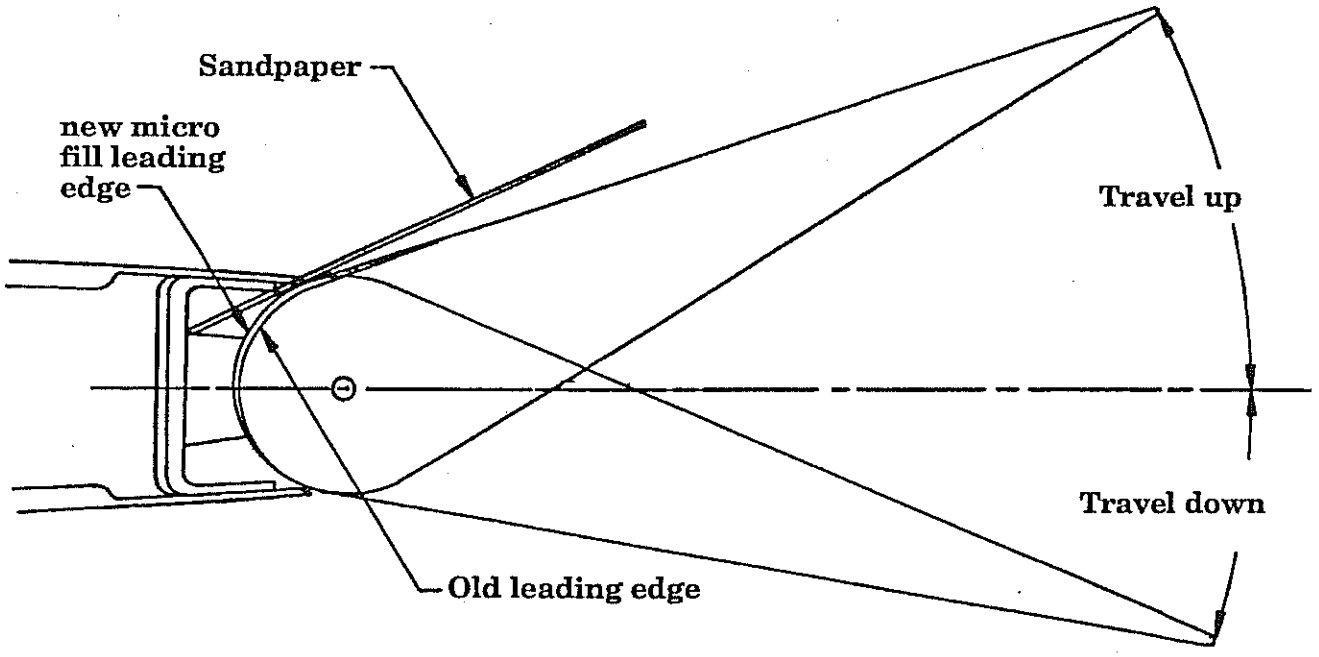
The standard method of bending and securing cotter pins is shown above. Many builders simply bend the two cotter prongs around the bolt and call it done. Without cutting the prongs to proper length, the prongs could grab a stray piece of upholstery or wire, possibly jamming the system.

4. Control surface gaps

If you'd like to get a closer gap on your control surfaces, try this method. No matter how good the mold, the leading edges of the elevators, ailerons, flaps, and the rudders never seem to fit the trailing edge of the wings and stabs just right. If you have this problem on your elevator, for example, mount the elevator to the horizontal stab and make sure you have at least 1/16" gap between the elevator leading edge and the stab trailing edge. Mark on the elevator where the gap is too great or fairly close and remove the elevator. Now add a micro layer, mixed thick, to the areas marked "too great" and shape a rough radius (a little sculpting skill is helpful).

Gapping control surfaces

Figure 1-57



After the micro cures, sand it so the elevator will just fit back into the stab, and sand the stab trailing edge straight, parallel to the hingeline. Got all that? Now take one strip of sandpaper, 3M or Norton 40 grit longboard sheets work best, and run it back and forth between the elevator and the stab, sanding the micro on the elevator. Another pair of hands is very helpful in this process to hold the elevator stable while you work the sandpaper. Have your helper raise or lower the elevator slightly when you feel the resistance on the sandpaper decrease. Slowly work the elevator through it's full range of travel. Now you should see a consistent gap between stab and elevator when the elevator is moved through it's travel range.

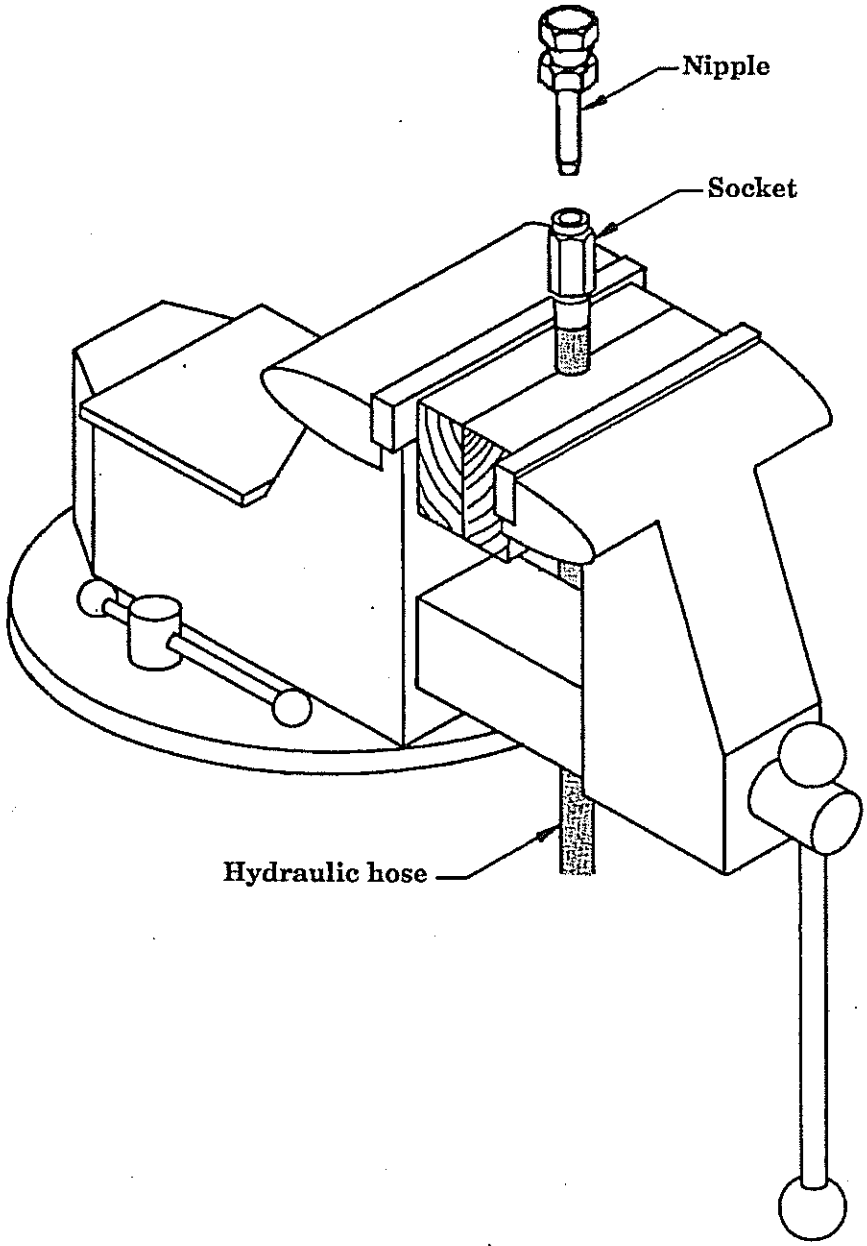
P. Hydraulic systems

1. Eastman hydraulic fittings

Let's talk hydraulics. When installing the Eastman hose-end fittings, drill a 3/8" hole through a 1"x 2" piece of 3/4" plywood, then cut it in two. Use this to clamp the hydraulic hose in a vise and avoid any damage the bare vise jaws may cause.

Installing Eastman fittings

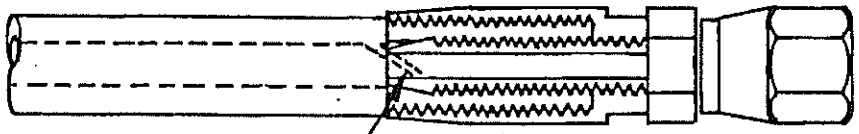
Figure 1-58



Another good idea is to cut off and polish a gutter nail, and insert it into the hose to help screw the left-hand threads of the socket onto the hose. Be sure to back off the socket from the full bottomed position to avoid gouging the hose when the nipple is inserted. If the nipple does partially gouge the inside of the hose, it can cause a flapper door effect, blocking flow in one direction. We blow through our hoses both ways after installing an Eastman fitting. If the hose sounds different when you blow through it one direction than the other, you might have a flapper. Be careful.

Hose blockage

Figure 1-59



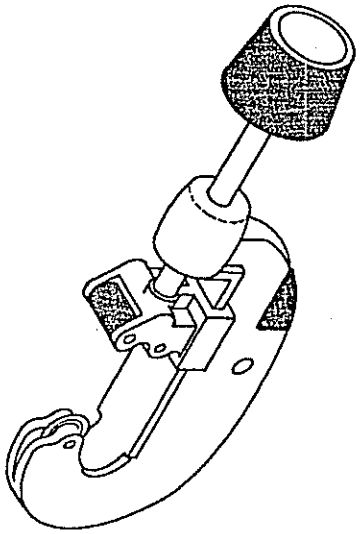
When threading fitting into flex tubing, tubing may be cut by sharp edges, resulting in blockage.

2. Cutting hydraulic lines

Most Lancair hydraulic lines are made from 1/4", 5052 aluminum tubing. A tubing cutter is the standard, and best, tool for cutting the aluminum tubing to length.

Tubing cutter

Figure 1-60

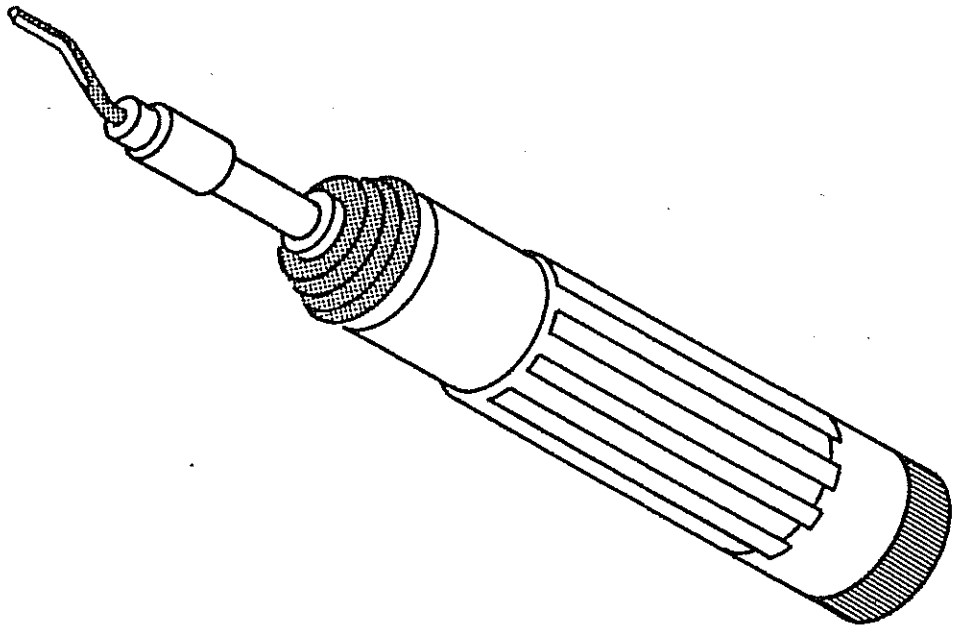


We use a small cutter because it's much easier to handle. Simply roll the cutter around the tube, tighten the handle slightly, then roll it around the tube again, etc., etc...

After every cut you must deburr the inside of the aluminum tube. A small deburring tool makes quick of this.

WARNING: Only deburr what is necessary to achieve a smooth edge. Excess use of a deburring tool will remove too much material and potentially weaken the subsequently flared end.

Deburring tool
Figure 1-61



Tony Bingelis has much more information on tubing cutting and deburring in his Sportplane Builder books and Sport Aviation columns. These books are extremely helpful to the home builder. Get them and read them!

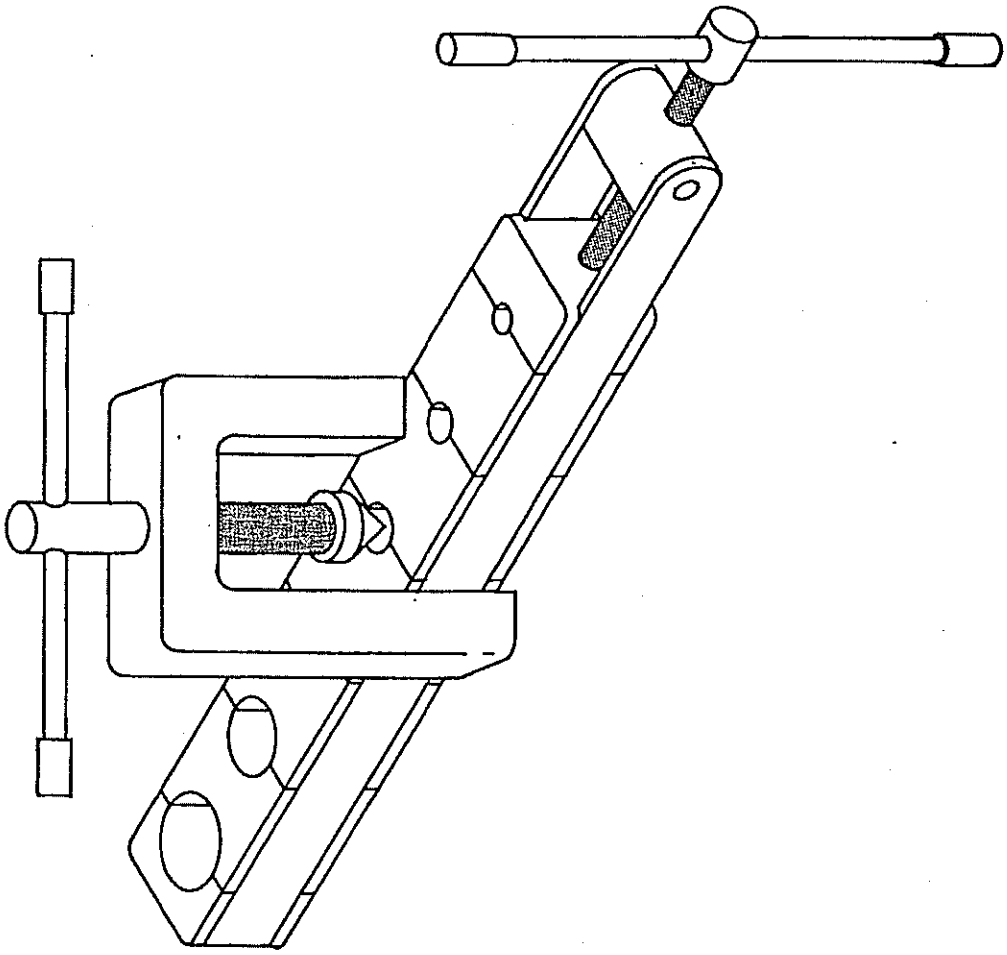
3. Tube flaring

Here's another area of construction where you need a specialized tool, the flaring tool.

The tube must be deburred, as described in the previous section, in order to get a clean flare. Otherwise you could score the inside of the tube when flaring. The tube may not seal properly in this condition.

Flaring tool

Figure 1-62



We usually grease the cone shaped part of the flaring tool so it will not gouge the tube.

Don't flare the tube too much, the expanding aluminum may crack. The cracks are visible if you look closely.

Experiment and learn how to use your flaring tool. Again, the books by Tony Bingelis contain a lot of valuable info on these sorts of specialized jobs.

Q. **Painting**

In the last year, the Neico shop has prepared and painted the Lancair IV prototype and repainted the bottom half of the Lancair 320 prototype (the brilliant Ferrari red had faded to a dirty tomato shade). In the process, we've learned a few basic painting tips and rules you may finds interesting. Or even helpful.

Painting is a disgusting, dirty, tedious, boring, stressful, sometimes toxic process that you will do once and swear never to attempt again. Lock up all your weapons because with one slip of the spray gun, one little mistake, you might feel like ending it all. Bet you can't wait to get started on your paint job now, huh?

Seriously though, if you take your time and don't try to produce a flying Mona Lisa, a good looking paint job is fairly easy to produce. Here's the basic flow chart that we follow for preparation and painting of our Lancairs.

1. Clean all surfaces
2. Sand all surfaces with 80 grit
3. Prime with featherfill
4. Sand with 100 grit
5. Paint with normal primer
6. Sand down to 220 grit
7. Fill pinholes
8. Prime with normal primer
9. Sand down to 360 grit
10. Clean for color coat
11. Paint your favorite color!

Now let's get more detailed, step by step:

Step 1. Before the initial sanding of your surfaces, and before each primer and color coat, you MUST clean the area to remove any contaminants that would affect the paint. We use DuPont Prep-Sol cleaner for this purpose.

Step 2. After you've Prep-Soled your bare fiberglass or carbon fiber surface, scuff up the surface with 80 grit so the primer can bond properly. We use a dual action (DA) sander to make short work of this step.

Step 3. Clean your surfaces with Prep-Sol again in preparation for the first primer coat. We use the polyester based Featherfill primer as a first coat. It may sound strange, but we actually apply the Featherfill with a paint brush. We find brushing on the first coat of primer fills the pinholes much better than spraying does. Don't worry about making this first coat pretty, most all of it will be sanded off anyway.

Step 4. The goal of the Featherfill was to fill the weave of the material and the scattered pinholes. Now you can sand most of the Featherfill away with 100 grit. Use a longboard sanding block or one of the sanding blocks that use 1/2 sheet of sandpaper. If there are low spots in the surface, here is where you'll start to see them.

Step 5. Blow off the surface with an air nozzle and clean with Prep-Sol. This next coat of primer should be the same brand as your color paint. Be sure of compatibility! We've found a few really good primers. The WLS system is a great primer, we used it on the Lancair IV prototype, but the white WLS paint we applied over it isn't sticking worth a darn, especially on the leading edges (We just tell people that the paint tends to burn off during reentry into the earth's atmosphere). We just tried the Superflite primer on the 320 and we're very happy with it's application and sanding properties. Whatever brand you use, spray on a good, thick coat.

Step 6. Sand the primer smooth with 180 grit. We usually wet sand at this point, the sandpaper is much more efficient when wet. This is where many builders start to run into trouble. They begin to paint on coat after coat of primer, only to sand off each coat they apply. They complain about the huge amount of time required to get a good finish on their planes. Well of course it takes a long time if you sand off every bit of primer you put on. They might as well use watercolors, it'd come off real quick when wet sanding. Anyway, you don't have to sand all the way through the primer coat you just applied. Sand until it's smooth and that's all. On the bottom of your plane, you may not want to apply any more primer if this coat has sanded smooth without sanding through. In this case, simply switch to 320 grit and finish it off, ready for the color coat.

Step 7. This is the best time to look for pinholes in your surfaces. Use the air nozzle to blow the dust off the smoothly sanded surface and out of the pinholes. We use Evercoat polyester glazing putty to fill pinholes, chips, and other boo boos. The lacquer glazing putties tend to shrink too much with age, as does Bondo. Use a putty knife, or squeegee, to force the putty into the pinholes. Lightly resand the pinholed areas after filling.

Step 8. Now clean all your surfaces and spray on what should be your last coat of primer. Use the same brand of primer as the previous coat. Use your judgement to decide if you need a thinner or thicker primer coat (usually this last coat is applied thinner). This primer coat should look pretty good, very evenly applied and few, if any, sandpaper scratches visible.

Step 9. Wet sand this last coat of primer with 360 grit. Some builders would cringe at this, saying that the last primer coats should be sanded down to at least 400 grit. We've found that 400 grit sands the surface just a bit too smooth, the paint doesn't have anything to grab onto. The last grit we used on the Lancair 320 repaint job was 320 grit (easy to remember, 320 on a 320) and the light gray color coat did not show any scratch marks.

Step 10. This is it! Blow off and clean all your surfaces thoroughly with Prep-Sol. Fill any remaining, pesky pinholes now or forever hold your peace. Use a tack rag, available at all automotive paint stores, to remove the dust and dirt from the surfaces. Congratulations, you're ready to paint.

Step 11. The best advice we can give you about painting the color coat on your aircraft is DON'T, at least not if you don't have the proper facility, tools and training. We convinced ourselves here at Neico that spraying the color coat on during the early dawn or dusk hours, with the pavement wetted down and no wind, would produce a lovely finish suitable for framing. It just doesn't work that way. Shooting the primer coats on in your back yard with a lousy spray gun is one thing, but getting a dust free, no runs, color coat is another. Seriously consider taking your plane to a paint shop. The Lancairs are perfectly suited for this because you can take the wings off and roll them anywhere. Having a professional shoot the color coat is not as expensive as you think IF you do all the preparation yourself. All the painter will have to do is shoot the color.

If you absolutely must spray the color on yourself, seek advice and assistance from a painter who could probably tell you ten times more than we could about painting.

Again, we're not saying this is the best, or even a standard process for finishing your Lancair, but it works for us. Sure, some of the parts may need an extra coat of primer, some edges may have to be puttied up and reprimered, but these are part of the joys of building your own plane, aren't they?