SECTION/OPERATION

1

STANDARD CONSTRUCTION PROCEDURES

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I. PROPER USE OF TOOLS

A. Drills and Reamers

1. It is preferred to use a "D" drill for drilling 1/4" AN bolt holes. 1/4" AN bolts are normally .003" undersize. A tighter fit can be obtained with a .246" letter "D" drill.

2. In order to drill a hole closer to the exact size, always start with a slightly smaller drill, then finish the hole with a freshly sharpened drill of the exact size.

3. Drills must be sharp when drilling through 4130 steel. If the drill is dull, it will heat the material rather than cut it. Once this has happened, the metal will harden and it will be almost impossible to make the drill cut through. In such a case, it will be necessary to heat the material with a torch until it is cherry red. Allow the material to cool completely before attempting to re-drill, this time with a sharp drill. (Do not quench.)

4. When attempting to drill 4130 steel, always use a slow drill speed and apply pressure.

5. A reamer may be used for final sizing a precision hole to within plus or minus .001". A good rule of thumb is to use half the speed for reaming that you do for drilling. Use plenty of oil.

6. To drill out a rivet, use a drill the size of the rivet. Start drilling in the center of the rivet head and rotate the drill in a circle until the head of the rivet comes off. Stop drilling and use a punch to remove the shank.

B. Torque Wrench

1. A Torque wrench is a must for precision assembly. If you do not already have one, purchase a 3/8" drive micrometer type and make sure that it has a scale on it marked in ft.lbs. The main blade retention bolts have the highest torque of any bolt on the ship and are torqued to 65-75 ft.lbs. Therefore, it is not necessary to have a torque wrench that reads over 100 ft.lbs. A heavier torque wrench will not give as accurate a reading at the low end of the scale (6 - 10 ft.lbs).

C. Dial Indicator

1. A dial indicator with a pointer which reads in .001" increments, along with a magnetic base and gooseneck to hold it, is an absolute must for main rotor blade rigging procedures. A dial indicator is also useful for checking shaft straightness. A shaft may be suspended from either end in "V" blocks. The point of the dial indicator is placed on the top of the shaft in the center. The total indicated reading (TIR) for a 360 degree rotation can be noted. In addition, a dial indicator is useful for checking relative height settings. Its main use on the EXEC 90 will be setting lead/lad adjustments on the main rotor system.

D. Dial Caliper

1. A 6" dial caliper with a needle travel of .100" per revolution is a very useful tool for checking precise lengths and thicknesses.

E. Protractor Level

1. A protractor level is used throughout the construction for rigging procedures and rotor system adjustments. A quality protractor level will read in increments of 1/2° or less. An electronic protractor is a good option. In order to check the quality of the level you are purchasing, zero the bubble and place it on a level surface. Rotate the level 180° to the surface and see if the bubble maintains its centered relationship. Also, the lines on each side of the bubble should be as close as possible to the end of the bubble.

II. **GAS WELDING 4130 STEEL**

A. During the construction of the controls, horizontal trim fins, engine clutch and tail rotor, there are some assemblies of 4130 steel which will be fabricated and welded (not in the Quick Kit). It is not necessary for a builder to do the actual welding on these components. One of the problems that we have seen frequently in this regard is that a builder will fabricate these components and drop them off to be welded at his local welding shop. Many times, the brackets are still not positioned properly when the builder picks up his assembly. It is suggested that you, the builder, pre-fabricate all of the components and position them in place either by tack welding them yourself or by having a friend tack weld them in place. Once the brackets are correctly located, take the assembly to the welding shop and ask the key question, "Are you familiar with welding thin wall 4130 steel material?"

Let them know you want them to use 1/16" diameter mild steel welding rod in the process. If they insist on heli-arc welding the part, it must be properly annealed. Ask if they are familiar with the proper annealing procedures for this material! Virtually any welding shop that has a gas welding outfit will agree to use it if you ask them.

If you are uncertain of the shop's capability, have them weld a couple of pieces of material together and inspect the weld prior to giving them your work. If you are uncertain exactly what the welds should look like, compare them to the welds on your factory welded airframe.

III. **WORKING WITH 4130 STEEL**

A. Bracketry

1. Cut all the bracketry to size using the template drawings supplied. If there is a grain direction specified on the template, paste the label on the material in that orientation.

2. Use a 24 teeth per inch hacksaw blade or a low speed bandsaw to cut out bracketry. Radius all internal corners smoothly with a rat-tail file. This will help stop cracking during the bending operation.

3. If a bracket is to be bent, hold it in a vise with aluminum jaws; or bend a piece of scrap, then bend the good part over the scrap material so that as you hammer the bracket around the scrap, it will follow the radius of the scrap piece. Check for cracking after you have formed the bend. Heat may be applied during the process for brackets over 1/16" (.062") in thickness.

IV. **GENERAL FITTING AND ALIGNMENT PROCEDURES**

A. Do not force bolts into holes that are undersized. Pass a sharp drill of the appropriate size through the hole first. Do not use excess force to drive a bolt in place with a hammer. Whatever you put together will at some time have to be taken apart. Bear this in mind as you complete the construction.

B. Fit shafts and mating parts carefully. If a bearing does not slide onto the appropriate shaft, do not hammer it in place (it's OK to tap lightly). Use 400 to 600 grit sandpaper to sand the shaft down slightly until the bearing fits. In most cases, there will only be small burrs which need to be removed.

C. There are three types of fits normally used in assembling shafts and bearings:

1. The press fit. A press fit is one which requires a press to install the bearing. It may take anywhere from one hundred to several hundred pounds of pressure to press the bearing on the shaft. RotorWay does not expect the builder to work with this type of fit because it will make assembly impossible for a builder in the field.

2. The slip fit. A slip fit is one in which the bearing may be rotated onto the shaft by hand. The inner race should be rotated as the bearing is slid on the shaft. It will take a little hand pressure to force on a slip fit; however, no other means but hands will need to be used. There are several slip fits used on the EXEC 90 helicopter. In each case, on final assembly, you will clean the surfaces and coat them with Loctite prior to installing the bearings. A slip fit plus Loctite results in a fit almost as permanent as a press fit.

3. The loose fit. A loose fit is one in which the bearing may be dropped onto the shaft and will slide in place. If this fit results in over .001" in airspace around the shaft circumference, it is too loose for a highly loaded operation, even with the use of Loctite.

D. How to Remove Loctited Bearings

1. Removing a bearing which has been Loctited in place will require heating the inner race of the bearing. A bearing puller should be installed on the bearing and some pressure applied to it. As the inner race is heated, the bearing will pop loose. Obviously, the bearing must be replaced on reassembly, as the seals will have been damaged during the heating process. Do not place heat directly on the shaft, only on the inner race of the bearing.

V. **AIRCRAFT (AN) HARDWARE**

A. Several types of hardware are used on RotorWay helicopters including standard AN hardware and various military specifications (MS). Do not substitute original hardware with a lesser strength material. Hardware store variety nuts and bolts are normally mild steel and are not heat treated. AN hardware is twice as strong as most mild steel bolts of the same size.

B. Elastic lock nuts are used with some AN hardware. The purpose of the elastic lock nut is to keep it from vibrating off. Never attempt to tap threads further on an AN bolt. It is acceptable to use up to 2 washers underneath the head of the bolt and the nut prior to going to the next shorter length of bolt. Every length of every size of AN hardware is very difficult to find, therefore the use of extra washers is occasionally necessary.

C. All bolts used as pivots or hinges in operation must use castellated nuts and cotter pins. (Examples: Swash plate scissor and tail rotor actuator arm). In this application the nut can not be tightened to a point where the bolt is not free to rotate. Elastic lock nuts are not approved for this application. The cotter pin should fit snug in the hole.

D. After you have tightened the elastic lock nuts, check to see that you have a minimum of 1 and a maximum of 3 threads showing. Nuts must not bottom out on the threads.

E. Use cheap hardware store bolts to hold components together during any welding processes so that you do not destroy the more costly AN hardware. Use the following torque specifications on 3/16" through 3/8" bolts unless otherwise noted in the construction drawings or photo sequence.

TORQUE

3/16".....4 ft. lbs.
1/4".....7 ft. lbs.
5/16".....12 ft. lbs.
3/8".....16 ft. lbs.

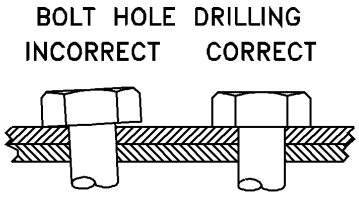
F. Make sure bolt holes are perpendicular (90 degrees) to the surface involved and are not oversized. A bolt in an incorrectly drilled hole will not carry its shear load until the surface that is in contact with the bolt has deformed. Contact Rotorway before drilling oversized or elongated holes in critical components, as there are many factors to be considered.
The bolt grip length is the unthreaded portion of the bolt shank and should always be correct. Normally the grip length is equal to that of the thickness being bolted together, though bolts of slightly longer length can be used along with washers.

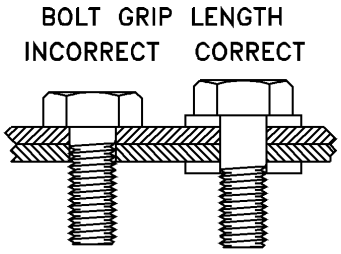
G. Ensure that washers are used under both heads of nuts and bolts unless otherwise specified. A washer guards against mechanical damage to the material and also helps prevent corrosion.

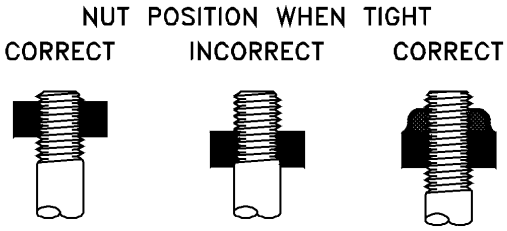
H. Never run a nut to the bottom of the bolt threads as it cannot be pulled tight and can possibly be twisted off when tightened. When elastic lock nuts are being used, one to three threads of the bolt should extend through the nut.

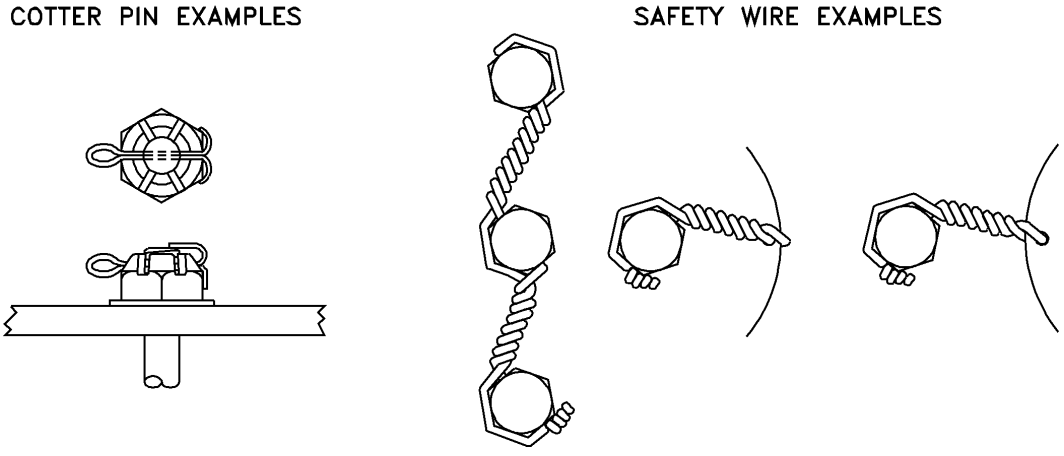
I. Do not use elastic lock nuts on bolts which have Cotter pin holes in the threaded end, as the sharp edge of the hole will cut the locking device rendering it ineffective.

H. It is important that any bolts or nuts, apart from the self-locking type, be safety fastened after installation, so as to prevent them vibrating loose during flight. Safety wiring is the most suitable approach and consists of two or more units being wired together, so that if one should come loose, its movement will be prevented by the others to which it is fastened.









VI. WORKING WITH ALUMINUM

A. .025" aluminum may be cut with left and right hand metal cutting shears. .050" may be cut with a bandsaw or hacksaw. The same rules apply for bending aluminum as for 4130 steel. If the radius is too sharp, the material may crack. .025" aluminum may be clamped in a vise against a board and bent around the end of the board. Sufficient sheet material has been supplied in the kit; take care to position the layout templates in such a manner that you use up the material effectively.

VII. WORKING WITH PLEXIGLASS

A. Use caution when handling the plexiglass windscreen. The edges of the windscreen should be immediately sanded smooth using 80 to 100 grit wet/dry sandpaper to prevent possible cracking during the handling process.

B. When a crack begins to form in plexiglass, immediately drill the end of the crack with a small drill (about 1/16" diameter) or the crack will propagate like a zipper. Before the windscreen is final installed, the screw holes will be drilled over-sized so that there is less bearing stress between the screws and the sides of the holes. The windscreen should be allowed to move slightly.

C. Clarity may be maintained in the windscreen by frequent polishing with mirror glaze.

D. The edge of the plexiglass material may be ground down with an air sander or a file and then sanded smooth. During any sanding process, be careful to support the material adequately in the area in which it is being worked. If you are using an air sander (2"-3" diameter), be especially careful.

VIII. WORKING WITH FIBERGLASS

WARNING: WHEN WORKING WITH FIBERGLASS, DO SO IN AN AREA WITH ADEQUATE VENTILATION.

A. Locate additional supplies, including: acetone, rubber squeegee, 1" to 2" wide brushes, and plenty of rags. Rubber gloves and eye protection should also be used.

B. MIX 20 drops of catalyst with 4 oz. of resin. The hotter the outside temperature, the less catalyst is used. The resin should not take more than 35 minutes to “kick”. Test a small sample to get a feel for what works best. (20 drops = 1/2cc).

C. All components which are fiberglassed to one another will use a layer of mat or cloth to bond the two surfaces together. Materials provided include 2 oz. mat and cloth. These may be used in two or four ply thickness as appropriate (one mat or one cloth equals one ply). Do not start any fiberglass process unless you have some acetone and rags on hand for clean up.

D. Prior to fiberglass application, prepare all surfaces by sanding and cleaning with acetone.

IX. WORKING WITH PLASTIC FILLER (Bondo)

A. Before bondo or fiberglass is applied to any surface, the surface must be sanded lightly and cleaned with acetone. The bondo material needs only a small amount of hardener, the material will "kick" within just a couple of minutes. Mix a small amount of material at one time. The material is best applied with a small rubber squeegee. The fastest method of finishing is to cut the bondo off with a "cheese grader" file as soon as it becomes firm. Finish to final configuration by hand sanding. The primary rule in using bondo is to not apply too much, so that the least amount of material needs to be removed before the next layer is applied. It is easy to mix another batch and apply more material but the sanding process is time consuming.

X. WIRING TECHNIQUES

A. Stripping and Soldering Procedures

1. Acquire the proper wire striping and crimping tools. You will need a small soldering gun or iron along with a roll of resin core solder. All attaching lugs should be crimped on the correctly stripped wire. Each must then be soldered in place. Shrink wrap is placed in the wire prior to soldering the connection so that it may be later moved into place and shrunk. Identify each wire as you lay out the wires in the wiring harness. Once all wires have been run, use a small wire tie to make a wiring bundle. At a later date, the harness will be able to be removed as a one piece unit. Follow the photo sequence for the wiring installation. Properly attached lugs and neat wire routing are a sign of quality construction. A continuity tester is necessary to properly test the completed wiring system. The wiring diagram is laid out as simply as possible so that even a novice who has never done wiring before can readily see where each wire goes and what size the wire is.

XI. **PAINTING AND FINISHING**

A. We recommend that you talk to a local aircraft painter or paint supplier to find out what preparation and material give best results in your climate. For instance, in some areas near the ocean, zinc-chromate primmer is required to protect aluminum from salt air. If you do not have much experience spraying paint, you may prefer to have a paint shop do the work for you. Following are our general recommendations:

Body, Tailcone and Main Rotor Blades:
primer as required
1 part Polyurethane paint

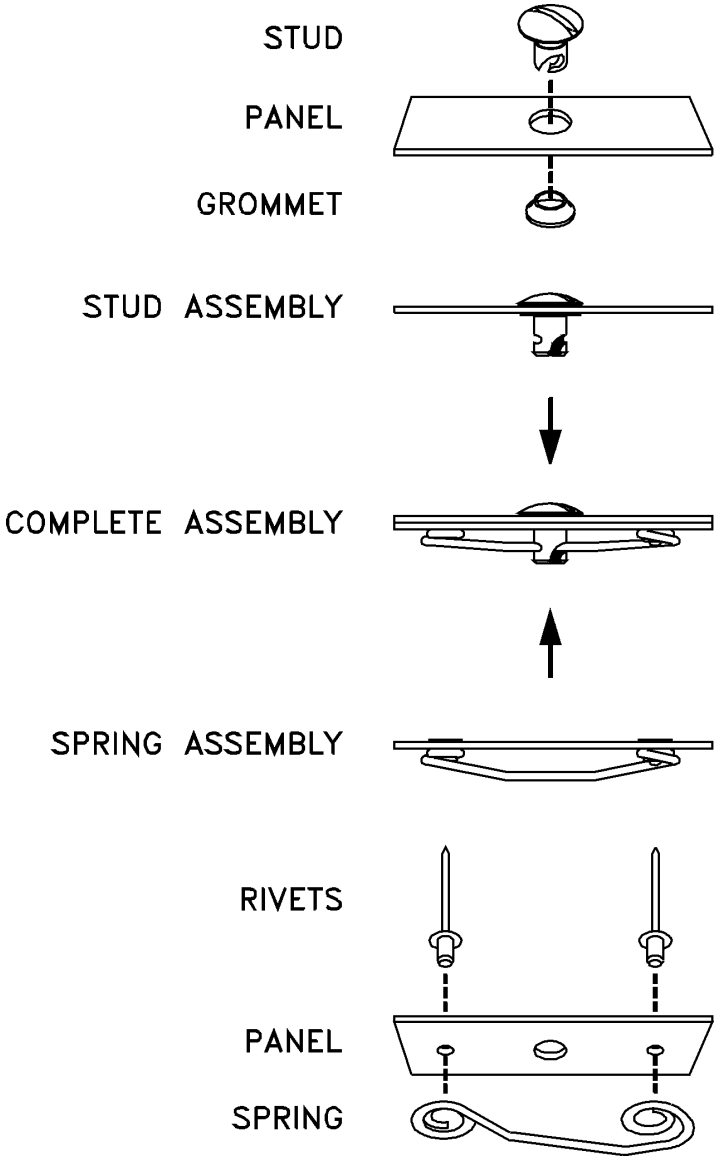
Airframe:
sandblast with fine grit sand
2 part epoxy paint

XII. **PLATING AND ANODIZING**

A. Contact RotorWay for recommendation of items that you want to plate or anodize. For example, a high stress item cannot be plated. Have the plating done ONLY by a company qualified to plate aircraft parts.

XIII. **DZUS FASTENERS AND NUT PLATES**

Dzus turnlock fasteners are composed of a stud, grommet and spring. The grommet is of aluminum alloy and is a holding device for the stud. The spring is cadmium plated steel (to prevent corrosion), its function is to supply a force, locking or securing the stud in place. Studs are steel, and are also cadmium plated. A quarter turn clockwise locks the fastener, while the counter clockwise direction unlocks, by the means of a Dzus key or screwdriver.



Nut Plates

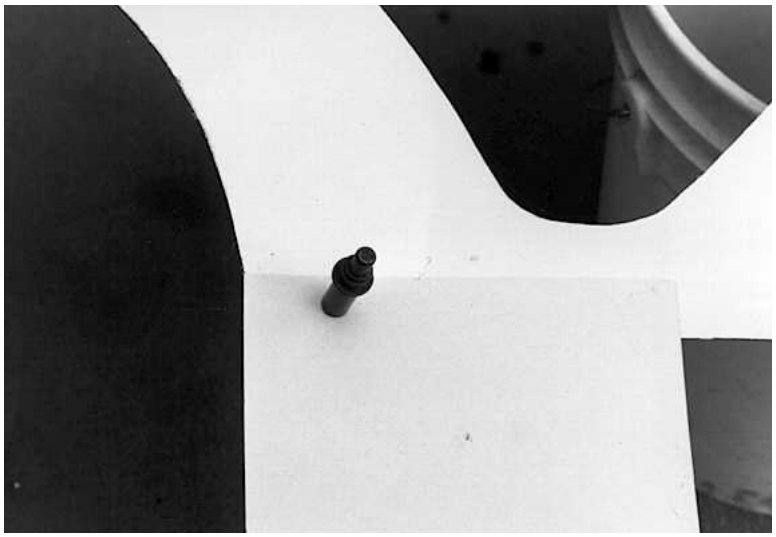


Photo #1

Two or more parts held together with cleco.

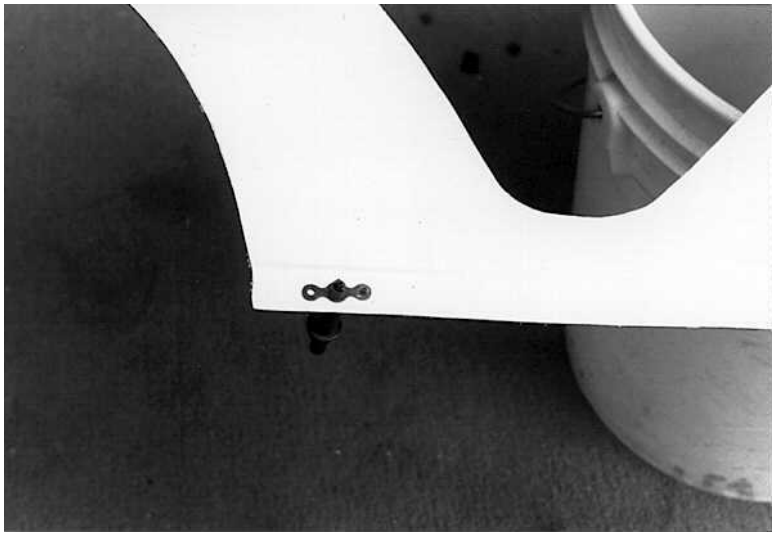


Photo #2

When installing a nut plate, use a cleco to hold the nut plate.

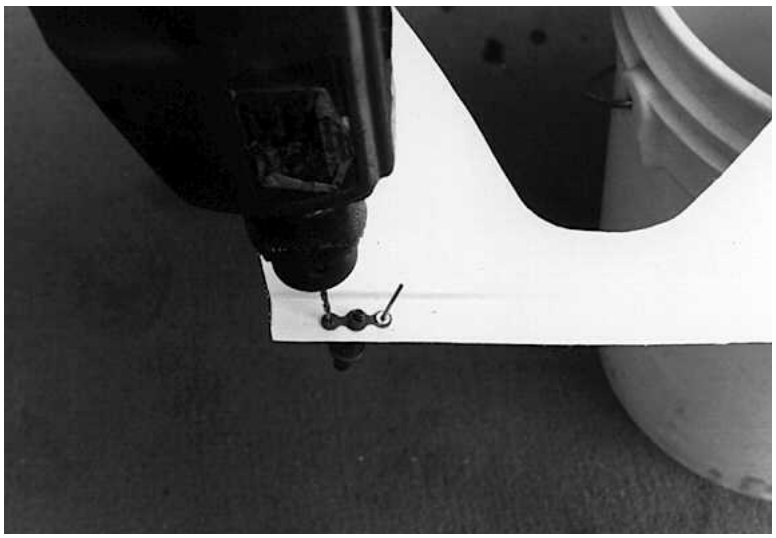


Photo #3

Use the nut plate as a template and drill the holes for the pop rivets.

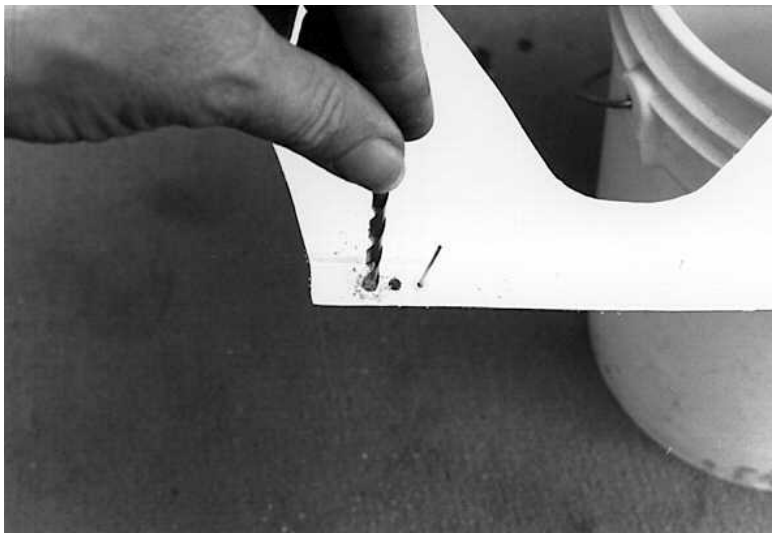


Photo #4

Using a large drill bit, countersink the holes for the pop rivets. Use a hand drill and open the hole for the size of screw or bolt to be used.

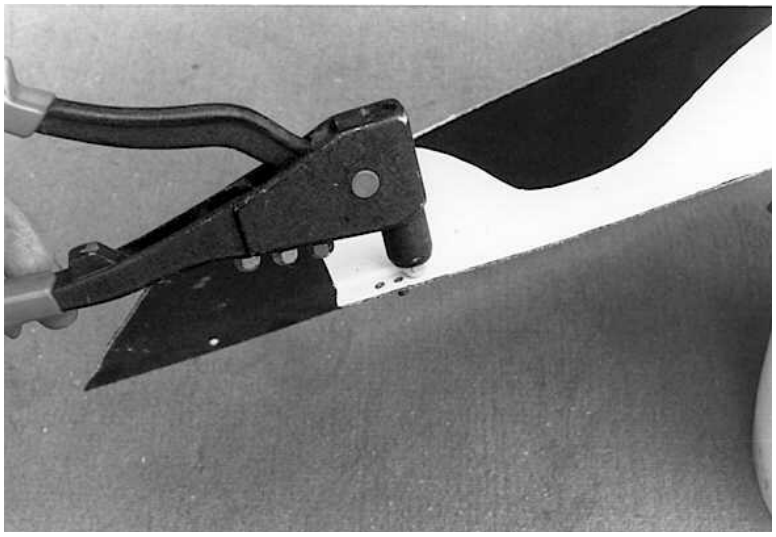


Photo #5

Use a pop rivet gun and install the nut plate rivets.

Photo #6

When installing several nut plates, it is recommended to make a drill template from a flat strip of metal, 1-3/4" wide and 6" long. Drill a hole in the center close to one end for the size of screw being used. Screw on a nut plate and use the nut plate as a template to locate the pop rivet holes.

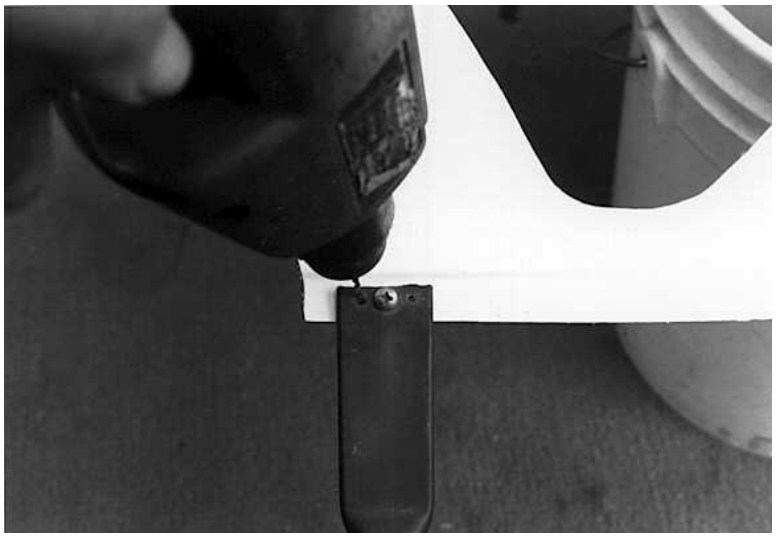


Photo #7

Remove the nut plate, glue the screw in the hole and use the template to drill the pop rivet holes.

Dzus Buttons

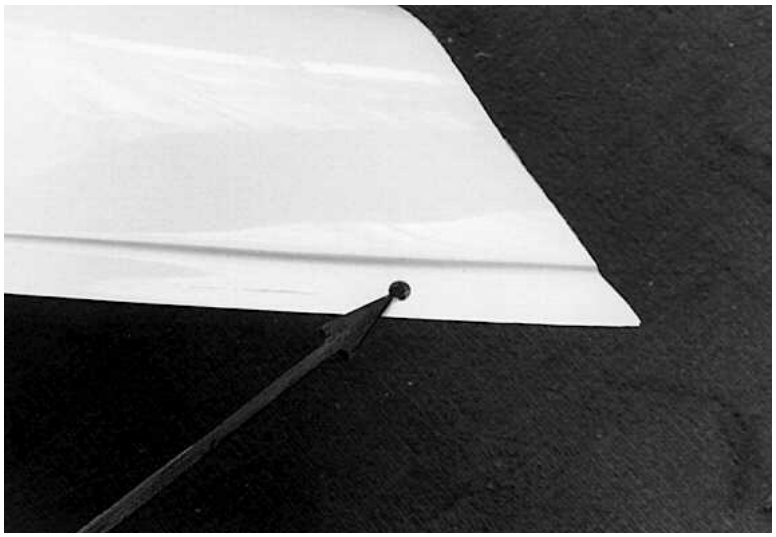


Photo #8

Use a hand drill and open the 1/8" hole to 5/16" for the Dzus button.

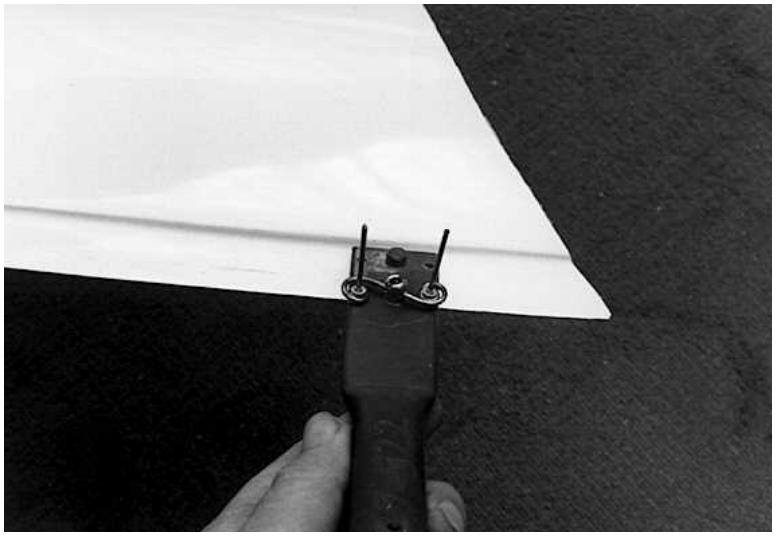


Photo #9

Make a drill template from a strip of flat metal, 1-3/4" wide and about 6" long. Drill a 5/16 " hole, centered widthwise, close to one end. Install a Dzus button in the hole and place the spring on the back of the strip, parallel to the end. Use the spring to locate and drill two holes for the 1/8" pop rivets. Remove the Dzus button and spring, and install a rod in the 5/16" hole. (Use a short 5/16" bolt with the thread sawed off if you do not have anything else.)

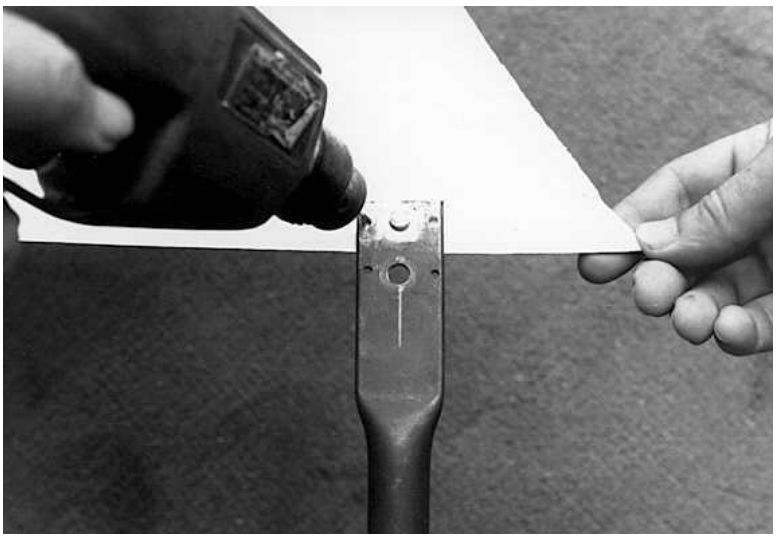


Photo #10

Use the drill template to drill the 1/8" pop rivet holes.

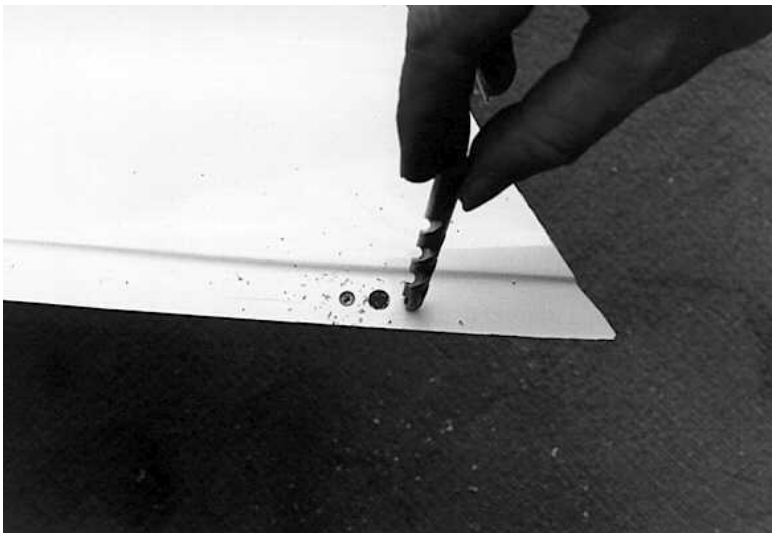


Photo #11

Use a large drill bit to countersink the 1/8" pop rivet holes.

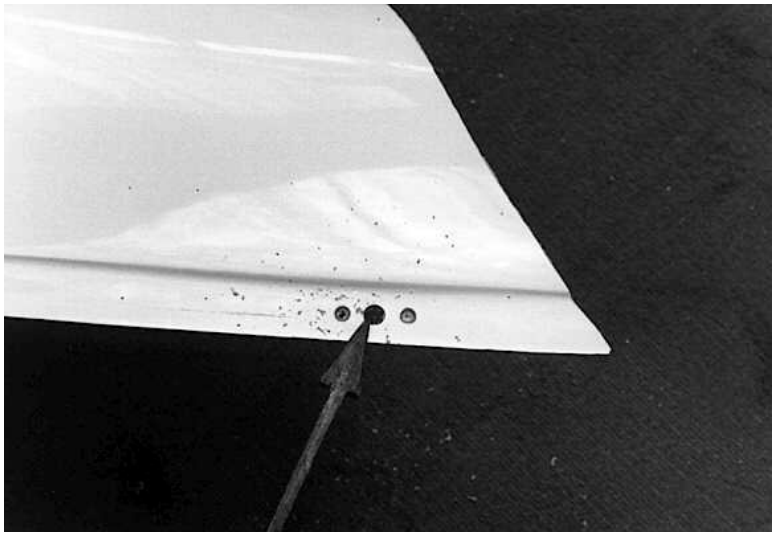


Photo #12

Use a hand drill and a 3/8" bit to open the Dzus button hole. Then install the spring wire with pop rivets.

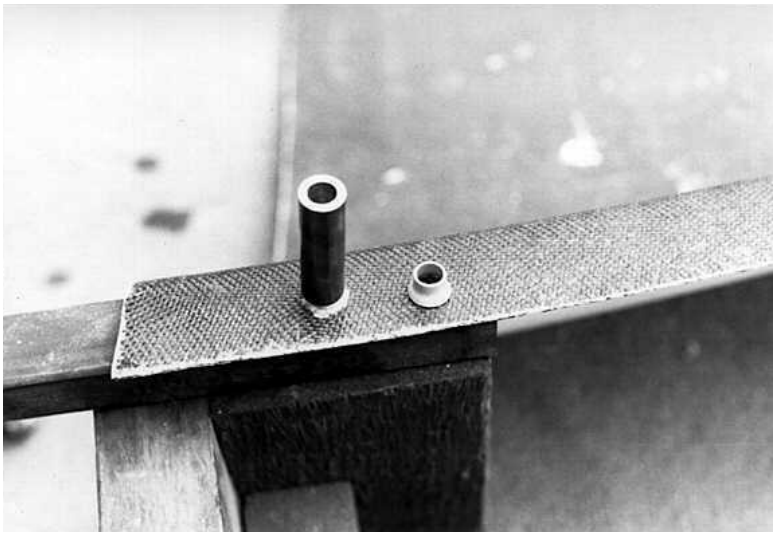


Photo #13

Use a hand drill and a 3/8" bit to open the hole for the grommet. Install the grommet with the large end on the same side that the head of the button will be on. Place it on a hard surface with the pointed end of the tool toward the grommet. Hammer to expand the small end.

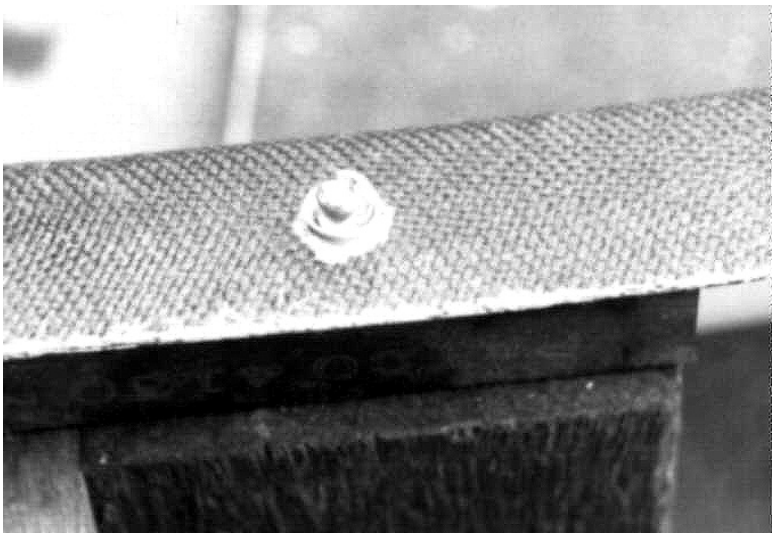


Photo #14

Install the Dzus button.

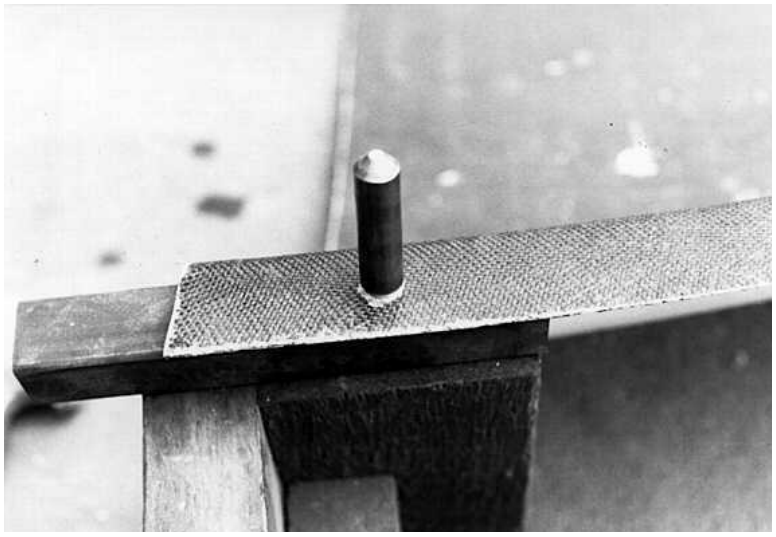


Photo #15

Place the head of the Dzus button on a hard surface, and place the open end of the tool over the shank of the Dzus button. Hit the pointed end of the tool to lock the Dzus button to the grommet.

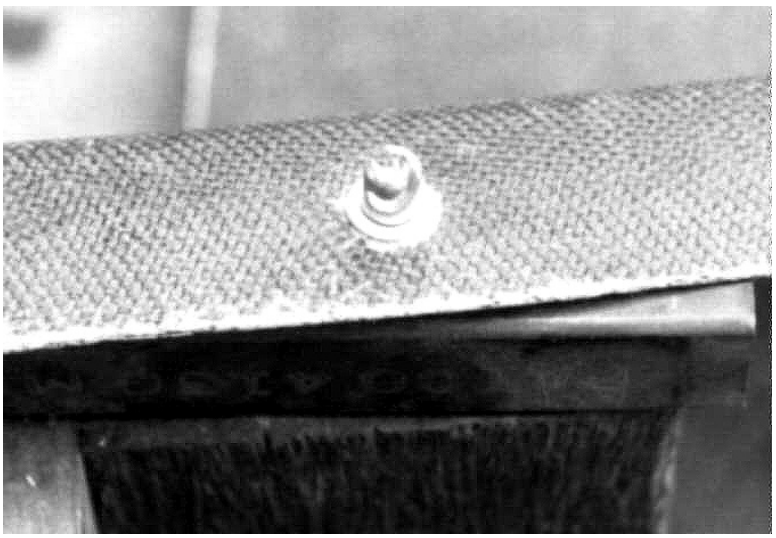


Photo #16

Remove the tool and check for even compression of the grommet.

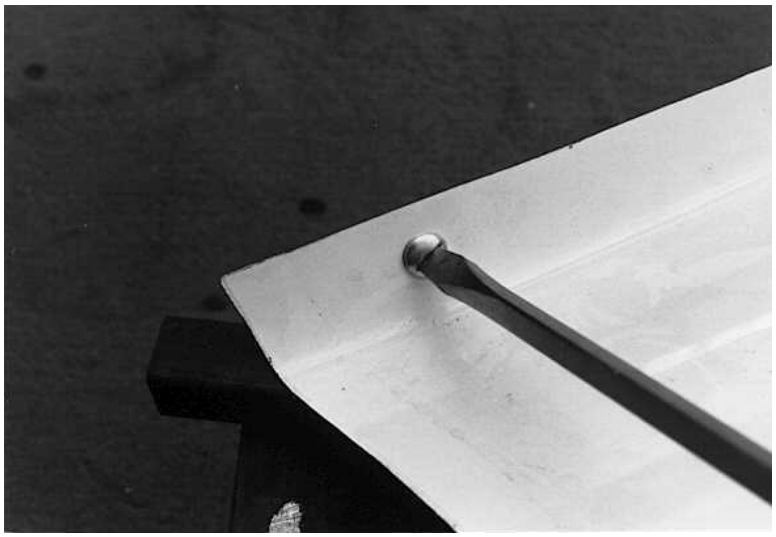


Photo #17

Use a screwdriver to turn and free up the Dzus button.

REFERENCE: An excellent reference book on standard construction procedures, equipment and some miscellaneous details is the *STANDARD AIRCRAFT HANDBOOK* by AERO PUBLISHERS.
Editors: STUART LEAVELL & STANLEY BUNGAY.
AERO PUBLISHERS,INC., 329 Aviation Rd., Fallbrook, CA 92028.